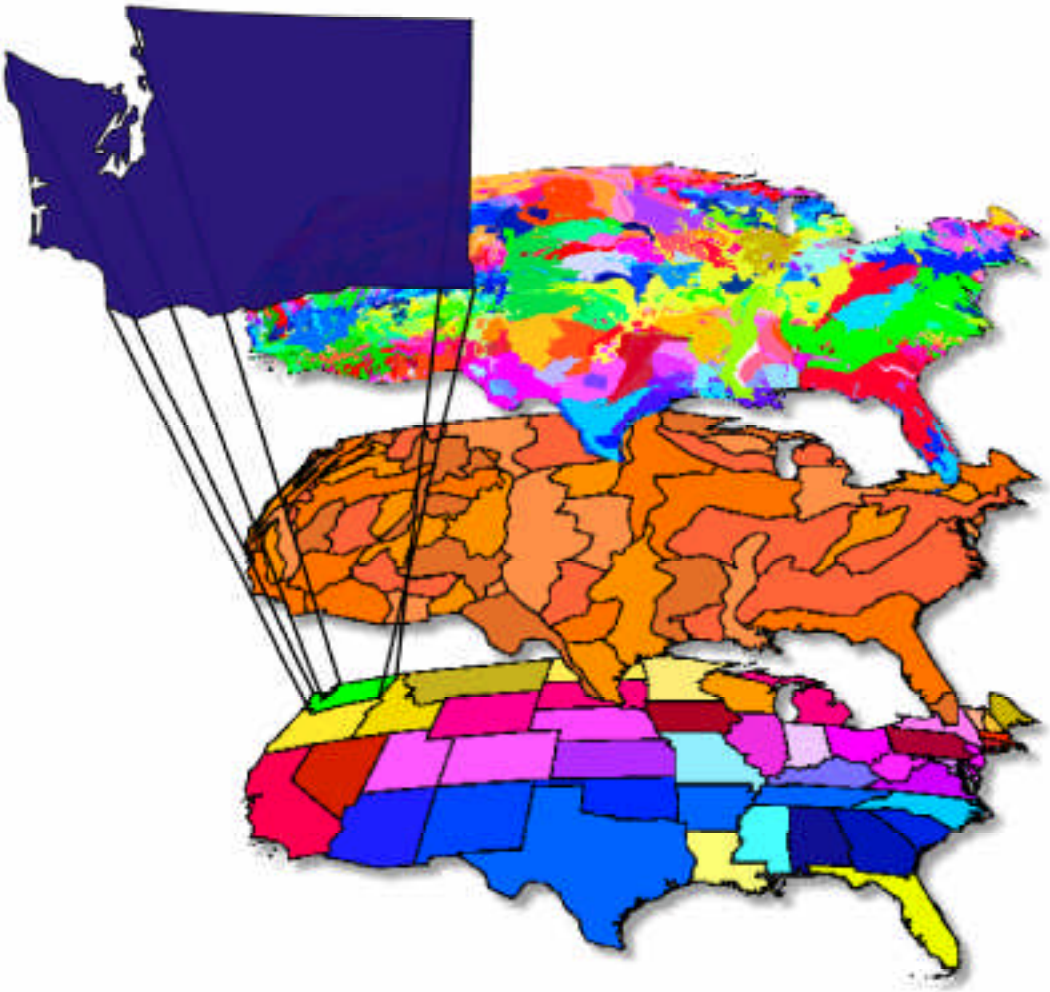
USGS
science for a changing world

A GAP ANALYSIS OF WASHINGTON

G
A
P

1997 Final Report



A GEOGRAPHIC APPROACH TO PLANNING FOR BIOLOGICAL DIVERSITY

U.S. Department of the Interior
U.S. Geological Survey

GAP ANALYSIS OF WASHINGTON STATE
An Evaluation of the Protection of Biodiversity

Washington State Gap Analysis Final Report
Volume 5
1997

Kelly M. Cassidy
Michael R. Smith
Christian E. Grue
Karen M. Dvornich
Jane E. Cassady
Kelly R. McAllister
Richard E. Johnson

Contract Administration Through:
Idaho Cooperative Fish and Wildlife Research Unit
College of Forestry, Wildlife & Range Sciences
University of Idaho
Moscow, ID 83844-1136

Submitted by:
Washington Cooperative Fish and Wildlife Research Unit
Box 357980
University of Washington
Seattle WA 98195
206-543-6475

Research Performed Under:
Cooperative Agreement No. 14-16-0009-1571
Research Work Order No. 13

CITATION

Citation for this volume:

Cassidy, K. M., M. R. Smith, C. E. Grue, K. M. Dvornich, J. E. Cassady, K. R. McAllister, and R. E. Johnson. 1997. Gap Analysis of Washington State: An evaluation of the protection of biodiversity. Volume 5 *in* Washington State Gap Analysis - Final Report (K. M. Cassidy, C. E. Grue, M. R. Smith, and K. M. Dvornich, eds.). Washington Cooperative Fish and Wildlife Research Unit, University of Washington, Seattle, 192 pp.

Citation for the entire report:

Cassidy, K. M., C. E. Grue, M. R. Smith, and K. M. Dvornich, eds. 1997. Washington State Gap Analysis - Final Report. Washington Cooperative Fish and Wildlife Research Unit, University of Washington, Seattle, Volumes 1-5.

Citations for other volumes:

Volume 1: Cassidy, K. M. 1997. Land cover of Washington State: Description and management. Volume 1 *in* Washington State Gap Analysis - Final Report (K. M. Cassidy, C. E. Grue, M. R. Smith, and K. M. Dvornich, eds.). Washington Cooperative Fish and Wildlife Research Unit, University of Washington, Seattle, 270 pp.

Volume 2: Dvornich, K. M., K. R. McAllister, and K. B. Aubry. 1997. Amphibians and reptiles of Washington State: Location data and predicted distributions. Volume 2 *in* Washington State Gap Analysis - Final Report (K. M. Cassidy, C. E. Grue, M. R. Smith, and K. M. Dvornich, eds.). Washington Cooperative Fish and Wildlife Research Unit, University of Washington, Seattle, 146 pp.

Volume 3: Johnson, R. E., and K. M. Cassidy. 1997. Mammals of Washington State: Location data and predicted distributions. Volume 3 *in* Washington State Gap Analysis - Final Report (K. M. Cassidy, C. E. Grue, M. R. Smith, and K. M. Dvornich, eds.). Washington Cooperative Fish and Wildlife Research Unit, University of Washington, Seattle, 304 pp.

Volume 4: Smith, M. R., P. W. Mattocks, Jr., and K. M. Cassidy. 1997. Breeding birds of Washington State: Location data and predicted distributions. Volume 4 *in* Washington State Gap Analysis - Final Report (K. M. Cassidy, C. E. Grue, M. R. Smith, and K. M. Dvornich, eds.). Seattle Audubon Society Publications in Zoology No. 1, Seattle, 538 pp.

Copyright 1997

DEDICATION

"Congress always makes liberal appropriations for the investigation of the flora and fauna, and the mineral indications, as well as the water supply or rainfall, in the territories, and in the desert portions of the United States. Rugged old Ben Wade, while a Senator from Ohio, always opposed these appropriations as a waste of the people's money in what he styled, bug-hunting expeditions." Orange Jacobs, a lawyer and 19th century pioneer in Washington State. (Jacobs 1908, p. 64).

We dedicate this report to all the "bug hunters" of Washington State, past and present.

ACKNOWLEDGMENTS

We thank Ted LaRoe and Reid Goforth and the staff of the headquarters of the Cooperative Research Units for their administration of GAP; Doyle Frederick and John Mosesso of the National Biological Service' s (NBS) Office of Inventory and Monitoring, who have been extremely supportive of the national program, especially during its transition from the US Fish and Wildlife Service (USFWS) to the NBS (which recently became the Biological Resources Division of the US Geological Survey [USGS]); and Amos Eno and the staff of the National Fish and Wildlife Foundation, who funded the early development of GAP. Thanks also to the National Gap Analysis Program, specifically Patrick Crist, Blair Csuti, Michael Jennings, and J. Michael Scott for their support of the Washington Gap Analysis Project.

We offer special thanks to the many cooperators of, and contributors to, the Washington State Gap Analysis Project, including the Washington Department of Fish and Wildlife, Washington Department of Natural Resources, Digital Image Analysis Laboratory of Washington State University (especially Steve Gill and Dave Wherry), Center for Quantitative Sciences and the Long-Term Ecological Research GIS laboratory at the University of Washington, Seattle Audubon Society, US Forest Service, US Fish and Wildlife Service, Breeding Bird Atlas volunteers, David Manuwal (for help with the bird analysis), the numerous individuals who supplied land cover data, and the many museums that supplied data. Individuals that contributed to specific parts of the project are acknowledged in the relevant volume. Individuals that contributed to general aspects of the project included Anne Avery, Susan Fregien, Barbara Funke, James Grassley, and Greg Stought.

Financial support for the Washington Gap Analysis Project was provided by the US Department of the Interior (USFWS, NBS, and USGS), the Washington Department of Fish and Wildlife, the Washington Department of Natural Resources, and the University of Washington through the Washington Cooperative Fish and Wildlife Research Unit, School of Fisheries, University of Washington, Seattle.

TABLE OF CONTENTS

CITATION ..... **III**

DEDICATION ..... **V**

ACKNOWLEDGMENTS ..... **VI**

TABLE OF CONTENTS ..... **VII**

LIST OF TABLES ..... **X**

LIST OF FIGURES ..... **XII**

LIST OF MAPS ..... **XIII**

EXECUTIVE SUMMARY ..... **XV**

OBJECTIVES XV
METHODS XV
RESULTS XVII
MANAGEMENT CONSIDERATIONS AND RECOMMENDATIONS XXII
Highest Conservation Priorities xxii
Moderately High Priorities xxiii
The Role of Status 3 and Status 4 Lands xxiv

INTRODUCTION **1**

THE GAP ANALYSIS CONCEPT 1
OBJECTIVES 2
GENERAL LIMITATIONS 2
STUDY AREA 3
HOW THIS REPORT IS ORGANIZED 4

LAND COVER CLASSIFICATION AND MAPPING **5**

INTRODUCTION 5
LAND COVER CLASSIFICATION 5
METHODS 6
Overview 6
Imagery Acquisition 6
The Land Cover Classification Scheme for Washington 6
Map Development 8
Calculation of Cover Class Areas 10
Map Editing 10
For More Information 10
RESULTS 19
Steppe Zones 19
East-side Forest Zones 22
West-side Forest Zones 25
High-elevation Zones 28
Statewide Statistics 29
ACCURACY ASSESSMENT 29

LIMITATIONS AND DISCUSSION....30

PREDICTED ANIMAL DISTRIBUTIONS AND SPECIES RICHNESS....31

INTRODUCTION....31
METHODS....31
Overview....31
Record Collection....31
Habitat Association....34
Habitat Quality Coding....35
Selection of At-risk Species....35
RESULTS....36
Sample Maps and Complete Atlases....36
The Effect of Habitat Quality on Richness Maps....36
Amphibians....37
Reptiles....37
Mammals....38
Birds....41
ACCURACY ASSESSMENT....48
LIMITATIONS AND DISCUSSION....49
The Subjective Nature of Habitat Quality Coding....49
The Effects of Land Cover Mapping Error and Resolution on Vertebrate Models....49
Scale Limitations....50

LAND STEWARDSHIP AND CONSERVATION STATUS....51

INTRODUCTION....51
METHODS....52
Public Stewardship Cover....52
Conservation Status....52
RESULTS....53
LIMITATIONS AND DISCUSSION....56

ANALYSIS BASED ON STEWARDSHIP AND MANAGEMENT STATUS....57

INTRODUCTION....57
LAND COVER ANALYSIS....57
Description of the Land Cover Analysis Tables....58
Stewardship Analysis....78
Conservation Status Analysis....78
Conservation Priority Index (CPI)....79
The Role of Status 3 and Status 4 Lands....84
LIMITATIONS OF LAND COVER ANALYSIS....85
PREDICTED SPECIES DISTRIBUTIONS ANALYSIS....86
Description of the Species Distributions Analysis Tables....86
Distribution versus Percent Representation....86
Conservation Status of Individual Species and Selected Assemblages....118
Vertebrate Richness and Location of Status 1 and 2 Lands....120
The Role of Status 3 and Status 4 Lands....122
Special Features Analysis....123
Analysis of Statewide Endemics....123
Individual Species Analysis....123
Ecoregional Analysis....131
LIMITATIONS AND DISCUSSION....133

CONCLUSIONS AND MANAGEMENT IMPLICATIONS....135

HIGHEST CONSERVATION PRIORITIES....135

Steppe Zones and Columbia Basin-dependents....135
The Puget-Willamette Trough Zones....136
MODERATELY HIGH PRIORITIES....136
The Ponderosa Pine and Oak Zones....136
The Sitka Spruce and Western Hemlock Zones....137
THE ROLE OF STATUS 3 AND STATUS 4 LANDS....137

DATA USE AND AVAILABILITY....139

HOW TO OBTAIN THE DATA....139
Hard-copy....139
Digital Data Sets....139
Minimum GIS Required for Data Use....140
DISCLAIMER....140
METADATA....140
APPROPRIATE USES....127

LITERATURE CITED....143

ABBREVIATIONS....146

GLOSSARY OF TERMS....147

GLOSSARY OF ACRONYMS....150

APPENDIX (EFFECT OF NAPS AND NRCAS ON ANALYSIS)....151

MAPS....155

LIST OF TABLES

TABLE 1: SATELLITE THEMATIC MAPPER (TM) SCENES USED FOR WASHINGTON. 11
TABLE 2: ECOREGIONS OF WASHINGTON STATE 12
TABLE 3: VEGETATION ZONES OF WASHINGTON STATE. 13
TABLE 4: PRIMARY, SECONDARY, AND TERTIARY COVER CLASSES 15
TABLE 5: LAND COVER (AS A PERCENTAGE OF ZONE) FOR STEPPE ZONES. 20
TABLE 6: LAND COVER (IN HECTARES) OF STEPPE ZONES. 21
TABLE 7: LAND COVER (AS A PERCENTAGE OF ZONE) OF EAST-SIDE FOREST ZONES 23
TABLE 8: LAND COVER (IN HECTARES) OF EAST-SIDE FOREST ZONES 24
TABLE 9: LAND COVER (AS A PERCENTAGE OF ZONE) OF WEST-SIDE FOREST ZONES 26
TABLE 10: LAND COVER (IN HECTARES) OF WEST-SIDE FOREST ZONES 27
TABLE 11: LAND COVER OF HIGH-ELEVATION ZONES. 28
TABLE 12: LAND COVER STATEWIDE. 29
TABLE 13: CONSERVATION STATUS CATEGORIES AND MANAGING ENTITIES. 54
TABLE 14: CONSERVATION STATUS OF STEPPE ZONES (PERCENT). 59
TABLE 15: CONSERVATION STATUS OF STEPPE ZONES (HECTARES). 59
TABLE 16: CONSERVATION STATUS OF EAST-SIDE FOREST ZONES (PERCENT) 60
TABLE 17: CONSERVATION STATUS OF EAST-SIDE FOREST ZONES (HECTARES) 60
TABLE 18: CONSERVATION STATUS OF WEST-SIDE FOREST ZONES (PERCENT) 61
TABLE 19: CONSERVATION STATUS CATEGORIES OF WEST-SIDE FOREST ZONES (HECTARES) 61
TABLE 20: CONSERVATION STATUS OF HIGH-ELEVATION ZONES (PERCENT). 62
TABLE 21: CONSERVATION STATUS OF HIGH-ELEVATION ZONES (HECTARES). 62
TABLE 22: STATEWIDE CONSERVATION STATUS. 62
TABLE 23: CONSERVATION STATUS AND STEWARDSHIP OF THE BLUE MOUNTAINS STEPPE ZONE. 63
TABLE 24: CONSERVATION STATUS AND STEWARDSHIP OF THE PALOUSE ZONE. 63
TABLE 25: CONSERVATION STATUS AND STEWARDSHIP OF THE THREE-TIP SAGE ZONE. 64
TABLE 26: CONSERVATION STATUS AND STEWARDSHIP OF THE KLICKITAT MEADOW STEPPE ZONE. 64
TABLE 27: CONSERVATION STATUS AND STEWARDSHIP OF THE BITTERBRUSH ZONE 64
TABLE 28: CONSERVATION STATUS AND STEWARDSHIP OF THE CENTRAL ARID STEPPE ZONE. 65
TABLE 29: CONSERVATION STATUS AND STEWARDSHIP OF THE WHEATGRASS/FESCUE ZONE. 66
TABLE 30: CONSERVATION STATUS AND STEWARDSHIP OF THE CANYON GRASSLAND ZONE 66
TABLE 31: CONSERVATION STATUS AND STEWARDSHIP OF THE BIG SAGE/FESCUE ZONE 66
TABLE 32: CONSERVATION STATUS AND STEWARDSHIP OF THE OAK ZONE 67
TABLE 33: CONSERVATION STATUS AND STEWARDSHIP OF THE PONDEROSA PINE ZONE 67
TABLE 34: CONSERVATION STATUS AND STEWARDSHIP OF THE INTERIOR DOUGLAS-FIR ZONE 68
TABLE 35: CONSERVATION STATUS AND STEWARDSHIP OF THE GRAND FIR ZONE 68
TABLE 36: CONSERVATION STATUS AND STEWARDSHIP OF THE COMBINED INTERIOR WESTERN HEMLOCK AND INTERIOR REDCEDAR ZONES. 69
TABLE 37: CONSERVATION STATUS AND STEWARDSHIP OF THE SUBALPINE FIR ZONE 69
TABLE 38: CONSERVATION STATUS AND STEWARDSHIP OF THE BLUE MOUNTAINS HIGH OPEN FOREST ZONE. 70
TABLE 39: CONSERVATION STATUS AND STEWARDSHIP OF THE BLUE MOUNTAINS HIGH BASALT RIDGES ZONE. 71
TABLE 40: CONSERVATION STATUS AND STEWARDSHIP OF THE LOW-ELEVATION LAVA FLOW ZONE. 71
TABLE 41: CONSERVATION STATUS AND STEWARDSHIP OF THE HIGH-ELEVATION LAVA FLOW ZONE 71
TABLE 42: CONSERVATION STATUS AND STEWARDSHIP OF THE WILLAMETTE VALLEY ZONE. 71
TABLE 43: CONSERVATION STATUS AND STEWARDSHIP OF THE COWLITZ RIVER ZONE. 72
TABLE 44: CONSERVATION STATUS AND STEWARDSHIP OF THE WOODLAND/PRAIRIE MOSAIC ZONE 72
TABLE 45: CONSERVATION STATUS AND STEWARDSHIP OF THE PUGET SOUND DOUGLAS-FIR ZONE 73
TABLE 46: CONSERVATION STATUS AND STEWARDSHIP OF THE SITKA SPRUCE ZONE 74

TABLE 47: CONSERVATION STATUS AND STEWARDSHIP OF THE OLYMPIC DOUGLAS-FIR ZONE 74
TABLE 48: CONSERVATION STATUS AND STEWARDSHIP OF THE WESTERN HEMLOCK ZONE 75
TABLE 49: CONSERVATION STATUS AND STEWARDSHIP OF THE SILVER FIR ZONE 76
TABLE 50: CONSERVATION STATUS AND STEWARDSHIP OF THE MOUNTAIN HEMLOCK ZONE 76
TABLE 51: CONSERVATION STATUS AND STEWARDSHIP OF THE ALPINE/PARKLAND ZONE 77
TABLE 52: CONSERVATION STATUS AND STEWARDSHIP OF THE PERMANENT ICE/SNOW ZONE 77
TABLE 53: CONSERVATION PRIORITY INDEX (CPI) FOR EACH ZONE. 82
TABLE 54: AMPHIBIAN SPECIES DISTRIBUTION ANALYSIS. 87
TABLE 55: REPTILE SPECIES DISTRIBUTION ANALYSIS. 89
TABLE 56: MAMMAL SPECIES DISTRIBUTION ANALYSIS. 90
TABLE 57: BIRD SPECIES DISTRIBUTION ANALYSIS. 97

LIST OF FIGURES

FIGURE 1. LAND COVER CLASSIFICATION SCHEME FOR WASHINGTON STATE. 17
FIGURE 2. DISTRIBUTION VERSUS REPRESENTATION ON STATUS 1 OR 2 LANDS - AMPHIBIANS 114
FIGURE 3. DISTRIBUTION VERSUS REPRESENTATION ON STATUS 1 OR 2 LANDS - REPTILES 115
FIGURE 4. DISTRIBUTION VERSUS REPRESENTATION ON STATUS 1 OR 2 LANDS - MAMMALS 116
FIGURE 5. DISTRIBUTION VERSUS REPRESENTATION ON STATUS 1 OR 2 LANDS - BIRDS 117

LIST OF MAPS

Map Title	Map Number
ECOREGIONS	1
VEGETATION ZONES	2
LAND COVER, VERSION 6	3
RECORD LOCATIONS FOR HERPETOFAUNA	4
MAMMAL RECORD FREQUENCY BY TOWNSHIP/RANGE	5
NUMBER OF BIRD SPECIES RECORDED AT THE 'POSSIBLE BREEDING LEVEL'	6
SAMPLE HERPETOFAUNA MAP	7
SAMPLE MAMMAL MAP	8
SAMPLE BIRD MAP	9
RICHNESS OF AMPHIBIAN SPECIES, GOOD HABITATS, CORE ZONES	10
RICHNESS OF REPTILE SPECIES, GOOD HABITATS, CORE ZONES	11
RICHNESS OF MAMMAL SPECIES, GOOD HABITATS, CORE ZONES	12
RICHNESS OF BIRD SPECIES, GOOD HABITATS, CORE ZONES	13
RICHNESS OF AMPHIBIAN SPECIES, ALL HABITATS, ALL ZONES	14
RICHNESS OF REPTILE SPECIES, ALL HABITATS, ALL ZONES	15
RICHNESS OF MAMMAL SPECIES, ALL HABITATS, ALL ZONES	16
RICHNESS OF BIRD SPECIES, ALL HABITATS, ALL ZONES	17
RICHNESS OF AMPHIBIANS MOST AT-RISK FROM HUMAN ACTIVITIES	18
RICHNESS OF REPTILES MOST AT-RISK FROM HUMAN ACTIVITIES	19
RICHNESS OF INSECTIVORA	20
RICHNESS OF CHIROPTERA	21
RICHNESS OF LAGOMORPHS	22
RICHNESS OF CARNIVORA	23
RICHNESS OF ARTIODACTYLA	24
RICHNESS OF RODENTIA	25
RICHNESS OF INTRODUCED MAMMAL SPECIES	26
RICHNESS OF COLUMBIA BASIN-DEPENDENT MAMMALS	27
RICHNESS OF MAMMALS MOST AT-RISK FROM HUMAN ACTIVITIES	28
RICHNESS OF NON-PASSERINE SPECIES	29
RICHNESS OF PASSERINE SPECIES	30
RICHNESS OF SWIMMING BIRD SPECIES	31
RICHNESS OF WADING BIRD SPECIES	32
RICHNESS OF DIURNAL RAPTOR SPECIES	33
RICHNESS OF OWL SPECIES	34
RICHNESS OF WOODPECKER SPECIES	35
RICHNESS OF FLYCATCHER SPECIES	36
RICHNESS OF GLEANER SPECIES	37
RICHNESS OF FINCH SPECIES	38
RICHNESS OF SPARROW SPECIES	39
RICHNESS OF BIRD SPECIES WITH MOST OF THEIR RANGES EAST OF THE CASCADE CREST	40
RICHNESS OF BIRD SPECIES WITH MOST OF THEIR RANGES WEST OF THE CASCADE CREST	41
RICHNESS OF BIRD SPECIES WITH MOST OF THEIR RANGES WITHIN THE COLUMBIA BASIN	42
RICHNESS OF BIRD SPECIES LARGELY DEPENDENT ON THE PRESENCE OF SAGEBRUSH	43
RICHNESS OF BIRDS MOST AT-RISK FROM HUMAN ACTIVITIES	44
RICHNESS OF NEOTROPICAL MIGRANTS	45
MAJOR PUBLIC LAND OWNERSHIP	46
CONSERVATION STATUS CATEGORIES	47

VEGETATION ZONES RANKED BY CONSERVATION PRIORITY INDEX 48
VEGETATION ZONES RANKED BY CONSERVATION PRIORITY INDEX, EXCLUDING CONVERTED LANDS....49
CONSERVATION STATUS OF AREAS OF HIGHEST NATIVE AMPHIBIAN SPECIES RICHNESS 50
CONSERVATION STATUS OF AREAS OF HIGHEST NATIVE REPTILE SPECIES RICHNESS 51
CONSERVATION STATUS OF AREAS OF HIGHEST NATIVE MAMMAL SPECIES RICHNESS 52
CONSERVATION STATUS OF AREAS OF HIGHEST NATIVE BIRD SPECIES RICHNESS 53
CONSERVATION STATUS OF AREAS OF HIGHEST AT-RISK SPECIES RICHNESS 54

EXECUTIVE SUMMARY

Objectives

The objectives of the Washington State Gap Analysis Project (WAGAP) were to map land cover; model the distributions of terrestrial vertebrates; identify land cover types, vertebrate species, and areas of high vertebrate species richness inadequately represented on protected areas; and make these data available to users in a readily accessible format. To achieve the latter, data and results are reported in both a hard-copy and digital format. The hard-copy format is a five volume report. Volume 1 is a description of current land cover and its conservation status. Volumes 2, 3, and 4 are atlases for herpetofauna, mammals, and birds, respectively. This volume, Volume 5, is a summary and analysis of the information presented in the first four volumes, with our conclusions concerning conservation priorities.

Methods

To facilitate land cover classification, vertebrate modeling, and analysis, we divided the state into 13 ecoregions and 31 vegetation zones. Ecoregions are contiguous areas of generally similar climate and geologic history (e.g., the Northeast Cascades and Columbia Basin). Vegetation zones are areas over which similar assemblages of natural vegetation communities tend to form. The vegetation zones we identified were:

- nine steppe zones: Blue Mountains Steppe, Palouse, Three-tip Sage, Klickitat Meadow Steppe, Bitterbrush, Central Arid Steppe, Wheatgrass/Fescue, Canyon Grassland, and Big Sage/Fescue;
- eleven east-side forest zones: Oak, Ponderosa Pine, Interior Douglas-fir, Grand Fir, Interior Redcedar and Interior Western Hemlock (combined for analysis), and Subalpine Fir, plus two minor Blue Mountains zones and two minor Mount Adams zones;
- nine west-side forest zones: four "Puget-Willamette Trough" zones (Willamette Valley, Cowlitz River, Woodland/Prairie Mosaic, Puget Sound Douglas-fir), plus the Sitka Spruce, Western Hemlock, Olympic Douglas-fir, Silver Fir, and Mountain Hemlock; and
- two high-elevation zones: Alpine/Parkland and Permanent Ice/Snow.

Vegetation zones indicate ecologically similar environmental conditions. They are not the equivalent of a potential vegetation map. We used vegetation zones as the primary framework for our analyses because zones provide a more appropriate ecological context than political state boundaries. Other advantages of using zones are: 1) natural communities are in a continual state of flux while zones are relatively static; 2) zonal analysis is less affected by potential errors in land cover interpretation; and 3) predicted vertebrate species' distributions are greatly improved by considering both zone and actual land cover rather than actual land cover alone.

Current land cover within each vegetation zone was mapped using 1991 Landsat satellite Thematic Mapper (TM) imagery at a nominal 100-hectare minimum mapping unit by on-screen digitization using

spectrally-clustered satellite imagery as a backdrop. Some landscape features smaller than 100 hectares were mapped if they were important to vertebrate distributions (e.g., islands and wetlands).

Distributions of terrestrial vertebrate species were modeled by intersecting each species' range limits with suitable habitats. We assigned codes to indicate habitat quality for each species based on ecoregion, vegetation zone, and land cover within the zone. Vegetation zones within an ecoregion were designated as "core" or "peripheral," where core zones were those in which the species was most common and peripheral zones were those in which the species occurred but was rare or the zone was believed to be a population sink. Habitat suitability of land cover within a zone was designated as "good," "adequate," or "contingently suitable." Good habitats were those in which the species was known to occur and breed successfully. Adequate habitats were those in which the species occurred but was rarer, or the habitat was believed to be a population sink. Contingently suitable habitats were those that were potentially good if they contained a feature that was below the mapping resolution of the project and that was not likely to occur in all habitats of similar designation (e.g., a talus slope or a pond below our mapping resolution but sufficiently large that the feature was unlikely to be in all macro-habitats).

A land ownership and management cover for the State was obtained from the Washington Department of Natural Resources and modified with small corrections, additions, and further separation of some ownership types. It was converted to a Conservation Status cover by assigning four Conservation Status categories. Status 1 lands are those maintained in a natural state (e.g., National Parks and Wilderness Areas); Status 2 lands are those maintained mostly in a natural state but with some extractive uses (National Wildlife Refuges, State Wildlife Areas, National Recreation Areas); Status 3 lands have some protection from development but are subject to either broad, low-intensity or locally intense extractive uses (National Forest multiple use lands, Washington Department of Natural Resource Trust lands, most Bureau of Land Management lands); and Status 4 lands are lands with little or no legislated protection (private lands, Tribal lands, most Department of Defense and Department of Energy lands). In practice, Status 1 and 2 lands were usually treated similarly with respect to conservation status.

The protection status of land cover was assessed using two methods: 1) the percent of the vegetation zone in Conservation Status 1 and 2 lands and 2) a Conservation Priority Index:

$$CPI = ((100 - \%\ protected)/(100 - \%\ converted)) * \log(\text{total area in the zone})$$

where "% converted" refers to the percentage of the zone converted to agriculture or development and "% protected" refers to the percentage of the zone in Status 1 and 2 lands.

The protection status of vertebrates was assessed using several methods: 1) for each vertebrate species, we calculated its total predicted distribution, the percentage of its distribution on Status 3 lands, and the percentage of its distribution of Status 1 or 2 lands; 2) vertebrate species richness of various taxonomic groups and assemblages was mapped by overlaying predicted species' distributions; and 3) areas of high vertebrate richness were mapped according to Conservation Status. The effects of basing vertebrate richness analyses on presence/absence versus the most suitable habitats for each species were also explored.

Results of these analyses (i.e., identification of "gaps" in the protection of land cover and vertebrate species) formed the basis of our conclusions concerning conservation priorities.

Results

- *Current land cover, statewide:* Excluding open ocean, the area of Washington State is approximately 17.52 million hectares. Of that, 36.7% (6.42 million hectares) is in conifer forest, 21.4% (3.75 million hectares) is in agriculture, 14.7% (2.58 million hectares) is in dry steppe, grassland, or savanna, 11.3% (1.98 million hectares) is in cuts, burns, or meadows among forests; 7.1% (1.25 million hectares) is in hardwood or mixed hardwood/conifer forest; 2.9% (0.52 million hectares) is in open water or wetlands, 2.5% (0.44 million hectares) is developed, 2.4% (0.41 million hectares) is in alpine or subalpine meadows, and 1.0% (0.17 million hectares) is in bare ground (ice, snow, mud flows, rock, etc.).
- *Current land cover, steppe zones:* The combined area of the steppe zones in the state is 6.08 million hectares. Slightly more than half of the steppe zones (51.1%) has been converted to agriculture. The Palouse zone has the highest percentage (88.1%) of its area in agriculture and the steep, rocky Canyon Grassland zone has the lowest percentage (18.5%). An average of 42.4% of the total area in steppe zones was classified as non-forested (a label that includes grassland, shrub savanna, shrubland, sparse vegetation, and tree savanna). The Palouse has the lowest percentage (6.7%) in non-forested and the Canyon Grassland zone has the highest percentage (71.2%). The greatest absolute area of non-forested cover in the steppe zones (1.46 million hectares) is in the Central Arid Steppe zone, where most communities are dominated by Big Sage (*Artemisia tridentata),* Bluebunch Wheatgrass (*Agropyron spicatum*), Sandberg' s Bluegrass (*Poa sandbergii*), and the introduced Cheatgrass (*Bromus tectorum*). None of the steppe zones have more than 2% of their area in development, and the average area of development in steppe zones is less than 1%.
- *Current land cover, east-side forest zones:* East-side forest zones cover a total of 4.80 million hectares of the state. The average forest cover of the east-side forest zones is 70.8% and, except for the Oak zone, conifer forest is the rule. Of the major east-side forest zones, the Oak zone has the highest percent (42.6%) of its area in non-forested cover (a combination of naturally occurring meadows, logged areas, and burns). In the other major zones, non-forested cover is between 18% and 23%. The largest east-side zones are the Ponderosa Pine and Interior Douglas-fir zones, and conifer forest within these zones covers over 41% of the combined area of all east-side forest zones. The Ponderosa Pine zone has the highest percentage of its area in development and agriculture (11.9% total). In all other east-side forest zones, the combined area of development and agriculture is 6% or less.
- *Current land cover, west-side forest zones:* West-side forest zones cover a total of 6.02 million hectares. In the Olympic Douglas-fir, Silver Fir, and Mountain Hemlock zones, conifer forest covers greater than 71% of the zone. In the Sitka Spruce and Western Hemlock zones, conifer forest covers 42.7% and 55.1% of the zone, respectively, and mixed or hardwood forest covers 25.4% and 21.4%, respectively. In the four Puget-Willamette Trough zones (Puget Sound Douglas-fir, Cowlitz River, Willamette Valley, and Woodland/Prairie Mosaic zones), the combined

mixed and deciduous forest cover is greater than the conifer forest cover. The decline in conifer forest cover and increase in hardwood and mixed forest in the Trough zones has been caused by development, agriculture, and logging. Mid- and late-seral conifer forest decreases markedly from the upper elevation to the lower elevation zones and is very low in the Puget-Willamette Trough zones. The Willamette Valley zone has undergone the greatest conversion to agriculture and development, with 66.8% of its area in one of those two land covers. The largest single cover type of the west-side forest zones is conifer forest in the Western Hemlock zone, which is generally dominated by Douglas-fir, Western Hemlock, and Western Redcedar.

- *Current land cover, high-elevation zones:* The two highest-elevation zones, the Alpine/Parkland and Permanent Ice/Snow zones, cover a total of 0.6 million hectares, of which 0.5 million hectares are subalpine meadows, shrub fields, parkland, small stands of subalpine tolerant conifers, and related communities. The remainder is bare rock and permanent ice and snow.
- *Land stewardship:* In most steppe zones, the major land stewards are private owners and the Washington Department of Natural Resources (WDNR), but some steppe zones (particularly the Central Arid Steppe zone) have substantial amounts of their areas on Tribal lands, Department of Defense (DoD) lands, or Department of Energy (DoE) lands. The majority of lands designated as Status 2 lands on steppe were State Wildlife Areas, State Parks, National Recreation Areas, or Bureau of Land Management Areas of Critical Environmental Concern (BLM ACECs). The Central Arid Steppe zone was an exception, with several large National Wildlife Refuges and the Fitzner/Eberhardt Arid Lands Ecology Reserve (FEALE - on the Hanford DoE site) forming a major part of the Status 2 lands. Ownership of forest zones depended greatly upon zone, with private lands dominating on lower-elevation zones, WDNR Trust lands and United States Forest Service (USFS) multiple use lands on mid-elevation zones, and National Parks and Wilderness Areas on high-elevation zones. Some zones have substantial areas on Tribal lands. The DoD is a prominent land holder in the Puget Sound Douglas-fir, Woodland/Prairie Mosaic, and Western Hemlock zones.
- *Conservation Status and land cover:* Statewide, the percentage of lands in Conservation Status 1 and 2 is 12.23%, but protected lands are unevenly distributed among vegetation zones. The steppe zones and the four Puget-Willamette Trough zones have the smallest acreage in Status 1 and 2: all steppe zones have less than 6% of their area in Status 1 and 2 lands, and six of nine steppe zones have less than 1%; all four Puget-Willamette Trough zones have less than 2.5%. The percentage of Status 1 and 2 lands in forests zones above steppe and outside the Puget-Willamette Trough zones generally increases with elevation. The Permanent Ice/Snow zone has the highest protection status of all zones, with over 97% of its area on Status 1 and 2 lands.
- *Conservation Priority Index, by vegetation zone:* When vegetation zones are ranked by Conservation Priority Index (CPI), the four top-ranked zones (those of highest priority based on low protection status, high anthropogenic conversion, and importance in terms of size) are three steppe zones (the Palouse, Big Sage/Fescue, and Wheatgrass/Fescue zones) and one west-side zone (the Willamette Valley zone). Of the seven zones of moderately high CPI, four are steppe zones and three are the remaining Puget-Willamette Trough zones. Thus, seven of nine steppe zones and all four of the Puget-Willamette Trough zones have high or moderately high CPIs.
- *Habitat quality, modeled distributions, and vertebrate richness patterns:* Because we included qualitative assessments of habitat quality in our vertebrate models, we were able to evaluate species

distributions, richness patterns, and conservation status in a variety of ways. If the model was based on all zones and cover types in which the species occurs, regardless of habitat quality, then the result is the predicted "presence/absence" model. If the model was based only on good or contingently suitable habitats in core vegetation zones, the result is the predicted "most suitable habitat." A comparison of native vertebrate richness maps based on presence/absence to richness maps based on most suitable habitats showed that presence/absence-based maps obscured the relative importance of low-elevation zones and habitats unaltered by human activity, i.e., while richness based on either model showed similar declines with an increase in elevation and on human-altered cover types, the relative declines were more pronounced when the richness maps were based on most suitable habitats. All subsequent vertebrate analyses were based on the most suitable habitat for each species.

- *Comparison of protection status of vertebrate species by taxonomic group:* We arbitrarily chose 10% representation on Status 1 or 2 lands as a way to compare the relative protection status of taxonomic groups of vertebrates. For each group, the number of native species with less than 10% of their predicted distribution on Status 1 or 2 lands was:

Amphibians	14 of 24 (58%)
Salamanders	8 of 14 (57%)
Frogs and toads	6 of 10 (60%)
Reptiles	18 or 21 (86%)
Turtles	2 of 2 (100%)
Lizards	5 of 7 (71%)
Snakes	11 of 12 (92%)
Mammals	45 of 102 (44%)
Shrews and moles	5 of 12 (42%)
Bats	7 of 15 (47%)
Lagomorphs	4 of 6 (67%)
Carnivores	8 of 19 (42%)
Hoofed mammals	1 of 7 (14%)
Rodents	20 of 43 (47%)
Birds	138 of 230 (60%)
Non-passerine	73 of 120 (61%)
Passerine	65 of 110 (59%)
Swimmers	25 of 44 (57%)
Excluding marine birds	25 of 35 (71%)
Geese and ducks	15 of 19 (79%)
Waders	9 of 18 (50%)
Predators	20 of 30 (67%)
Woodpeckers	4 of 11 (36%)
Flycatchers	8 of 11 (73%)
Gleaners	11 of 19 (58%)
Finches	4 of 11 (36%)
Sparrows	9 of 17 (53%)

Other groups of interest included species most at risk of population declines due to anthropogenic activities (species that are poorly adapted to development, agriculture, or logging, or that are otherwise sensitive to people), State and Federally listed species (including State and Federal Species of Concern, Candidate Species, Threatened Species, and Endangered Species), and Columbia Basin-dependents (species with most of their range in Washington in the Columbia Basin). For these groups, the number of species with less than 10% of their predicted distributions on Status 1 or 2 lands was:

At-risk due to human activities - amphibians	6 of 12 (50%
At-risk due to human activities - reptiles	4 of 7 (57%)
At-risk due to human activities - mammals	11 of 25 (44%)
At-risk due to human activities - birds	22 of 38 (58%)
State or Federally listed amphibians	6 of 8 (75%)
State or Federally listed reptiles	2 of 3 (67%)
State or Federally listed mammals	7 of 15 (47%)
State or Federally listed birds	11 of 27 (41%)
Columbia Basin-dependent amphibians	3 of 3 (100%)
Columbia Basin-dependent reptiles	5 of 8 (62%)
Columbia Basin-dependent mammals	17 of 20 (85%)
Columbia Basin-dependent birds	29 of 42 (69%)
Neotropical migrants (birds)	43 of 62 (69%)

The groups (some overlapping) that have the lowest protection status (as a group; not necessarily as individual species) are reptiles, Lagomorphs (rabbits, hares, and Pika), non-marine swimming birds, predatory birds, flycatchers, listed amphibians and reptiles, all Columbia Basin-dependents, and neotropical migrants. Groups with the highest protection status are hoofed mammals, woodpeckers, and finches. Groups with low protection status have a large number of their members restricted to low elevation forest zones or to steppe. At-risk species tend to have a level of protection similar to or better than species as a whole, but their protection status is somewhat misleading, since many of these species have been extirpated over much of their unprotected former range.

- *Individual vertebrate species protection status*: For each species, we calculated its total modeled distribution in Washington, and the percentage of the modeled distribution on Status 3 lands and Status 1 or 2 lands. This table allows comparisons of protection status and distribution extent among species. It also indicates the relative influence that different land owners might be able to exert on species management within a species' current distribution.
- *Vertebrate richness - amphibians:* Native amphibian richness is highest in mid- to late-seral conifer forests in low- to mid-elevation west-side forest zones. Mid- to late- seral conifer forests in the Western Hemlock zone on the southern Olympic Peninsula and the southwestern Cascades have particularly high amphibian richness. The areas of highest richness for at-risk species are similar to those of amphibians in general.
- *Vertebrate richness - reptiles:* Native reptile richness is highest in the steppe zones and low-elevation east-side forest zones in steppe habitats, open forests, and forest openings. Areas of highest richness for at-risk species are concentrated in the warmest, driest steppe, particularly in the Central Arid Steppe and Canyon Grassland zones.

- *Vertebrate richness - mammals:* Habitats with high mammal richness are riparian areas and forests in the Western Hemlock and Olympic Douglas-fir zones of the west side, and the Interior Western Hemlock, Interior Redcedar, and Grand Fir zones of the east side, but the patterns of species richness vary greatly among mammalian sub-groups. Areas of highest richness of at-risk species are low- to mid-elevation, mid- to late-seral forests in the northern Olympic Peninsula, most natural habitats of remote northeastern Washington and the northeast Cascades, and upland steppe. Compared to mammals in general, a disproportionate number of at-risk species occur in steppe habitats. The highest richness of Columbia Basin-dependent mammal species occurs in steppe along the Columbia and Snake Rivers in the Central Arid Steppe and Canyon Grassland zones.
- *Vertebrate richness - birds:* Native bird richness is generally highest in low-elevation forests of the east side and low-elevation wetlands throughout the State, however the patterns of species richness vary considerably among avian sub-groups. Areas of highest richness of at-risk species are mid- to late-seral, low- to mid-elevation west-side forests, low-elevation east-side forests, and upland steppe habitats. Areas of highest richness of Columbia Basin-dependents occur in wetlands and steppe in the vicinity of major rivers and lakes, with a large contiguous area of high richness on the Yakima Training Center (DoD) and Hanford (DoE) areas, and north along the Columbia River and major canyons.
- *Vertebrate richness and Conservation Status - amphibians:* The largest blocks of Status 1 and 2 lands of high amphibian richness are on the lowest elevations of the Olympic and Mount Rainier National Parks and their surrounding Wilderness Areas; the lower elevations of the Mount St. Helens National Monument; the upper reaches of the Skagit River where it runs through the Ross Lake Recreation Area (Whatcom/Skagit Counties); and the Trapper Creek Wilderness Area (Skamania County). The largest block of Status 3 land with high amphibian richness is in the southwest Cascades and is composed mostly of the Gifford-Pinchot National Forest. Other large blocks of Status 3 lands are the WDNR Trust lands of the Black Hills Capitol State Forest; WDNR Trust lands and Olympic National Forest lands surrounding the Olympic National Park, and scattered patches of WDNR and National Forest land in the northwestern Cascades and southwestern Washington. Large areas of high-richness Status 4 lands lie in southwestern Washington; in the southwest and west-central Cascades; and, to a lesser extent, in forest fragments in the northwest Cascades and the foothills of the Olympic Mountains.
- *High reptile richness and Conservation Status:* Areas of high reptile richness are dominated by Status 4 lands. Status 3 lands are primarily composed of WDNR Trust lands that often lie in a section-block checkerboard pattern with Status 4 lands or Status 2 State Wildlife Areas. The majority of Status 1 and 2 (mostly 2) lands with high reptile richness are State Wildlife Areas, NWRs, and the buffer zone around Hanford. The buffer zone around Hanford provides the largest blocks of high-reptile richness Status 2 lands. The L. T. Murray Wildlife Area on the lower east slope of the Cascades (Kittitas/Yakima Counties) forms the next largest Status 2 area. The largest unfragmented area of high richness lies across eastern Kittitas, northeastern Yakima, northern Benton, and southern Grant Counties. This area is dominated by Status 4 lands of the Yakima Training Center and the Hanford Nuclear Reservation, with large blocks of Status 2 and 3 lands on the periphery.
- *High mammal richness and Conservation Status:* On the east side, areas of high mammal richness lie primarily on Status 3 National Forest lands in the extreme northeast corner and the east-

central Cascades, with some adjacent Status 1 lands on Wilderness Areas, especially in the northeast Cascades. On the west slope of the Cascades, areas of high mammal richness are predominantly Status 4 lands, with some blocks of Status 3 lands. The largest area of Status 1 or 2 land in the west Cascades is along the upper Skagit River in Whatcom County where it lies on the Ross Lake Recreation Area. On the Olympic Peninsula, the areas of Status 1, 3 and 4 lands with high richness are about equal, but Status 4 lands tend to be at the lowest elevations.

- *High bird richness and Conservation Status:* High richness areas of the west side and Columbia Basin (predominately low-elevation wetlands) lie almost entirely on privately-owned Status 4 lands. The few Status 1 or 2 lands are primarily parts of National Wildlife Refuges, State Wildlife Areas, and the buffer zone around Hanford. Along the east slope of the Cascades, lands with high bird-richness are mostly a mix of Status 3 and Status 4 lands. The largest block of Status 1 and 2 land rich in avian species in the northeast Cascades occurs on parts of the Lake Chelan National Recreation Area, the Glacier Peak Wilderness, and the North Cascades National Park. Areas of high bird-richness in northeastern Washington lie predominately on Status 4 lands of private owners and the Colville and Spokane Indian Reservations; Status 3 lands of the Colville National Forest cover large areas of high-bird richness in northeastern Okanogan and northern Ferry Counties. Scattered Status 2 lands in the northeast lie on the Little Pend Oreille NWR (Stevens County), Mount Spokane State Park (Spokane County), Riverside State Park (Spokane County), and the Sherman Creek Wildlife Area (Ferry County).
- *High richness of at-risk species and Conservation Status*: We combined the richness maps of at-risk species of all vertebrate groups and displayed the Conservation Status of areas of highest richness. Areas of highest richness for all at-risk species are uncultivated, mostly upland, steppe habitats; mid- and late-seral, mid-elevation west-side conifer forests; and remote mid- and high-elevation east-side forest zones in the northeast Cascades and northeastern Washington. High numbers of at-risk species occur on Status 1 or 2 lands in Wilderness Areas and North Cascades National Park in the northeast Cascades, lower elevations of Olympic National Park, the Hanford Nuclear Reservation buffers, and State Wildlife Areas in the west-central Basin. Large areas of high richness on Status 3 lands are located in the southwest Cascades on the Gifford-Pinchot National Forest, the Olympic National Forest and WDNR Trust lands surrounding the Olympic National Park, the northeast Cascades (Wenatchee and Okanogan National Forests, and WDNR Trust lands), and the northeast corner (mostly the Colville and Kaniksu National Forests). Areas of high richness on Status 3 lands in the Columbia Basin are mostly WDNR Trust lands. Large areas of high richness on Status 4 lands are found in remaining mid- to late-seral forest patches in southwestern Washington and the Olympic Peninsula, the lower southwest slopes of the Cascades, and in the Columbia Basin

Management Considerations and Recommendations

Highest Conservation Priorities

Zones of highest conservation priority are those that have been most profoundly affected by agriculture and development. These zones typically have a low percentage of their areas in Status 1 and 2 lands.

Species of highest priority are those that rely on such zones, but which adapt poorly to anthropogenic change.

- *Steppe zones and Columbia Basin-dependents*: The most glaring gap in protection of biodiversity in Washington is in the steppe zones. The vegetation zones with the highest Conservation Priority Index (CPI) are steppe zones, and seven of nine steppe zones have a high or moderately high CPI. Vertebrate species that rely on steppe usually have a correspondingly low percentage of their distribution on areas managed primarily for biodiversity. The high CPI of steppe zones and the low representation of Basin-dependents on Status 1 and 2 lands makes the fate of the lands surrounding the Hanford Nuclear Reservation (DoE) particularly critical. The buffer areas around Hanford that are currently managed as refuges are the Saddle Mountain National Wildlife Refuge, the Fitzner/Eberhardt Arid Lands Ecology Reserve, and the Wahluke Wildlife Area. These three reserves combined comprise 35% of all Status 1 and 2 lands in the Columbia Basin and their removal from the reserve system (which is under consideration) would have a considerable impact on the conservation status of the Columbia Basin and on many Basin-dependent species. The DoD is another large public landholder in the Columbia Basin whose land management policies can have considerable impacts on Basin dependents. The DoD-owned Yakima Training Center (although considered Status 4 land) is a large, contiguous area of steppe that serves as a *de facto* reserve. Most mammalian and reptilian Basin dependents are associated with upland steppe, but some of the wetlands in steppe are among the areas of highest bird richness, and they support many birds that (in Washington) breed only in steppe zones. The zone with the highest CPI in the State is the Palouse, a mesic steppe zone in which almost all upland areas have been converted to dryland agriculture. The existing reserves are very small and isolated, but contain some of the few remnants of Palouse grassland that might be used as a source for restoration.
- *The Puget-Willamette Trough zones:* These zones include the Puget Sound Douglas-fir, Woodland/Prairie Mosaic, Willamette Valley, and Cowlitz River zones. All have been heavily converted to both agriculture and development. The remaining forests are now a patchwork of hardwood, mixed, and early-seral conifer forest. There are only a few small areas of moderate richness of at-risk species (primarily on prairies and woodlands of the southern Puget Sound), because most at-risk species have been extirpated from these zones. However, the wetland habitats (including riparian areas, lakes, marshes, etc.) of these zones support large numbers of bird and mammal species. Although some species in these zones thrive around people, increasing development is likely to cause even some of the tolerant species to decline. The amount of Status 1 and 2 lands on these high-richness wetland areas is low and mostly composed of National Wildlife Refuges, State Wildlife Areas, and State Parks. A major priority of these zones is management of the handful of vertebrate species or subspecies that cannot "retreat" into the less-impacted higher-elevation zones, for example, the Western Pond Turtle and various subspecies of the Mazama Pocket Gopher.

Moderately High Priorities

Zones of moderately high priority are those that have not been as severely impacted by development and agriculture as the highest priority zones, but that have low protection status and that have (or might soon experience) widespread changes in disturbance regimes as a result of human activities. Vertebrate

species of moderately high priority are those that occur outside the most severely impacted zones, but that are least adaptable to human-induced changes in disturbance regimes or other anthropogenic impacts.

- *The Ponderosa Pine and Oak Zones:* These lowest elevation east-side forest zones have moderately high CPIs. Both have less than 4% of their areas in Status 1 and 2 lands. They are zones of high reptile and bird diversity. Reduction in natural disturbance via fire suppression is a significant conservation problem in these zones, and maintenance of a natural fire regime in areas where houses are mixed with dry forest is difficult.
- *The Sitka Spruce and Western Hemlock Zones:* These wet to mesic, west-side forest zones have relatively little of their areas in development or agriculture, but logging has been extensive in these zones of naturally very low fire frequency. They are zones of high amphibian and mammal (especially bat) richness, and their remaining mid- to late-seral forests support large numbers of at-risk amphibian, mammal, and bird species. Our data indicate that less than 8% of the Sitka Spruce zone and less than 10% of the Western Hemlock zone remain in late-seral forest; an additional 14% of the Sitka Spruce zone and 20% of the Western Hemlock zone were estimated to be in mid-seral forest. Logging in these zones has been the focus of some of the most bitter and lasting conservation battles in the Pacific Northwest, and we will not even pretend to offer any advice on how to resolve these conflicts. The forests of these zones are unquestionably being logged faster than they can regenerate, but the economic value of their timber provides a powerful incentive to continue current harvest practices.

The Role of Status 3 and Status 4 Lands

Biodiversity management is easiest on Status 1 and 2 lands, where biodiversity protection is a major priority. However, the amount of Status 1 and 2 lands is unlikely to substantially increase, and many species have inadequate representation on Status 1 and 2 lands; many of the most endangered and large "charismatic" species are disproportionately represented on Status 3 lands and nearly a third of breeding terrestrial vertebrate species have 80% of their most suitable habitat on Status 4 lands. In Washington, the major Status 3 lands are WDNR Trust lands and USFS non-Wilderness ("multiple use") lands. Publicly-owned Status 4 lands (excluding Tribal lands) in Washington are primarily DoD and DoE lands.

Among Status 3 land owners, the WDNR has the largest impact on biodiversity management in many of the most poorly protected vegetation types and associated fauna in the State. Zones in which the combined percentage of Status 1 and 2 lands is less than 10% and WDNR Trust lands are the majority of Status 3 lands are: all steppe zones, one east-side forest zone (Oak), and six west-side forest zones (Willamette Valley, Cowlitz River, Woodland/Prairie Mosaic, Puget Sound Douglas-fir, Sitka Spruce, and Western Hemlock). The major zones in which the combined percentage of Status 1 and 2 lands is less than 10% and USFS multiple-use lands are the majority of Status 3 lands are the Ponderosa Pine and Interior Douglas-fir zones. Some Status 3 lands do not cover large percentages of zones, but are nonetheless significant for biodiversity management. The Status 3 Cedar River Watershed occupies a small percentage of the Western Hemlock zone compared to other Status 3 lands, but it encompasses nearly an entire watershed on which access is restricted, and is a *de facto* reserve for many species.

The Smoot Hill Research Area (owned by Washington State University) is an example of a very small but significant Status 3 area; it is important because it harbors some of the last remnants of Palouse vegetation in the zone with the highest CPI.

The most significant publicly-owned Status 4 lands for biodiversity management are the Fort Lewis Military Reservation (DoD) in the Woodland/Prairie Mosaic zone, and the Yakima Training Center (DoD) and the Hanford Nuclear Reservation core (DoE) of the Central Arid Steppe zone. Fort Lewis includes most of the remaining tracts of native upland vegetation of the Woodland/Prairie Mosaic zone. The Status 4 DoD and DoE lands in the Central Arid Steppe zone are a component of the largest remaining relatively contiguous and uncultivated block of land in that zone.

In zones with relatively small amounts of Status 1 and 2 lands, Status 3 and publicly-owned Status 4 lands will often represent the best opportunity to improve biodiversity protection. However, the majority of land in most low-elevation zones is privately owned, and the persistence of many species and vegetation types will continue to depend on management practices on private lands.

INTRODUCTION

The Gap Analysis Concept

The Gap Analysis Program (GAP) is a nation-wide program currently administered by the Biological Resources Division of the US Geological Survey (BRD-USGS; formerly the National Biological Service [NBS]). The overall goal of Gap Analysis is to identify elements of biodiversity that lack adequate representation in the nation' s network of reserves (i.e., areas managed primarily for the protection of biodiversity). Gap Analysis is a coarse-filter approach to biodiversity protection. It provides an overview of the distribution and conservation status of several components of biodiversity, with particular emphasis on vegetation and terrestrial vertebrates. Digital map overlays in a Geographic Information System (GIS) are used to identify vegetation types, individual species, and species-rich areas that are unrepresented or underrepresented in existing biodiversity management areas. Gap Analysis functions as a preliminary step to more detailed studies needed to establish actual boundaries for potential additions to the existing network of reserves.

The primary filter in Gap Analysis is vegetation type (defined by the Washington Gap Analysis Project as the composite of actual vegetation, vegetation zone, and ecoregion). Vegetation types are mapped and their conservation status evaluated based on representation on biodiversity management areas, conversion to human-dominated landscapes, and spatial context. Vegetation is used as the primary filter in Gap Analysis because vegetation patterns are determinants of overall biodiversity patterns (Levin 1981, Noss 1990, Franklin 1993). It is impractical to map the distributions of all plants and animals, but Gap Analysis makes the assumption that if all vegetation types are adequately represented in biodiversity management areas, then most plant and animal species will also be adequately represented. Combinations and arrangements of vegetation types can also be important aspects of the vegetation filter. For example, landscapes with great vegetation diversity (such as those with high edaphic variation or topographic relief) may provide habitat for many species, including those animals that depend on multiple habitat types to meet life history needs (Diamond 1986, Noss 1987).

The second major Gap Analysis filter is composed of information on the distribution of individual species. This filter can be used to identify individual species that lack adequate protection and, when individual species maps are overlaid, areas of high species richness. In most states, including Washington, vertebrates are the only taxa mapped because there is relatively little information available for other taxa, and because vertebrates currently command the most attention in conservation issues. At the present time, fish are excluded from the analysis because their habitats pose special problems in mapping and analysis (e.g., the linearity and connectivity of riparian systems), and the quantity and quality of fish distribution data vary within and among states.

The spatial scale at which organisms use the environment differs among species. Therefore, a coarse filter cannot be a complete assessment of biodiversity protection status and needs. Community-level (coarse-filter) protection is a complement to, not a substitute for, protection of individual rare species.

Species with large home ranges, such as large carnivores, or species with very local distributions may require individual attention. We also recognize that there are other important aspects of conservation evaluation in addition to those used in our analyses (e.g., human population growth, rate of habitat fragmentation, distribution of pollutants, locations of habitat corridors, and reserve context and design). More detailed analyses including these factors were not part of this project but are areas in need of further research.

Gap Analysis, by focusing on higher levels of biological organization, is believed to be less expensive and more likely to succeed than conservation programs focused on single species or populations (Scott et al. 1993). The Gap Analysis Program attempts to combine the problem-solving capabilities of federal, state, and private scientists to tackle the difficult issues of land cover mapping, vertebrate habitat characterization, and biodiversity conservation at state, regional, and national levels. The projected benefits are not only the resulting analyses, but also the base data layers developed by the individual state Gap Analysis projects.

Objectives

The Gap Analysis Program has a four point mission (Scott et al. 1996): 1) map the land cover of the United States, 2) map predicted distributions of vertebrates for the U.S., 3) document the representation of land cover types and vertebrate species in areas managed for the long-term maintenance of biodiversity, and 4) provide this information to planners and policy makers for land use decisions, and to educators, scientists, natural resource managers, and the public.

To meet these objectives, it is necessary that GAP be operated at the state level but maintain consistency with national standards. Within a state, participation by a wide variety of cooperators is necessary and desirable to ensure understanding and acceptance of the data and to forge relationships that will lead to cooperative conservation planning.

General Limitations

The following are general limitations of Gap Analysis; specific limitations for particular datasets are described in the appropriate sections:

1. Gap Analysis data are derived from remote sensing and modeling to make general assessments about conservation status. Any decisions based on the data must be supported by ground-truthing and more detailed analyses.

2. Gap Analysis is not a substitute for the listing of threatened and endangered species and associated recovery efforts. A primary argument in favor of Gap Analysis is that it is proactive in recognizing areas of high biodiversity value for the long-term maintenance of populations of native species and natural ecosystems before individual species and plant communities become threatened with extinction. A goal of Gap Analysis is to reduce the rate at which species require listing as threatened or endangered.

3. The static nature of the Gap Analysis data limit their utility in conservation risk assessment. Our database provides a snapshot of a region in which land cover and land ownership are dynamic and where trend data would be especially useful.

4. Gap Analysis is not a substitute for a thorough national biological inventory. As a response to rapid habitat loss, Gap Analysis is intended to provide a quick assessment of the distribution of vegetation and associated species before they are lost and to provide focus and direction for local, regional, and national efforts to maintain biodiversity. The process of improving knowledge in systematics, ecology, and distribution of species is lengthy and expensive. That process must be continued and expedited in order to provide the detailed information needed for a comprehensive assessment of the nation's biodiversity.

5. Gap Analysis is a coarse-filter approach. The network of Conservation Data Centers (CDC) and Natural Heritage Programs established cooperatively by The Nature Conservancy and various state agencies maintain detailed databases on the locations of rare elements of biodiversity. Conservation of such elements is best accomplished through the fine-filter approach of the above organizations. It is not the role of GAP to duplicate or disseminate Natural Heritage Program or CDC Element Occurrence Records. Users interested in more specific information about the location, status, and ecology of populations of such species are directed to their state Natural Heritage Program or CDC.

6. Currently, land cover types and terrestrial vertebrates are the primary focus of GAP's mapping efforts. The vegetation filter is the primary means of capturing non-vertebrate diversity elements. Even if resources were available to include non-vertebrate taxa, our knowledge of them is very limited. Some research is currently being conducted on the technique of "complementarity analysis" as a way of using vertebrate distributions to help in conservation planning for other species. In this technique, a set of areas is found in which all, or nearly all, mapped species are represented. Capture of all species in one taxonomic group requires that most or all different ecological types be selected. Thus, in theory, a set of areas with complementary sets of species for one higher taxon (e.g. mammals) will also be likely to adequately represent most species of other higher taxa (e.g., Pressey et al. 1993, Williams et al. 1996, Csuti et al. 1997).

Study Area

This report is a summary of the results of Gap Analysis for Washington State. Washington State is larger than most states. However, at 17 million hectares, it is the smallest of the western states. A tremendous variety of natural communities, from dry steppe to wet conifer forest to alpine meadows occur because of Washington's complex topography. The State is divided roughly in half by the Cascade Mountains. Land cover west of the Cascade crest is characterized by mesic to wet conifer forests. East of the crest, there is a natural cover of cool steppe vegetation in the Columbia Basin partially ringed by dry to mesic conifer forests along the east slope of the Cascade Mountains, in the Blue Mountains, and in northeastern Washington. Conifer forests give way to alpine and subalpine meadows at high elevations. Permanent ice and snow covers the highest peaks and ridges of the Cascades and Olympics.

How This Report is Organized

The organization of this report follows the general chronology of Gap Analysis, beginning with the production of the individual data layers and concluding with analysis of the data. It diverges from standard scientific reporting by embedding results and discussion sections within individual chapters. This organization was designed to allow the individual data products to stand on their own as testable hypotheses and provide users with a concise and complete report for each data and analysis product.

We begin with descriptions of the base data layers (land cover, terrestrial vertebrate distributions, and land stewardship), followed by the Analysis section, in which we report the status of the elements of biodiversity (vegetation types and terrestrial vertebrate species) for Washington State. We then discuss conservation priorities indicated by our analyses. Last, we provide information on how to acquire and use the data.

The Washington State report is in five-volumes. Volume 1 is a detailed report of current land cover and its conservation status. Volumes 2, 3, and 4 are atlases for the herpetofauna, mammals, and breeding birds, respectively, in the State. This volume, Volume 5, is a summary of the information presented in the first four volumes, with analyses that use data drawn from the previous four volumes. For more detailed descriptions of land cover and vertebrate distributions, see the appropriate volume.

LAND COVER CLASSIFICATION AND MAPPING

Introduction

Mapping land cover requires a level of effort equal to or greater than the development of other GAP data layers. The land cover map is more than a source of information about the status of natural vegetation; it is also the basis of the vertebrate distribution models, and it serves as a surrogate for biodiversity of some of the unmapped species. Generally, the process of mapping land cover includes adopting or developing a land cover classification system, delineating areas of relative homogeneity, and labeling these areas using categories defined by a classification system. More detailed attributes of the individual areas are added as more information becomes available. An iterative process of validating both polygon pattern and labels is applied during the editing and revision of the map. An assessment of the overall accuracy of the data is conducted if resources allow. GAP relies on a wide variety of information sources for land cover mapping, but Landsat Thematic Mapper (TM) imagery, which provides a compromise between cost and resolution, is the primary source of information.

Land Cover Classification

The criteria for a land cover classification system for GAP were: (a) ability to distinguish areas of different actual dominant vegetation; (b) utility for modeling the habitats of vertebrate species; (c) suitability for use within and among biogeographic regions; (d) applicability to Landsat TM imagery for rendering a base map; (e) use as a framework that can interface with classification systems used by other organizations and nations to the greatest extent possible; and (f) capability to fit, both categorically and spatially, with classifications of other themes such as agricultural and developed environments.

For GAP, the system that was adopted as a national standard is provisionally referred to as the Natural Land Cover Classification System (NLC). This system has also been referred to as the UNESCO/TNC system (Lins and Kleckner 1996). It is based on the structural characteristics of vegetation derived by Mueller-Dombois and Ellenberg (1974), adopted by the United Nations Educational, Scientific, and Cultural Organization (UNESCO 1973) and later modified for application to the United States by Driscoll et al. (1983, 1984). The Nature Conservancy and the Natural Heritage Network (Grossman et al. 1994) have been improving upon this system in recent years with partial funding provided by GAP. The basic assumptions and definitions for this system have been described by Jennings (1993).

A land cover classification system for Washington State had already been developed by the Washington State Gap Analysis Project (WAGAP) before NLC was accepted as the GAP standard. The WAGAP system, developed after extensive consultation with State cooperators, explicitly includes static landscape characteristics of ecoregion and vegetation zone along with the actual vegetation. It has been cross-walked to the NLC to match land cover classifications of neighboring states and for regional analysis (Murray 1996). The WAGAP system is retained in this report for Washington State analyses

because of the inevitable loss of resolution and accuracy created in the translation from one classification system to another.

Methods

Overview

The land cover for Washington State was based on 1991 Landsat TM imagery. The image data were spectrally clustered into approximately 200 classes per scene, and classes were grouped by similar spectral values. Areas of similar land cover type were delineated manually using the clustered TM imagery as a backdrop and a nominal minimum mapping unit of 100 hectares. Each resulting land cover polygon was given a label that included ecoregion; vegetation zone; and actual primary, secondary, and tertiary land cover. Label information was based on visual interpretation of the TM data and available ground data.

Imagery Acquisition

Sixteen TM images from 1991 were acquired from EOSAT (Lanham, MD) and archived by the Multi-Resolution Land Characterization Project (EROS, United States Geological Survey, Sioux Falls, SD). A 1992 scene for the northeast Cascades was added to the purchase because of the late date of the 1991 scene (September) for the same area. Scenes were selected on the basis of cloud cover and time of year (Table 1). For the Columbia Basin, we attempted to choose scenes from late spring and early summer (late May to early July) when the grassland vegetation was at peak biomass. For forested areas, we attempted to choose scenes from mid to late summer (late June to late July) when vegetation was at peak biomass and snow cover was at a minimum. Other considerations in scene selection were the need to minimize cloud cover, the need to minimize shadows in mountainous areas (by choosing dates near the summer solstice), and the late snow melt at high elevations (i.e., the optimal dates for alpine vegetation - August and September - were less optimal for lower elevations and well past the summer solstice). If we had the option, we generally sacrificed the quality of a scene over alpine areas to optimize scene dates for earlier-growing, lower-elevation vegetation. Because the Landsat satellite orbits each path once every 16 days, there are only six to eight opportunities for a scene during the height of the growing season, of which only two or three are near the optimal dates. In some cases, heavy cloud cover left only one viable option for a scene. All 16 scenes were map-oriented, georeferenced and terrain-corrected by EOSAT in Universal Transmercator (UTM) projection; Clarke 1866 spheroid; 25-meter resample size; with nearest-neighbor resampling.

The Land Cover Classification Scheme for Washington

Ecoregions and vegetation zones: An ecoregion is a contiguous geographic area of similar climate and geologic history, for example, the Northwest Cascades. We identified 13 ecoregions in Washington (Table 2; Map 1). A vegetation zone is an area in which moisture, temperature, elevation, and other environmental parameters combine to create conditions that favor similar assemblages of vegetation communities, for example, the Ponderosa Pine or Alpine/Parkland zones. We identified 31 vegetation zones in the State (Table 3; Map 2).

Ecoregions and vegetation zones are abstract concepts that are independent of the actual land cover. Boundaries between zones and regions are usually fuzzy, and they move with long term changes in climate. They can also appear to move because of anthropogenic activities. For example, fire suppression for most of the 20th century has led to range expansion of less fire-resistant species, like Grand Fir, so that the apparent extent of the present-day Grand Fir zone, particularly in the southeast Cascades and Blue Mountains, is probably larger than it would have been 100 years ago. Anthropogenic activities that alter large expanses of land can also obscure zone boundaries. For example, the conversion of half the Columbia Basin to agriculture has made it difficult to determine steppe zone boundaries. Scale also affects zone delineation, because, the coarser the scale, the greater the loss of zone boundary details such as interdigitation and inclusion of disjunct zone fragments.

Despite the subjectivity and artificiality of defining ecoregions and vegetation zones, there are several advantages to incorporating them directly into a land cover classification rather than mapping only actual land cover (as is usually done). Knowledge of regional and zonal boundaries assists in actual land cover interpretation and improves vertebrate models. Most importantly, regions and zones (particularly the latter) provide more ecologically appropriate units of analysis than the politically defined state boundary. At the same time, regions and vegetation zones should not be interpreted as the equivalent of potential vegetation. Potential vegetation at any particular location in a zone will depend not only on the zone, but on microsite characteristics, soil, and other factors. Furthermore, plant communities are in a continual state of flux, and we rarely know the natural ratio of early-, mid-, and late-seral stages of communities of a given type in a given zone. A more appropriate image of a zone is of a predictable assemblage of communities, rather than as an indicator of potential vegetation. For example, the Ponderosa Pine zone is covered mostly by Ponderosa Pine-dominated forests interspersed with dry meadows, but it also includes other communities, such as stands of closed Douglas-fir/Ponderosa Pine forests in mesic microsites and riparian corridors lined with Black Cottonwood and Quaking Aspen. The character of a vegetation zone within a region is due as much to the assemblage of communities, many of them too small for our mapping resolution, as to the predominant cover. The reason vertebrate models are improved by considering zone as well as actual land cover is that animals often depend as much on the assemblage of communities in a zone and/or the environmental conditions that determine a zone as on the predominant cover alone.

Polygon attributes: Each polygon was labeled with several attributes: ecoregion; vegetation zone; primary, secondary and tertiary land cover; the respective occupancy classes of the primary, secondary, and tertiary cover in each polygon; labeling date; the source of the information for the label if the label was based on information other than the appearance of the polygon from the satellite data; the person doing the labeling; and comments (Figure 1). The primary land cover (Table 4; Map 3) was the actual land cover that occupied the greatest proportion of the area in a polygon, for example, closed canopy conifer forest or non-irrigated row-crop agriculture. Secondary and tertiary land covers, if needed, were the actual land covers that occupied the second and third greatest proportion of area in the polygon. Primary, secondary, and tertiary covers were each assigned one of six occupancy classes indicating the proportion of the polygon occupied by each. The occupancy classes were:

1: <5%	Midpoint: 2.5%

2: 5%-25%	Midpoint: 15%
3: 25%-50%	Midpoint: 37.5%
4: 50%-75%	Midpoint: 62.5%
5: 75%-95%	Midpoint: 85%
6: 95%-100%	Midpoint: 97.5%

Derivation of ecoregion and vegetation zones and land cover classification system: Delineation of ecoregions and vegetation zones was based on the satellite data, compilations and modifications of several previously published accounts, and consultations with individuals currently working on refinements of regions and zones for the state. Published sources included Daubenmire (1970), Franklin and Dyrness (1973), Colville National Forest (1978), and Harris and Chaney (1984). The most important unpublished sources were personal communications with Jan Henderson (Mt. Baker-Snoqualmie National Forest), Rex Crawford (Washington State Natural Heritage Program), and David Pater (ManTech Environmental, Corvallis, Oregon). The land cover classification system was a joint effort between Kelly Cassidy, Rex Crawford, Jim Eby (Washington Department of Fish and Wildlife), and Lawrence Bliss (University of Washington).

Map Development

Polygon delineation and labeling: Areas of similar land cover were delineated on-screen in ArcEdit using the clustered, colored TM imagery as a backdrop. Roads, hydrology, and elevation were also displayed as needed to aid in delineation and labeling. Polygons were drawn with a nominal 100-hectare minimum mapping unit for terrestrial cover types and a 40-hectare minimum mapping unit for wetlands, i.e., the area of each polygon was greater than or equal to 100 or 40 hectares, respectively. In practice, some important land covers smaller than the minimum mapping units were delineated, notably small Pacific islands important for seabird colonies. Other polygons were considerably larger than the minimum mapping units because the land cover was uniform over large areas (e.g., agricultural polygons in the Columbia Basin) or time constraints prevented further refinement. Polygons were labeled based on their appearance on the TM scene and with additional information from maps and ground data when available.

Ground information for polygon labeling: Correct interpretation of satellite data and subsequent labeling of polygons require some prior knowledge of actual ground cover. For a project of this size, there are both too many and too few sources of ground data. There are air photos of varying resolution, quality, and date for much of the state; printed detailed maps or descriptions of very small areas; miscellaneous sources for point data scattered over large areas; volunteers willing to visit sites and report their observations; etc. Certainly, virtually every square inch of the state is seen by *someone* in the course of a year, vegetation does not hide like animals do, so one would suppose that interpretation could be as unambiguous and detailed as one desired. The obstacles to making full use of all these available sources are:

a) Existing ground data are scattered and often difficult to find. Many potentially useful surveys gather dust in filing cabinets, are discarded when an employee leaves, or are stored on outdated computer media or microfiche that is unreadable or cannot be copied without special equipment.

b) The exact locations of some ground points on private lands are intentionally shifted because of private land owners' concerns, making it difficult for an interpreter to know whether the interpretation is wrong or the point is displayed in the wrong place.
c) Land cover classification systems are different for every project, and the translation from one system to another is often fraught with mis-interpretation.
d) Land cover interpretation is subjective. Cover categories may appear unambiguous on paper, but they are usually much less well-defined to either a ground-based observer or an interpreter in the laboratory.
e) The expertise of people on the ground or doing interpretation varies considerably. In fact, the expertise of an individual varies with location, depending on his/her familiarity with an area.

We made use of as much ground information as could be assimilated in the time available. More information was available but was not used because of lack of time to either find the data or put it in a usable form. Visitation of areas on the ground by project personnel was the best source of data, but time was too short to visit more than a few hundred sites. Ground data that were used were provided by:

a) Senior Environmental Corps volunteers, who compared color maps of clustered satellite data with accessible sites on the ground. They gathered a few hundred points.
b) Jim Agee, University of Washington, provided maps of the North Cascades National Park and vicinity, plus the ground data used for the mapping.
c) Thomas Farrenkopf, Forest Sciences Laboratory, Portland, Oregon; summary of Forest Resource Inventory data (based on air photo interpretation) on private land west of the Cascades.
d) James Powell, Pacific GIS, collected ground data in Pacific County.
e) Washington Department of Natural Resources, Forest Resource Inventory Summary Data for two tracts of their lands.
f) A map of the Canyon Lakes Creek Study Area provided by Tom Gaines, Western Washington University.
g) Yakama Indian Nation (mostly via Tom Hoppensteadt) provided information about several sites on the Reservation.
h) Megan Gahr, former graduate student, University of Washington; sample data for Sagebrush Flats (Douglas County).
i) Nisqually National Wildlife Refuge map of Refuge vegetation.
j) Makah Indian Reservation; provided a map of the cover on their lands hidden by clouds in the satellite imagery.
k) Hanford Reservation; maps of the Hanford Site.
l) Washington Department of Fish and Wildlife; Doug Swanson' s data for transects in steppe vegetation.
m) Seattle Audubon Society, Klickitat County Oak Inventory (converted to digital form by the Washington Department of Fish and Wildlife).
n) Rex Crawford, personal communication regarding vegetation cover in scattered locations east of the Cascades.

o) Jon Titus, personal communication and assistance in labeling parts of the Cascades, especially the Mt. St. Helens area.
p) Jan Henderson, personal communication regarding general descriptions of forest cover west of the Cascades (as well as his ideas on zones and regions).

Calculation of Cover Class Areas

Since the land cover occupancy classes were ranges rather than specific values, estimates of area occupied by each cover class were based on the midpoint of the occupancy class. The result was that the area estimates did not exactly match the true area in a polygon. As an illustration, suppose that a hypothetical 100-hectare polygon had the following attributes:

Region: Southeast Cascades
Zone: Ponderosa Pine
Primary cover: Open canopy conifer forest
Primary occupancy class: 4 (50%-75%; Midpoint 62.5%)
Secondary cover: Non-forested, grassland
Secondary Occupancy class: 2 (5-25%; Midpoint 15%)
Tertiary cover: Freshwater lake
Tertiary occupancy class: 2 (5-25%; Midpoint 15%)

These attributes describe a polygon covered mostly by open conifer forest (most likely Ponderosa Pine dominated), interspersed with open grassy meadows (probably dry meadows dominated by *Agropyron spicatum*, *Festuca idahoensis*, and/or *Bromus tectorum*), with a lake somewhere in the polygon. The sum of estimated areas based on the midpoints is 62.5 + 15 + 15 ha = 92.5 hectare. For this illustration, the areas of all the covers estimated with the midpoint of the occupancy class would be multiplied by 100/92.5. In tables of estimated area of land cover types, areas are rounded to the nearest hectare. Area estimates are surely not that precise. We report the estimates at that precision because the real precision is difficult to determine and to avoid increasing rounding errors in subsequent calculations.

Map Editing

Land cover mapping is a continual process of refining and improving spatial resolution and polygon labels. Because the land cover map changes with each revision, version numbers were assigned as changes were made. Land cover analysis was based on Version 6 of the land cover map. Version 5 of the land cover map was used for the vertebrate models, because we did not have time to rerun the vertebrate models with the latest version. The differences between the two versions, however, are very minor. Most changes between Version 5 and Version 6 were in vegetation zone labels and polygon delineation in Asotin County in extreme southeastern Washington.

For More Information

Volume 1 of this report contains more detailed land cover information than that presented here, including descriptions of natural vegetation, maps of primary land cover in each zone, maps of conservation status in each zone and region, and management considerations.

Table 1: Satellite Thematic Mapper (TM) scenes used as a basis for the Washington State land cover map.

Path/Row	Name	Date
43/26	Priest Lake	8/3/91
43/27	Spokane	7/2/91
43/28	Blue Mountains	7/2/91
44/26	Republic	5/22/91
44/27	Moses Lake	5/22/91
44/28	Tricity	5/22/91
45/26	Okanogan	9/18/91
		5/31/92
45/27	Wenatchee	8/1/91
45/28	Yakima	8/1/91
46/26	North Cascades	7/7/91
46/27	Puget	7/7/91
46/28	St. Helens	7/7/91
47/26 (quarter scene)	San Juans	7/30/91
47/27	Olympics	7/30/91
47/28 (quarter scene)	Astoria	7/30/91
48/26-27 (movable scene)	Cape Flattery	7/5/91

Table 2: Ecoregions of Washington State.

Region Name	Location
Northeast Corner	Northeastern Washington; west to the Kettle Range; south to around Cheney.
Okanogan Highlands	From the eastern foothills of the Okanogan Valley to the crest of the Kettle Range; south to the Columbia Basin.
Columbia Basin	Steppe vegetation up to the lower timberline, but excluding the Blue Mountains Steppe zone to the north and east of the Blue Mountains.
Blue Mountains	The Blue Mountains, including the Blue Mountains Steppe to the north and east of the forested Blue Mountains zones.
Northeast Cascades	The northeast Cascades south to Lake Chelan.
East Central Cascades	The east central Cascades north to Lake Chelan and south to around American Ridge.
Southeast Cascades	The southeast Cascades from around American Ridge south to the Columbia River.
Northwest Cascades	The northwest Cascades south to Snoqualmie Pass.
Southwest Cascades	The southwest Cascades from Snoqualmie Pass to the Columbia River but not including the Willamette Valley.
Willamette Valley	The northern most extent of the Willamette Trough that has its major portion in Oregon; includes only the lowlands around Vancouver, Washington. (Note: the name "Willamette Valley" only indicates environmental conditions similar to those in the Willamette River drainage. The Willamette "Valley" of Washington is not drained by the Willamette River.)
Puget Sound	The flat, low valley of the Puget Sound formed by the weight and scouring of glaciers during the last ice ages.
Inner Olympic Peninsula	The east side of the Olympic Peninsula on the "rain shadow" side of the Peninsula's mountains and hills.
Outer Olympic Peninsula	The west side of the Olympic Peninsula facing the Pacific Ocean.

Table 3: Vegetation zones of Washington State.

Name	Comments
Steppe Zones	
Blue Mountains Steppe	Steppe zone to the northeast of the Blue Mountains; the *Festuca idahoensis/Rosa nutkana* zone.
Palouse	The lush meadow steppe of eastern Washington; the *Festuca idahoensis/Symphoricarpos albus* zone.
Three-tip Sage	Northern and northeastern periphery of the Columbia Basin; the *Artemisia tripartita/Festuca idahoensis* zone.
Klickitat Meadow Steppe	Fescue dominated grass and herb meadow steppe of Klickitat County; the *Festuca idahoensis/Hieracium cynoglossoides* zone.
Bitterbrush	Bitterbrush and fescue dominated zone in Klickitat County; the *Purshia tridentata/Festuca idahoensis* zone.
Central Arid Steppe	The driest, central part of the Columbia Basin; the *Artemisia tridentata/Agropyron spicatum* zone.
Wheatgrass/Fescue	Grasslands to the north and south of the Snake River; the *Agropyron spicatum/Festuca idahoensis* zone.
Canyon Grassland	Warm, dry grasslands along the Snake River and part of the Columbia River; the *Agropyron spicatum/Poa sandbergii* zone.
Big Sage/Fescue	Intermediate between the driest and most mesic steppe in the northeast part of the Columbia Basin; the *Artemisia tridentata/Festuca idahoensis* zone.
East-side Forest Zones	
Oak	Garry Oak and Garry Oak/conifer savanna, woodlands, and forest at lower elevations in the Southeast Cascades.
Ponderosa Pine	Open Ponderosa Pine forest bordering the eastern Washington steppe.
Interior Douglas-fir	Eastern Washington forest zone above the Ponderosa Pine zone.
Grand Fir	Eastern Washington forest zone usually above the Interior Douglas-fir zone.
Interior Western Hemlock and Interior Redcedar	The most mesic eastern Washington zones (combined for analysis); in the Northeast, East Central, and Southeast Cascades, usually above the Grand Fir zone.

Subalpine Fir	The subalpine forest zone up to the end of continuous timber; mostly eastern Washington, but also includes the dry subalpine forests in the Olympic Mountains rain shadow.
Blue Mountains - High Open Conifers	A minor Blue Mountains zone characterized by shrubs and open conifer woodland at high elevations.
Blue Mountains - High Basalt Ridges	A minor Blue Mountains zone characterized by sparse vegetation on high basalt ridges.
Low-elevation Lava Flows	A minor Mt Adams zone on recent lava flows below 4000 ft.
High-elevation Lava Flows	A minor Mt Adams zone on recent lava flows above 4000 ft.
West-side Forest Zones	
Willamette Valley	The northernmost extent of the Willamette Valley; identical to the Willamette Valley Region.
Cowlitz River	The Cowlitz River drainage from the plains of central Lewis County to the Columbia River.
Woodland/Prairie Mosaic	Localized western Washington grasslands and woodlands in dry lowlands in and around the Puget Sound.
Puget Sound Douglas-fir	Douglas-fir dominated forest zone of the low, flat Puget Sound.
Sitka Spruce	The low-elevation coastal forest zone in the fog belt of the Pacific Ocean.
Olympic Douglas-fir	The mid-montane forest on the rain-shadowed northeast side of the Olympic Mountains.
Western Hemlock	The low- to mid-elevation wet forest zone covering most of western Washington.
Silver Fir	The mid- to high-elevation wet forest zone of western Washington.
Mountain Hemlock	The wet subalpine zone of western Washington up to the end of continuous timber.
High-elevation Zones	
Alpine/Parkland	Treeless alpine, subalpine parkland, and patchy subalpine woodlands mixed with subalpine meadows.
Permanent Ice/Snow	The unvegetated tops of high mountain peaks and ridges.

Table 4: Primary, secondary, and tertiary cover classes used in labeling land cover polygons.

General Cover*	Attribute A	Attribute B
Unvegetated	rock/mud ice sand	basalt (a rock type)
Developed	mixed/unknown density high density moderate density low density	mixed/unknown type residential business/industrial mines roads
Agriculture	mixed/unknown irrigation status irrigated non-irrigated	mixed/unknown crop type maintained pastures/hayfields row crops orchards/vineyards soil conservation reserve bunchgrass
Open water	fresh water ocean water brackish water	mixed rivers, lakes lakes sewage ponds scabland ponds wide rivers irrigation canals
Wetlands	estuarine marsh riparian vernal pools beaches	sparsely vegetated (e.g., mudflats) graminoids and/or shrubs hardwood trees coniferous trees
Non-forested (steppe, forest openings, etc.)	unknown/mixed disturbance status disturbed (clear-cut, heavily grazed) climax	mixed types sparsely vegetated (10-30% cover) grassland (< 10% shrub cover) shrub savanna (10-25% shrub cover) shrubland (> 25% shrub cover) tree savanna (10-25% tree cover)
Hardwood forest	mixed/unknown seral stage early-seral mid-seral late-seral	mixed/unknown closure open-canopy (25-60% tree cover) closed-canopy (> 60% tree cover)
Mixed hardwood/ conifer forest	mixed/unknown seral stage early-seral mid-seral late-seral	mixed/unknown closure open-canopy (25-60% tree cover) closed-canopy (> 60% tree cover)
Conifer forest	mixed/unknown seral stage early-seral mid-seral late-seral	mixed/unknown closure open-canopy (25-60% tree cover) closed-canopy (> 60% tree cover)

*Primary, secondary and tertiary land covers were characterized by a general cover label modified by two attributes. For example, the primary land cover (the cover occupying the greatest amount of area) of a polygon in the East Central Cascades region, Douglas-fir zone, might have been described as ‘ Conifer forest, mixed/unknown seral stage, open-canopy’ and the secondary cover as ‘ Non-forested, disturbed, shrubland.’ This label would indicate a polygon containing mostly closed forest with some logged or burned areas that had regrown to the shrub stage. The region and zone suggests that the dominant trees of the forested cover are likely to be Douglas-fir, Lodgepole Pine, and/or Western Larch.

Land Cover Attributes

		Primary Cover	Occupancy Class
Ecoregion ----------	Vegetation Zone----------	Secondary Cover	Occupancy Class
		Tertiary Cover	Occupancy Class

Example

		Conifer forest-late seral	Class 4 (50%-75% cover)
NW Cascades--------	Western Hemlock----------	Shrubland-disturbed	Class 3 (25%-50% cover)
		Open water-lake	Class 1 (<5% cover)

Figure 1. Land cover classification scheme for Washington State. The example describes a polygon in the Northwest Cascades region in the Western Hemlock zone. The cover that occupies the greatest area of the polygon is late-seral conifer forest (50% to 75% of the polygon), the cover that occupies the second greatest area is shrubland created by logging or burning (25% to 50%), and the cover occupying the third greatest area is a freshwater lake (<5%). Species composition of the cover is inferred from the ecoregion and vegetation zone. Given this ecoregion and vegetation zone, the forest will usually be dominated by Western Hemlock and Douglas-fir, with smaller amounts of Western Redcedar. Redcedar will be more important along drainages and in wet areas and Douglas-fir will increase in importance in drier, warmer locales. The shrubby clearings will almost always be the result of logging, since fires are very rare in this region and zone.

Results

Steppe Zones

The nine steppe zones used in this study closely followed those defined by Daubenmire (1970). Eight of the zones lie mostly or entirely within the Columbia Basin ecoregion. Outlying zone fragments intermingle with forest zones in the neighboring mountainous regions. The Blue Mountains Steppe zone, on the eastern folds of the Washington Blue Mountains, was included within the Blue Mountains ecoregion.

Slightly over half of the steppe (51%) has been converted to agriculture (Tables 5, 6). The Palouse zone has the highest percentage (88%) of its area in agriculture and the steep, rocky Canyon Grassland zone has the lowest percentage (18%). Not surprisingly, the percentage of non-forested cover in each steppe zone declines as agriculture increases. (Non-forested cover includes tree savanna, steppe and shrub-steppe, and disturbed grassland.) An average of 42% of the area in steppe zones was classified as non-forested. The Palouse zone has the lowest percentage (7%) in non-forested and the Canyon Grassland zone has the highest percentage (71%). The greatest absolute area of non-forested cover in the steppe zones (1.46 million hectares) is in the Central Arid Steppe zone, where most communities are dominated by Big Sage (*Artemisia tridentata),* Bluebunch Wheatgrass (*Agropyron spicatum*), Sandberg' s Bluegrass (*Poa sandbergii*), and the introduced Cheatgrass (*Bromus tectorum*). None of the zones have more than 2% of their area in development, and the average area of development in steppe zones is less than 1%.

Table 5: Land cover (as a percentage of zone) for steppe zones.

	Blue Mts.	Palouse	Three-tip Sage	Klickitat Meadow	Bitterbrush	Central Arid	Wheatgr./ Fescue	Canyon Grassland	Big Sage/ Fescue	All steppe zones
Bare ground	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.09%**	**0.00%**	**0.05%**	**0.00%**	**0.05%**
Developed	**0.00%**	**0.80%**	**0.19%**	**0.48%**	**0.13%**	**1.31%**	**0.59%**	**1.89%**	**0.28%**	**0.93%**
Agriculture	**23.16%**	**88.07%**	**39.26%**	**56.80%**	**44.69%**	**45.49%**	**69.57%**	**18.49%**	**75.12%**	**51.05%**
(irrigated)	(0.00%)	(0.58%)	(2.34%)	(8.79%)	(0.00%)	(27.34%)	(3.95%)	(8.23%)	(5.18%)	(15.48%)
(non-irrigated)	(23.16%)	(87.16%)	(35.90%)	(48.01%)	(42.35%)	(17.65%)	(64.95%)	(10.22%)	(69.86%)	(35.01%)
(mixed/unk)	(0.00%)	(0.33%)	(1.02%)	(0.00%)	(2.33%)	(0.50%)	(0.67%)	(0.05%)	(0.07%)	(0.57%)
Open water and wetlands	**2.30%**	**1.31%**	**2.51%**	**0.00%**	**0.00%**	**4.62%**	**0.99%**	**6.45%**	**0.59%**	**3.31%**
(open water)	(0.41%)	(0.27%)	(0.97%)	(0.00%)	(0.00%)	(2.78%)	(0.01%)	(5.44%)	(0.14%)	(1.80%)
(ponds, marsh)	(0.00%)	(0.07%)	(0.42%)	(0.00%)	(0.00%)	(0.68%)	(0.14%)	(0.01%)	(0.05%)	(0.45%)
(riparian)	(1.89%)	(0.96%)	(1.12%)	(0.00%)	(0.00%)	(1.17%)	(0.84%)	(1.00%)	(0.40%)	(1.06%)
Non-forested	**61.44%**	**6.73%**	**51.58%**	**40.25%**	**54.70%**	**47.24%**	**28.48%**	**71.24%**	**24.01%**	**42.37%**
(sparse)	(0.00%)	(0.00%)	(0.04%)	(0.00%)	(0.24%)	(0.30%)	(0.03%)	(0.55%)	(0.00%)	(0.18%)
(grassland)	(45.63%)	(5.05%)	(23.68%)	(30.20%)	(35.73%)	(19.44%)	(24.68%)	(60.41%)	(21.48%)	(21.78%)
(shrub savanna)	(0.08%)	(0.74%)	(24.31%)	(6.71%)	(16.88%)	(19.75%)	(1.72%)	(3.69%)	(2.53%)	(15.03%)
(shrubland)	(15.70%)	(0.52%)	(2.09%)	(2.24%)	(0.00%)	(1.59%)	(1.49%)	(4.69%)	(0.00%)	(1.79%)
(tree savanna)	(0.04%)	(0.42%)	(0.61%)	(1.11%)	(1.85%)	(0.05%)	(0.17%)	(0.11%)	(0.00%)	(0.21%)
(mixed/unk)	(0%)	(0.01%)	(0.86%)	(0.00%)	(0.00%)	(6.11%)	(0.39%)	(1.80%)	(0.00%)	(3.37%)
Forested	**13.10%**	**3.09%**	**6.45%**	**2.47%**	**0.48%**	**1.24%**	**0.37%**	**1.88%**	**0.00%**	**2.31%**

Discrepancies in addition are due to rounding. Percentages are given to two decimal places, but actual precision is unknown.

Table 6: Land cover (in hectares) of steppe zones.

	Blue Mts.	Palouse	Three-tip Sage	Klickitat Meadow	Bitterbrush	Central Arid	Wheatgr./ Fescue	Canyon Grassland	Big Sage/ Fescue	All steppe zones
Bare ground	**0**	**0**	**0**	**0**	**0**	**2,717**	**0**	**100**	**0**	**2,817**
Developed	**0**	**3,729**	**2,107**	**300**	**32**	**40,570**	**5,139**	**3,943**	**571**	**56,391**
Agriculture	**15,031**	**411,701**	**426,808**	**35,790**	**10,932**	**1,404,676**	**605,478**	**38,668**	**154,531**	**3,103,615**
(irrigated)	(0)	(2,715)	(25,412)	(5,538)	(0)	(844,323)	(34,391)	(17,208)	(10,663)	(940,250)
(non-irrigated)	(15,031)	(407,446)	(390,268)	(30,251)	(10,361)	(545,061)	(565,252)	(21,361)	(143,725)	(2,128,756)
(mixed/unk)	(0)	(1,540)	(11,129)	(0)	(571)	(15,292)	(5,836)	(99)	(143)	(34,610)
Open water and wetlands	**1,491**	**6,122**	**27,293**	**0**	**0**	**142,801**	**8,604**	**13,480**	**1,224**	**201,015**
(open water)	(267)	(1,277)	(10,514)	(0)	(0)	(85,904)	(88)	(11,366)	(298)	(109,714)
(ponds, marsh)	(0)	(337)	(4,560)	(0)	(0)	(20,847)	(1,226)	(25)	(112)	(27,107)
(riparian)	(1,224)	(4,509)	(12,219)	(0)	(0)	(36,051)	(7,290)	(2,089)	(814)	(64,196)
Non-forested	**39,875**	**31,475**	**560,702**	**25,361**	**13,381**	**1,458,915**	**247,845**	**148,958**	**49,397**	**2,575,905**
(sparse)	(0)	(0)	(434)	(0)	(58)	(9,232)	(254)	(1,144)	(0)	(11,122)
(grassland)	(29,610)	(23,600)	(257,373)	(19,026)	(8,741)	(600,474)	(214,774)	(126,303)	(44,198)	(1,324,099)
(shrub savanna)	(55)	(3,458)	(264,245)	(4,229)	(4,129)	(609,837)	(14,995)	(7,722)	(5,199)	(913,873)
(shrubland)	(10,186)	(2,433)	(22,717)	(1,409)	(0)	(49,145)	(12,955)	(9,812)	(0)	(108,657)
(tree savanna)	(23)	(1,944)	(6,595)	(697)	(453)	(1,622)	(1,501)	(222)	(0)	(13,057)
(mixed/unk)	(0)	(36)	(9,339)	(0)	(0)	(188,606)	(3,362)	(3,756)	(0)	(205,099)
Forested	**8,499**	**14,448**	**70,096**	**1,557**	**118**	**38,414**	**3,201**	**3,933**	**0**	**140,266**
Total	**64,896**	**467,471**	**1,087,006**	**63,008**	**24,463**	**3,088,093**	**870,267**	**209,082**	**205,723**	**6,080,009**

Discrepancies in addition are due to rounding. Areas are given to the nearest hectare, but actual precision is unknown.

East-side Forest Zones

The major east-side forest zones are the Oak, Ponderosa Pine, Interior Douglas-fir, Grand Fir, Interior Redcedar, Interior Western Hemlock, and Subalpine Fir zones. Two minor zones in the Blue Mountains and two minor zones on Mount Adams were also recognized. The Interior Redcedar and Interior Western Hemlock zones were combined in the analysis, since they are considered very similar to one another. A disjunct part of the Subalpine Fir zone (2.3% of the entire zone in Washington) occurs in the northeastern Olympics on the west side of the State, but it was included with the main part of the zone in the analysis. The idealized forest zone sequence on the east side is Ponderosa Pine - Douglas-fir - Grand Fir - Interior Redcedar - Interior Western Hemlock - Subalpine Fir as elevation increases. The Northeast and East Central Cascades regions are most likely to show this idealized sequence, although the Grand Fir zone nearly disappears in the Northeast, and the Interior Redcedar zone is absent to rare in the East Central Cascades. The Blue Mountains region most obstinately defies attempts to identify clear zone boundaries, so some caution should be used in treating Blue Mountains zones similarly to analogous zones in other regions.

In all major east-side forest zones, forest is the predominant cover (Tables 7, 8). The average forest cover of east-side forest zones is 71% and, except for the Oak zone, conifer forest is the rule. Of the major east-side forest zones, the Oak zone has the highest percentage (43%) of its area in non-forested cover. In the other major zones, non-forested cover is between 18% and 23%. The Ponderosa Pine zone has the highest percentage of its area in development and agriculture (12% total). In all other east-side forest zones, the combined area of development and agriculture is 6% or less. The largest east-side forest zones are the Ponderosa Pine and Interior Douglas-fir zones, which cover 1.5 and 1.4 million hectares, respectively.

Table 7: Land cover (as a percentage of zone) of east-side forest zones.

	Oak	Ponderosa Pine	Interior Douglas-fir	Grand Fir	Interior Redcedar/ Hemlock	Subalpine Fir	Blue Mts. Open Forest	Blue Mts. Basalt Ridges	Lava Flows, combined	Total
Bare Ground	**0.04%**	**0.04%**	**0.00%**	**0.00%**	**0.00%**	**0.01%**	**0.00%**	**0.00%**	**0.00%**	**0.02%**
Developed	**0.27%**	**2.24%**	**0.12%**	**0.42%**	**0.05%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**0.81%**
Agriculture	**5.88%**	**9.70%**	**5.69%**	**1.93%**	**2.00%**	**0.00%**	**0.00%**	**0.00%**	**0.00%**	**5.39%**
Water	**3.09%**	**3.76%**	**1.26%**	**1.35%**	**0.59%**	**0.13%**	**0.00%**	**0.00%**	**0.00%**	**1.90%**
(open)	(1.00%)	(3.23%)	(0.80%)	(1.02%)	(0.54%)	(0.05%)	(0.00%)	(0.00%)	(0.00%)	(1.47%)
(marsh)	(0.00%)	(0.03%)	(0.20%)	(0.00%)	(0.00%)	(0.01%)	(0.00%)	(0.00%)	(0.00%)	(0.07%)
(riparian)	(2.09%)	(0.50%)	(0.26%)	(0.33%)	(0.07%)	(0.07%)	(0.00%)	(0.00%)	(0.00%)	(0.36%)
Non-forested	**42.59%**	**20.84%**	**18.24%**	**22.55%**	**19.78%**	**21.40%**	**36.52%**	**87.77%**	**27.62%**	**21.11%**
(disturbed)	(5.60%)	(7.19%)	(13.57%)	(13.40%)	(17.03%)	(6.72%)	(0.00%)	(0.00%)	(0.00%)	(10.51%)
(meadows)	(4.89%)	(0.75%)	(2.03%)	(3.62%)	(1.62%)	(12.08%)	(0.00%)	(0.00%)	(27.62%)	(3.34%)
(unknown)	(32.10%)	(12.90%)	(2.65%)	(5.53%)	(1.14%)	(2.59%)	(36.52%)	(87.77%)	(0.00%)	(7.27%)
Hardwood/ Mixed For.	**38.20%**	**1.10%**	**0.53%**	**1.52%**	**0.18%**	**0.43%**	**0.00%**	**0.00%**	**0.00%**	**2.22%**
Conifer For.	**9.93%**	**62.31%**	**74.16%**	**72.22%**	**77.39%**	**78.04%**	**63.47%**	**12.23%**	**72.38%**	**68.55%**
(open-can.)	(6.99%)	(52.40%)	(15.12%)	(16.13%)	(0.63%)	(19.33%)	(46.90%)	(12.23%)	(72.25%)	(26.11%)
(closed-can.)	(2.59%)	(9.30%)	(56.75%)	(53.17%)	(75.10%)	(58.05%)	(16.57%)	(0.00%)	(0.00%)	(41.01%)
(mixed/unk)	(0.35%)	(0.62%)	(2.29%)	(2.92%)	(1.67%)	(0.66%)	(0.00%)	(0.00%)	(0.13%)	(1.42%)

Discrepancies in addition are due to rounding. Percentages are given to two decimal places, but actual precision is unknown.

Table 8: Land cover (in hectares) of east-side forest zones.

	Oak	Ponderosa Pine	Interior Douglas-fir	Grand Fir	Interior Redcedar/ Hemlock	Subalpine Fir	Blue Mts. Open Forest	Blue Mts. Basalt Ridges	Lava Flows, combined	Total
Bare Ground	**75**	**603**	**0**	**9**	**0**	**89**	**0**	**0**	**0**	**775**
Developed	**507**	**34,510**	**1,663**	**1,915**	**250**	**0**	**0**	**0**	**0**	**38,853**
Agriculture	**10.988**	**149,378**	**79,311**	**8,819**	**10,048**	**0**	**0**	**0**	**0**	**258,544**
Water	**5,770**	**57,982**	**17,535**	**6,166**	**2,975**	**892**	**0**	**0**	**0**	**91,320**
(open)	(1,867)	(49,707)	(11,121)	(4,680)	(2,725)	(331)	(0)	(0)	(0)	(70,431)
(marsh)	(0)	(534)	(2,801)	(0)	(0)	(58)	(0)	(0)	(0)	(3,393)
(riparian)	(3,902)	(7,741)	(3.613)	(1,486)	(250)	(503)	(0)	(0)	(0)	(17,495)
Non-forested	**79,619**	**320,930**	**254,447**	**102,994**	**99,489**	**149,829**	**3,567**	**409**	**1,964**	**1,013,248**
(disturbed)	(10,471)	(110,777)	(189,293)	(61,182)	(85,617)	(47,067)	(0)	(0)	(0)	(504,407)
(meadows)	(9,146)	(11,474)	(28,255)	(16,541)	(8,162)	(84,618)	(0)	(0)	(1,964)	(160,160)
(unknown)	(60,002)	(198,679)	(36,899)	(25,271)	(5,710)	(18,144)	(3,567)	(409)	(0)	(348,681)
Hardwood/ Mixed For.	**71,415**	**16,973**	**7,455**	**6,964**	**922**	**2,979**	**0**	**0**	**0**	**106,708**
Conifer For.	**18,569**	**959,690**	**1,034,498**	**329,814**	**389,184**	**546,415**	**6,198**	**57**	**5,147**	**3,289,572**
(open-can.)	(13,071)	(806,925)	(210,966)	(73,673)	(3,145)	(135,383)	(4,580)	(57)	(5,138)	(1,252,938)
(closed-can.)	(4,848)	(143,282)	(791,613)	(242,820)	(377,663)	(406,440)	(1,618)	(0)	(0)	(1,968,284)
(mixed/unkn)	(650)	(9,483)	(31,919)	(13,322)	(8,376)	(4,592)	(0)	(0)	(9)	(68,351)
Total	**186,942**	**1,540,068**	**1,394,911**	**456,689**	**502,867**	**700,205**	**9,766**	**466**	**7,111**	**4,799,025**

Discrepancies in addition are due to rounding. Areas are given to the nearest hectare, but actual precision is unknown.

West-side Forest Zones

The major west-side forest zones are the four low-elevation Puget-Willamette Trough zones (Willamette Valley, Cowlitz River, Woodland/Prairie Mosaic, and Puget Sound Douglas-fir zones) and the Sitka Spruce, Western Hemlock, Olympic Douglas-fir, Silver Fir, and Mountain Hemlock zones. The idealized west-side zone sequence with increasing elevation is from either Sitka Spruce (along the Pacific coast) or one of the four Puget-Willamette Trough zones (inland) to Western Hemlock - Silver Fir - Mountain Hemlock. This sequence is followed over most of the west side, although elevation limits of the zones vary widely depending on rainfall and proximity to the ocean. In the rain shadow of the Olympic Mountains, the Olympic Douglas-fir zone replaces the Western Hemlock zone, and the Silver Fir and Mountain Hemlock zones are absent. A disjunct segment of the Subalpine Fir zone succeeds the Olympic Douglas-fir zone.

In the Olympic Douglas-fir, Silver Fir, and Mountain Hemlock zones, conifer forest is the rule, covering greater than 71% of each zone (Tables 9, 10). In the Sitka Spruce and Western Hemlock zones, conifer forest covers 43% and 55% of the zone, respectively, and mixed or hardwood forest covers 25% and 21%, respectively. In the four Puget-Willamette Trough zones, the combined mixed and deciduous forest cover is greater than the conifer forest cover. (Note, however, that tall shrubs and densely packed Douglas-fir seedlings have a spectral signature similar to that of hardwood and mixed forest, so some early seral conifer forest may be mislabeled as hardwood or mixed.) In the Puget-Willamette Trough zones, the decline in conifer forest cover and increase in hardwood and mixed forest has been caused by development, agriculture, and logging. Mid- and late-seral conifer forest decreases markedly from the upper elevation to the lower elevation zones and covers very little area in the Puget-Willamette Trough zones. The Willamette Valley zone has undergone the greatest conversion to agriculture and development, with 67% of its area in one of those two land covers. The largest single cover type of the west-side forest zones (covering 1.4 million hectares) is conifer forest in the Western Hemlock zone, which is generally dominated by Douglas-fir, Western Hemlock, and Western Redcedar.

Table 9: Land cover (as a percentage of zone) of west-side forest zones.

	Willamette Valley	Cowlitz River	Woodland/ Prairie	Puget Snd Douglas-fir	Sitka Spruce	Western Hemlock	Olympic Douglas-fir	Silver Fir	Mountain Hemlock	Total of west-side zones
Bare ground	**0.00%**	**0.32%**	**0.00%**	**0.00%**	**0.02%**	**0.23%**	**0.00%**	**0.57%**	**0.89%**	**0.28%**
Developed	**22.20%**	**6.83%**	**14.34%**	**24.75%**	**2.38%**	**0.58%**	**0.00%**	**0.00%**	**0.00%**	**5.69%**
(high-density)	(3.82%)	(3.32%)	(3.25%)	(4.54%)	(0.27%)	(0.03%)	(0.00%)	(0.00%)	(0.00%)	(1.04%)
(med-density)	(10.51%)	(1.71%)	(2.76%)	(7.66%)	(0.54%)	(0.08%)	(0.00%)	(0.00%)	(0.00%)	(1.69%)
(low-density)	(7.87%)	(1.51%)	(8.34%)	(12.55%)	(1.54%)	(0.48%)	(0.00%)	(0.00%)	(0.00%)	(2.94%)
(mixed/unkn)	(0.00%)	(0.28%)	(0.00%)	(0.00%)	(0.03%)	(0.00%)	(0.00%)	(0.00%)	(0.00%)	(0.01%)
Agriculture	**44.61%**	**34.36%**	**24.97%**	**19.03%**	**2.80%**	**2.62%**	**0.00%**	**0.00%**	**0.00%**	**6.51%**
Open water and wetlands	**15.91%**	**7.40%**	**4.68%**	**5.16%**	**8.09%**	**3.75%**	**0.13%**	**0.43%**	**0.85%**	**3.70%**
(open fr water)	(7.32%)	(4.63%)	(1.57%)	(2.43%)	(2.59%)	(1.56%)	(0.00%)	(0.03%)	(0.39%)	(1.54%)
(estuarine)	(0.00%)	(0.00%)	(0.00%)	(0.93%)	(1.48%)	(0.02%)	(0.00%)	(0.00%)	(0.00%)	(0.28%)
(marsh)	(1.74%)	(0.08%)	(0.40%)	(0.10%)	(0.12%)	(0.10%)	(0.00%)	(0.07%)	(0.19%)	(0.13%)
(riparian)	(6.85%)	(2.69%)	(2.59%)	(1.58%)	(2.73%)	(2.06%)	(0.13%)	(0.33%)	(0.27%)	(1.64%)
(beach)	(0.00%)	(0.00%)	(0.11%)	(0.12%)	(1.17%)	(0.01%)	(0.00%)	(0.00%)	(0.00%)	(0.11%)
Non-forested	**1.84%**	**13.73%**	**15.37%**	**5.15%**	**18.57%**	**16.32%**	**10.50%**	**24.34%**	**22.97%**	**16.01%**
(disturbed)	(1.80%)	(13.73%)	(8.84%)	(4.94%)	(17.69%)	(15.77%)	(10.26%)	(20.51%)	(9.09%)	(13.63%)
(meadows)	(0.00%)	(0.00%)	(1.97%)	(0.03%)	(0.05%)	(0.52%)	(0.24%)	(2.74%)	(13.47%)	(1.94%)
(unk origin)	(0.04%)	(0.00%)	(4.56%)	(0.18%)	(0.83%)	(0.03%)	(0.00%)	(1.09%)	(0.41%)	(0.44%)
Hardwood For	**12.05%**	**14.06%**	**9.12%**	**11.05%**	**8.61%**	**8.37%**	**0.00%**	**1.73%**	**1.57%**	**7.26%**
Mixed Forest	**2.62%**	**13.27%**	**12.57%**	**20.24%**	**16.81%**	**13.00%**	**4.52%**	**1.74%**	**0.55%**	**11.45%**
Conifer Forest	**0.77%**	**10.04%**	**18.95%**	**14.63%**	**42.71%**	**55.13%**	**84.85%**	**71.19%**	**73.17%**	**49.10%**
(early-seral)	(0.45%)	(6.95%)	(4.09%)	(5.40%)	(20.55%)	(25.01%)	(2.25%)	(13.36%)	(2.51%)	(15.86%)
(mid-seral)	(0.06%)	(3.04%)	(9.12%)	(6.93%)	(14.36%)	(20.25%)	(20.21%)	(13.23%)	(2.56%)	(13.89%)
(late-seral)	(0.00%)	(0.05%)	(2.15%)	(1.50%)	(7.54%)	(9.72%)	(62.40%)	(43.88%)	(60.44%)	(18.21%)
(mixed/unkn)	(0.26%)	(0.00%)	(3.59%)	(0.80%)	(0.26%)	(0.15%)	(0.00%)	(0.71%)	(7.66%)	(1.13%)

Discrepancies in addition are due to rounding. Percentages are given to two decimal places, but actual precision is unknown.

Table 10: Land cover (in hectares) of west-side forest zones.

	Willamette Valley	Cowlitz River	Woodland/ Prairie	Puget Snd Douglas-fir	Sitka Spruce	Western Hemlock	Olympic Douglas-fir	Silver Fir	Mountain Hemlock	Total of west-side zones
Bare ground	**0**	**291**	**0**	**0**	**87**	**5,983**	**0**	**5,406**	**4,831**	**16,598**
Developed	**15,548**	**6,248**	**22,480**	**272,809**	**10,047**	**15,101**	**0**	**0**	**0**	**342,233**
(high-density)	(2,678)	(3,040)	(5,088)	(50,075)	(1,137)	(724)	(0)	(0)	(0)	(62,743)
(med-density)	(7,360)	(1,565)	(4,320)	(84,426)	(2,267)	(1,984)	(0)	(0)	(0)	(101,922)
(low-density)	(5,511)	(1,384)	(13,071)	(138,307)	(6,512)	(12,393)	(0)	(0)	(0)	(177,178)
(mixed/unkn)	(0)	(258)	(0)	(0)	(131)	(0)	(0)	(0)	(0)	(389)
Agriculture	**31,237**	**31,453**	**39,149**	**209,756**	**11,844**	**68,379**	**0**	**0**	**0**	**391,818**
Open water and wetlands	**11,141**	**6,773**	**7,333**	**56,838**	**34,200**	**97,851**	**85**	**4,149**	**4,621**	**222,991**
(open fr water)	(5,127)	(4,242)	(2,457)	(26,785)	(10,959)	(40,744)	(0)	(314)	(2,134)	(92,762)
(estuarine)	(0)	(0)	(0)	(10,207)	(6,255)	(541)	(0)	(0)	(0)	(17,003)
(marsh)	(1,220)	(71)	(631)	(1,089)	(499)	(2,667)	(0)	(704)	(1,025)	(7,906)
(riparian)	(4,794)	(2,460)	(4,066)	(17,423)	(11,544)	(53,751)	(85)	(3,131)	(1,462)	(98,716)
(beach)	(0)	(0)	(180)	(1,333)	(4,943)	(147)	(0)	(0)	(0)	(6,603)
Non-forested	**1,287**	**12,565**	**24,099**	**56,828**	**78,476**	**425,616**	**7,087**	**232,580**	**125,154**	**963,692**
(disturbed)	(1,258)	(12,565)	(13,860)	(54,469)	(74,739)	(411,312)	(6,925)	(196,023)	(49,528)	(820,679)
(meadows)	(0)	(0)	(3,086)	(320)	(217)	(13,436)	(162)	(26,137)	(73,413)	(116,771)
(unk origin)	(30)	(0)	(7,152)	(2,039)	(3,521)	(868)	(0)	(10,421)	(2,213)	(26,244)
Hardwood For	**8,435**	**12,872**	**14,302**	**121,828**	**36,393**	**218,135**	**0**	**16,509**	**8,576**	**437,050**
Mixed Forest	**1,834**	**12,151**	**19,703**	**223,094**	**71,053**	**338,940**	**3,049**	**16,645**	**2,984**	**689,453**
Conifer Forest	**540**	**9,193**	**29,706**	**161,287**	**180,511**	**1,437,628**	**57,266**	**680,267**	**398,694**	**2,955,092**
(early-seral)	(314)	(6,358)	(6,417)	(59,487)	(86,864)	(652,171)	(1,516)	(127,669)	(13,671)	(954,467)
(mid-seral)	(42)	(2,784)	(14,299)	(76,432)	(60,679)	(528,083)	(13,639)	(126,428)	(13,940)	(836,328)
(late-seral)	(0)	(50)	(3,364)	(16,585)	(31,882)	(253,346)	(42,110)	(419,345)	(329,330)	(1,096,012)
(mixed/unkn)	(184)	(0)	(5,626)	(8,782)	(1,085)	(4,029)	(0)	(6,826)	(41,752)	(68,284)
Total	**70,022**	**91,545**	**156,773**	**1,102,439**	**422,611**	**2,607,634**	**67,487**	**955,557**	**544,860**	**6,018,928**

Discrepancies in addition are due to rounding. Areas are given to the nearest hectare, but actual precision is unknown.

High-elevation Zones

The highest-elevation zones in the State (Table 11) are the Alpine/Parkland and Permanent Ice/Snow zones. Although Alpine/Parkland is technically defined as the zone above continuous forest, a small amount (9%) of its area is conifer forest that occurs because the scale of the land cover resulted in some subalpine forest being captured in the higher zone. The Permanent Ice/Snow zone is 99% ice, snow, or rock. An estimated 1% of its area has high alpine vegetation, again included because of the scale of the map.

Table 11: Land cover of high-elevation zones.

	Alpine/ Parkland (percent)	Alpine/ Parkland (ha)		Permanent Ice/Snow (percent)	Permanent Ice/Snow (ha)
Bare ground	**18.38%**	**105,524**		**98.99%**	**43,712**
(Rock)	(1.44%)	(8,284)		(8.23%)	(3,634)
(Ice/Snow)	(16.94%)	(97,241)		(90.76%)	(40,079)
Open water and wetlands	**0.04%**	**249**		--	--
Non-forested	**72.09%**	**413,931**		**1.01%**	**447**
Conifer Forest	**9.49%**	**54,468**		--	--
		574,172			**44,159**

Discrepancies in addition are due to rounding. Percentages are given to two decimal places and areas to the nearest hectare, but actual precision is unknown.

Statewide Statistics

The land cover most common in Washington is conifer forest, covering 37% of the State compared to 7% coverage by hardwood and mixed forest combined (Table 12). The total percentage of cuts, burns, and meadows within forested zones is 11%. The total amount of steppe and arid grasslands is 15%. Agriculture and development combined cover 24% of the State.

Table 12: Land cover statewide.

	Percent of state	Area (ha)
Bare ground (includes snow, ice, basalt cliffs, Mt. St. Helens mud, ash)	**0.97%**	**169,426**
Developed	**2.50%**	**437,477**
Agriculture	**21.43%**	**3,753,977**
Open water and wetlands	**2.94%**	**515,575**
Non-forested	**28.36%**	**4,967,223**
(steppe, arid grassland in steppe zones)	(14.71%)	(2,575,905)
(cuts, burns, meadows in forested zones)	(11.28%)	(1,976,940)
(alpine, subalpine meadows)	(2.36%)	(414,378)
Hardwood/Mixed Forest	**7.13%**	**1,249,217**
Conifer Forest	**36.67%**	**6,423,392**
Total		**17,516,293**

Discrepancies in addition are due to rounding. Percentages are given to two decimals places and areas to the nearest hectare, but actual precision is unknown.

Accuracy Assessment

Resource limitations prevented an accuracy assessment of the land cover map. However, we can identify with some confidence the greatest potential sources of error, based on the difficulty in distinguishing some classes during labeling. These potential sources include:

- Difficulties in distinguishing tall shrubs, hardwood forest, mixed forest, and early-seral conifer forest, especially if there were tall shrubs among young conifers. All of these types are early-successional stages following clearing or burning of low- to mid-elevation west-side forests and tend to be intermingled with one another.
- Difficulties in distinguishing grassland, shrub savanna, and shrubland in steppe zones. The exposed soil signature often dominates in steppe zones, and uneven terrain mimics the shadowing that might be caused by shrubs.
- Difficulties in identifying seral stages of forest on rugged terrain or in dry areas. Seral stage is inferred mostly from the extent of shadowing caused by the increasing unevenness of the tree

canopy with age. On uneven terrain, shadowing is created by the topography. In dry forest, the more distant spacing of trees at all seral-stages, combined with an exposed, but often dry or sparse understory, creates a canopy structure less closely correlated with seral stage than in more mesic forests where lush dense shrubs are typically followed by a rapidly closing canopy. We generally did not attempt to assign seral stage to east-side forests, but we did usually assign seral stage to west-side forests. In areas of rugged terrain, or in the driest parts of the west-side, the seral stage designation will be least reliable.

Limitations and Discussion

Our land cover polygons were labeled to the degree to which we felt reasonably confident in our ability to separate land cover types, but confidence and accuracy depend on the familiarity of the labeler with the area being labeled, the quality of the TM scene, the topography, the cover type, and (probably most important) the time available to spend researching the area either through ground surveys, literature and expert review, or higher-resolution remote-sensing data. We intentionally avoided identifying species composition of plant communities because, with few exceptions, this attribute cannot be reliably determined from TM imagery. *Probable* species composition of a land cover polygon can be inferred from ecoregion, vegetation zone, and actual land cover, but it cannot be known with certainty from TM data alone. For example, in the Western Hemlock zone of the Southwest Cascades region, a primary land cover of early-seral, closed-canopy conifer forest implies that the predominant cover is most likely to be closed-canopy, sapling- to pole-sized Douglas-fir (the usual early-seral dominant in that region and zone) or Douglas-fir/Western Hemlock-dominated forest, but there are other, less likely possibilities for dominant tree cover, such as Western Hemlock, or a mix of Western Hemlock and Western Redcedar.

PREDICTED ANIMAL DISTRIBUTIONS AND SPECIES RICHNESS

Introduction

Species range maps are predictions about the occurrence of species within a particular area (Csuti 1994). Most species range maps, for example, the maps used in field guides, are created at a very coarse scale, and often show only range limits. GAP vertebrate modeling seeks to provide finer scale information about the current distributions of species, and to exclude inappropriate habitats within the species' range limits. With this information, better estimates can be made about the actual amount of habitat available for individual species and the configuration of the habitat.

In Gap Analysis, the predicted distributions of native vertebrate species are used to evaluate their conservation status relative to existing land management (Scott et al. 1993). Maps of vertebrate species distributions created by GAP may be used to answer a wide variety of management, planning, and research questions related to individual species or groups of species. In addition to the maps, great utility may be found in the specimen collection records and literature that are assembled into databases used to produce the maps.

Methods

Overview

Models were developed by using known locations to delineate range limits, and using known locations, literature review, and expert opinion to develop habitat associations. Predicted distributions were created by selecting appropriate habitats in the land cover map within each species' range limits.

Record Collection

Record collection methods varied among taxonomic groups. Museum data supplemented with data from research reports and reliable observations were the source of amphibian, reptile, and mammal records. The majority of bird records were from visual observations collected since 1987. Details of record collection by taxonomic group follow:

Amphibians and Reptiles: For herpetofauna, we assembled a database of 14,206 records representing 7,720 unique points (Map 4). Most records were obtained from museum collections. The museum database was supplemented with reliable observations collected from recent research projects.

Data were mapped as point locations associated by map reference number to a tabular database containing relevant information about the point. Each record in the tabular database had the following attributes: species, map reference number, mapping precision, location description, county, collector/observer name, museum or other source, museum catalog number if applicable, number of specimens, and comments. Multiple specimens from the same locality were assigned the same map

reference number (digitized point label). There were more records than points because some sites are popular collection locations and because specimens collected on a single trip were often submitted to multiple museums. The point location of each record was usually interpreted from information provided on the museum label. The precision code indicated the precision with which the mapper could interpret the information:

G - Location description was very general
N - Location description allowed plotting to within 1 mile
C - Location description allowed plotting to within 1/4 mile.

Very general locations were often assigned to a standardized point. For example, records with only the description "Mt. Rainier" were plotted at Paradise, ferry docks were used for locations given only as island names, and large parks were used for major cities.

Mammals: For mammals, we assembled a database of 23,891 records (Map 5). The majority of records (22,301) were obtained from museum collections. Almost all museum specimens were examined by Richard E. Johnson (Department of Zoology, Washington State University) to verify species' identity. Collection dates for museum records ranged from 1818 (a *Martes americana* record) to 1995. The museum database was supplemented by 1,590 records from miscellaneous sources such as hunting/trapping data, photographs, research papers and audio/visual records. These miscellaneous sources were used only if they provided unequivocal evidence of a species' identity.

The collection location of each record was determined to within a township/range (and section, if possible), usually from information on the museum label or the collector's notes. (A township/range is a political division, usually about 9.7 kilometers [6 miles] on a side, subdivided into 36 sections of 2.6 square kilometers [one square mile] each.) If the collection locale could not be located with reasonable certainty to within a township/range, the record was not included in the database, for example, museum records with location specified only to county were rejected. Records with location indicated as a city covering more than one township/range were assigned to the township/range containing the greatest area of the city unless there was some reason to believe that the location was in a different township/range.

Each record was entered into the database with the following information: species, county; month, year, township/range, section, record type (museum, photograph, etc.), source identification (a unique code for each museum or other individual source), and the number of individuals collected on that date at the same site.

Some sources of information about range limits were too general to be included in the database, but were useful in defining range limits. For example, the Washington Department of Fish and Wildlife's (WDFW) hunting take records are stored by hunting unit, where each hunting unit covers multiple township/ranges. These records were not added to the database but were helpful in delineating ranges of some of the hoofed mammals for which other data were scarce. Other valuable sources were reliable observations by biologists such as WDFW and USFS personnel, particularly for species whose museum data lagged behind recent range expansions, for example, Virginia Opossum and Moose.

Birds: We assembled a database of over 117,000 records of breeding birds in Washington (Map 6). Most records were collected from 1987 to 1996. Records were primarily from three sources: the Washington Breeding Bird Atlas project (95,417 records), the Washington Department of Fish and Wildlife shrub-steppe bird records (15,817 records, collected primarily by Fred Dobler), and the Washington Department of Fish and Wildlife' s Natural Heritage Database (6,193 records). Records from the first two sources were scrutinized and error-checked by Michael Smith and Phil Mattocks (Central Washington University). Data from the Natural Heritage Database were checked by Michael Smith. Collection methods varied for each database; methods are summarized below. Note that we included only birds known to breed in Washington.

The Breeding Bird Atlas (BBA) data were collected by volunteers within quarter-township (23.4-square kilometer [9-square mile]) ' blocks' throughout the state. Data were supplied for 2,312 of the 7,912 available blocks. The project was started in 1987 and data were collected through 1996. Birds encountered by volunteers within the blocks were assigned to one of four evidence categories:

Observed	Species observed, but no evidence of breeding
Possible	Species in suitable habitat during nesting season
	Singing male present in suitable habitat
Probable	Multiple singing males (7 or more) found during one visit
	Pair observed in suitable habitat
	Territory established
	Courtship behavior, copulation, cloacal protuberance
	Visiting probable nest site
	Agitated behavior from adults
	Nest building or excavation
Confirmed	Brood patch or egg in oviduct
	Distraction display
	Used nest or eggshells of positive identity
	Recently fledged young incapable of sustained flight
	Occupied nest; adults entering, leaving or incubating, but nest contents unseen
	Adult bringing food to a nest
	Adult removing fecal sac from nest
	Nest with eggs or young found, seen, heard

Data were entered by volunteers and imported into a GIS. The GIS coverage of BBA blocks was created by appending the Public Land Survey (PLS) coverages of the US Census Bureau' s TIGER files, then dissolving section lines to create a grid of quarter-townships. Water bodies were removed from the grid to maintain a continuous grid. This coverage had an attribute table with a record for each species for every block, with a value of 0 to 5 as shown below:

0 = No data
1 = "Observed" BBA status
2 = "Possible" BBA status
3 = "Probable" BBA status
4 = "Confirmed" BBA status
5 = Confirmed nesting evidence prior to 1987, but after 1980.

When blocks had multiple data points, the highest number between 0 and 4 was retained as the value. If no data were available except a class 5 data point, then 5 was assigned as the value.

The Washington Department of Fish and Wildlife shrub-steppe bird data did not contain enough information to yield a "probable" or "confirmed" status, so all these data were added as "possible" breeders for birds known to breed in steppe or "observed" for birds known only as migrants through the steppe (such as White-crowned Sparrow or Dark-eyed Junco). These data were collected at multiple sites throughout the Columbia Basin in habitats dominated by *Artemisia* species and were made available by Fred Dobler. The Washington Department of Fish and Wildlife's Heritage database contained records of highly variable quality. Since some records had a high degree of confidence, while others seemed highly improbable, each record (n = 6,193) was reviewed and assigned to a value as described above. If a record had any degree of uncertainty, it was interpreted conservatively, with many records being wholly removed from the database.

There was some concern over the release of sensitive data for six species: Northern Goshawk, Golden Eagle, Ferruginous Hawk, Peregrine Falcon, Prairie Falcon, and Spotted Owl. For these species, all data were generalized to, and displayed at, a township/range level.

Habitat Association

Literature review, record location, and consultation with experts were used to develop habitat associations. The availability of habitat association information varied widely among species, from exceedingly poor to more than we could use. Our challenge with all species was to translate the information from its reported scale and description to our (usually coarser) scale and descriptions. For example, an animal reported to be primarily associated with small clearings in conifer forest, but not with clear-cuts, would be associated in our models with conifer forest, not non-forested cover, because small forest openings would be well below our minimum mapping unit of 100 hectares. Our models relied on species' association with ecoregion, vegetation zone, and actual land cover, rather than cover alone. Vegetation zones are a surrogate for the combination of interacting environmental parameters (elevation, precipitation, aspect, latitude, etc.) that create conditions that favor dominance of a set of plant species. Animals often respond to the collection of environmental parameters that determine a zone, sometimes more predictably than to the actual cover type. Location information was most useful in establishing a species' presence in a vegetation zone. Detailed habitat descriptions were also helpful. On the other hand, reports of elevation limits without information about location or habitat were of limited value because a species' elevation limits are usually dependent on a combination of environmental parameters.

Habitat Quality Coding

For modeling, we created a habitat coding matrix with all possible habitats forming the rows and the species forming the columns. The habitats we used for modeling had three parts: ecoregion, vegetation zone, and actual cover. The suitability of each habitat for each species was assigned to one of eight categories:

0 - Not suitable.
1 - Present, but habitat quality unknown. (In practice, this code was never applied.)
2 - Good habitat in a core vegetation zone for that species.
3 - Adequate habitat in a core vegetation zone for that species.
4 - Land cover in a core zone that is suitable if it contains appropriate habitat below our mapping resolution; termed "contingently suitable, core zone".
5 - Good habitat in a peripheral vegetation zone for that species.
6 - Adequate habitat in a peripheral vegetation zone for that species.
7 - Land cover in a peripheral zone that is suitable if it contains appropriate habitat below our mapping resolution; termed "contingently suitable, peripheral zone".

Good habitat would be expected to be more suitable than adequate habitat. For a habitat to be labeled "contingently suitable," there had to be the possibility that imbedded suitable habitats below the minimum mapping unit were present, but these imbedded suitable habitats were not expected to occur in all or most of the larger habitats. For example, small clearings created by the death of a few large trees would be expected to occur in almost any 100 hectare forest stand, but imbedded habitats like ponds, talus slopes, caves, etc. would be less likely. For an animal associated with small clearings, forest would be good or adequate habitat (depending on the species), but for an animal associated with small ponds within forest, forest would be contingently suitable.

Core zones are zones in which the species is most common. Assuming appropriate habitat, if a species was believed to be present in a zone chiefly because of overflow from an adjacent zone (i.e., the zone was likely to be a population sink) or the population density of a species within a zone was believed to be low compared to other zones, then the zone was labeled peripheral.

Selection of At-risk Species

As part of the analysis, we selected species from each major taxonomic group that we considered to be most at risk of continued or future population declines due to human activities. The major criteria used for selection of "at-risk" species were:

- Lack of habitat suitability of human altered landscapes (developed, cultivated, heavily grazed, or logged areas),
- Dependence on late-seral forests
- A known declining trend in populations
- Susceptibility to cowbird parasitism, especially for bird species limited to low elevations
- State or Federal listing; however, some listed species were not included on our at-risk list because they have stable or increasing populations in Washington.

- Lack of large amounts of protected habitat into which the species can "retreat". Most species restricted to steppe and/or low-elevation forest zones were included if they were species that did not adapt well to development and agriculture because these species have no "retreat" into higher-elevation forests.
- Low reproductive rate combined with large area requirements which make the species susceptible to human-caused mortality (e.g., Gray Wolf, Grizzly Bear, Marten), even though habitat requirements may be quite general.
- Lack of information about the species, especially if combined with a low population or limited distribution.

Any list of this kind is, of necessity, subjective. Our list represents only our opinion and not the legal status of the species in question, and we struggled with inclusion or exclusion of many species. We assumed that migratory bird and raptor protection laws and hunting regulations will remain in effect for the foreseeable future. Our choices for "at-risk" species are listed with each taxonomic group in the Results section.

Results

Sample Maps and Complete Atlases

Sample modeled distributions with location data are shown in Maps 7, 8, and 9. Modeled distributions of all individual species are presented in Volumes 2, 3, and 4 for herpetofauna, mammals, and breeding birds, respectively. In this volume, we limit our presentation to patterns of species richness ("Results," this chapter) and protection status of individual species and species assemblages (in the chapter "Analysis Based on Stewardship and Conservation Status").

The Effect of Habitat Quality on Richness Maps

Native species richness maps for the four major taxonomic groups based on the most suitable habitats for each species (i.e., good and contingently suitable cover within the core vegetation zones), are shown in Maps 10 to 13. Richness maps for the four major taxonomic groups based on all habitats in which a species could occur, regardless of habitat quality (i.e., all suitable cover types within both core and peripheral zones) are shown in Maps 14 to 17. Both types of maps were based only on primary cover within a polygon, since inclusion of species found in secondary or tertiary habitats would weight richness towards fragmented polygons. For all of the major taxonomic groups, inclusion of less suitable vegetation zones and habitats (i.e., peripheral zones and adequate habitats, as opposed to only good or contingently suitable habitats in core zones) produced maps in which native richness declined less rapidly with elevation and with human-altered habitats (development and agriculture). In other words, native species richness based on simple presence or absence of species, rather than on the most suitable habitats, obscured the importance of lower-elevation zones and of habitats unaltered by human activity. Consequently, all subsequent vertebrate richness analyses were based on the most suitable habitats (i.e., good or contingently suitable cover types in core vegetation zones).

Note that the comparative increase of richness in low-elevation habitats and the decrease of richness in human-altered habitats using only the most suitable habitats does not imply that lower-elevation habitats and undeveloped and uncultivated habitats are best for *all* native species. It means that there are more native species for which the most suitable habitats are at lower elevations and/or undeveloped or uncultivated cover types than there are species for which the most suitable habitats include high-elevation zones and/or developed or agricultural lands.

Amphibians

Native amphibian richness (Map 10) is moderate to high in low- to mid-elevation forests of most types throughout the west side. Mid- to late- seral conifer forests in the Western Hemlock zone in the Olympics, Willapa Hills, and the southwestern Cascades have the highest species richness. On the east side, the highest richness occurs in mid-elevation, mesic forests. In the steppe zones, the highest richness occurs in irrigated fields and mesic steppe. Dryland agriculture in the steppe is not good habitat for any native amphibian. Arid steppe supports only a few amphibian species.

Columbia Basin-dependent amphibians: Most amphibian species in Washington occur on the west side. Only three species have most of their ranges within the Columbia Basin:

Tiger Salamander (*Ambystoma tigrinum*)
Great Basin Spadefoot (*Scaphiopus intermontanus*)
Woodhouse's Toad (*Bufo woodhousei*)

No richness map for these species is shown, but they are noteworthy because of the poor protection status of the Columbia Basin and its associated species (discussed in subsequent chapters).

Amphibian species most at risk of population declines due to human activities: We identified 12 "at-risk" amphibian species (see methods, this chapter, for a discussion of general criteria for selection of these species; for individual species discussions, see the Analysis Based on Land Stewardship and Management chapter):

Cope's Giant Salamander (*Dicamptodon copei*)	
Olympic Torrent Salamander (*Rhyacotriton olympicus*)	
Columbia Torrent Salamander (*Rhyacotriton kezeri*)	State Candidate
Cascades Torrent Salamander (*Rhyacotriton cascadae*)	State Candidate
Dunn's Salamander (*Plethodon dunni*)	State Candidate
Larch Mountain Salamander (*Plethodon larselli*)	State Sensitive; Fed. Species of Concern
Van Dyke's Salamander (*Plethodon vandykei*)	State Candidate
Tailed Frog (*Ascaphus truei*)	
Cascades Frog (*Rana cascadae*)	
Columbia Spotted Frog (*Rana luteiventris*)	State Candidate; Fed. Species of Concern
Oregon Spotted Frog (*Rana pretiosa*)	State Candidate; Fed. Candidate
Northern Leopard Frog (*Rana pipiens*)	State Candidate

Richness of these species (Map 18) showed a similar pattern to richness of all native amphibian species (Map 10), but the areas of highest richness are even more pronounced. The highest richness for "at-

risk" species occurs in mid-elevation, mesic to wet, mid-to late-seral, west-side forests, notably in the southwest Cascades, Olympics, and Willapa Hills.

Reptiles

Native reptile richness (Map 11) is high in the steppe zones and low-elevation, east-side forest zones in steppe habitats, open forests, and forest openings. The highest richness occurs in parts of the Oak zone in Klickitat and Yakima Counties, where several species reach their northern limits. Richness is generally low on the west side, and reptiles are virtually absent above the Western Hemlock zone. The highest richness on the west side occurs in the low-elevation Puget-Willamette Trough zones (which are warmer and drier than other west-side zones) along lakes and rivers, in forests and forest openings, and in west-side prairies. None of the native reptiles are particularly well-adapted to developed or agricultural lands. Within forested zones, richness in forest clearings is about equal to, or greater than, richness in forests, as many reptiles prefer open areas or access to open areas in which to bask.

Columbia Basin-dependent reptiles: Eight of the 21 native reptiles have ranges contained mostly within the Columbia Basin:

Short-horned Lizard (*Phrynosoma douglassii*)
Sagebrush Lizard (*Sceloporus graciosus*)
Side-blotched Lizard (*Uta stansburiana*)
Racer (*Coluber constrictor*)
Night Snake (*Hypsiglena torquata*)
Striped Whipsnake (*Masticophis taeniatus*)
Gopher Snake (*Pituophis catenifer*)
Western Rattlesnake (*Crotalus viridis*)

No richness map for these species is shown, but they are noteworthy because of the poor protection status of the Columbia Basin and its associated species (discussed in subsequent chapters).

Reptile species most at risk of population declines due to human activities: We identified seven "at-risk" reptile species (see methods, this chapter, for a discussion of general criteria for selection of these species; for individual species discussions, see the Analysis Based on Land Stewardship and Management chapter):

Western Pond Turtle (*Clemmys marmorata*)	State Endangered; Fed. Species of Concern
Short-horned Lizard (*Phrynosoma douglassii*)	
Sagebrush Lizard (*Sceloporus graciosus*)	
Side-blotched Lizard (*Uta stansburiana*)	
Night Snake (*Hypsiglena torquata*)	
Ca. Mountain Kingsnake (*Lampropeltis zonata*)	State Candidate
Striped Whipsnake (*Masticophis taeniatus*)	State Candidate

Compared to the richness patterns for reptiles in general (Map 11), the richness of these at-risk species (Map 19) is concentrated in steppe, particularly the warmest, driest steppe of the Central Arid Steppe and Canyon Grassland zones. Note, however, that one of these species (the Western Pond Turtle)

once occurred in the Puget Trough area, but is now believed to have been extirpated from there (see Volume 2 of this report).

Mammals

Native mammal richness (Map 12) is less localized geographically than richness of amphibians or reptiles. Habitats of high mammal richness tend to be riparian areas and forests in the Western Hemlock and Olympic Douglas-fir zones of the west side, and the Interior Western Hemlock, Interior Redcedar, and Grand Fir zones of the east side. The marine islands have generally low mammal richness regardless of habitat, since not all species have been able to colonize them since the last Ice Ages (see Volume 3 for more details). Richness of native species is especially low in dryland agricultural fields of the Columbia Basin and in high- and mid-density developed areas throughout the State. The patterns of species richness vary considerably among mammalian sub-groups:

- Native shrew and mole richness (Map 20) is highest in forests and wetlands of the Western Hemlock zone and the Olympic Douglas-fir zone, and in parts of the Interior Western Hemlock and Grand Fir zones of the east Cascades.
- Native bat richness (Map 21) is high in forests and wetlands of low- to mid-elevation zones. Bat richness declines with logging, agriculture, and development. It declines precipitously at high elevations. Low-elevation zones, especially on the west side, are even more important for some bat species than is indicated, since breeding females of some bat species are more restricted to lower elevations than their male counterparts. (We did not separate habitats by suitability for male and female bats.)
- Native Lagomorph richness (Map 22) is highest in steppe habitats in the Columbia Basin, but there are only six native Lagomorphs in Washington. Four are primarily species of the steppe zones and two are associated with the forested zones and the Alpine/Parkland zone. There is only one Lagomorph (the Snowshoe hare) throughout most of the forested zones. The Pika is limited to high-elevations, so Lagomorph diversity outside the Columbia Basin is highest in high-elevation forests and Alpine/Parkland where the ranges of the Pika and Snowshoe Hare overlap.
- Native Carnivora richness (Map 23) is highest in wetlands of low-elevation forest zones. Richness is also high in a variety of habitats in low- to mid-elevation west-side forest zones and mid-elevation east-side forest zones. Carnivora richness declines greatly in developed areas and is low in dryland agricultural fields of the Columbia Basin, but remains moderately high in agricultural fields of west-side zones and in irrigated fields of the Basin. Patterns of carnivore richness have been affected by human-induced local extirpations of some species and range expansions of others. For example, the very rare Gray Wolf and Grizzly Bear are restricted to the extreme northeast corner of the state and the northeast and north central Cascades, but they were once more widespread, while the Coyote has expanded its range due to forest removal and the decline of the Gray Wolf (Volume 3).
- Hoofed mammal richness (Map 24) is spotty and more dependent on the level of development and agriculture, historical extirpation and reintroduction, and current hunting pressure than on zone. Richness is low in the Columbia Basin. Among forest zones, it is largely independent of zone. Areas of high richness are more often due to incidental range overlaps than any general habitat feature. Richness is greatly reduced by development and agriculture.
- Native rodent richness (Map 25) is relatively independent of zone, but declines greatly with agriculture and development. Local areas of high richness occur in several zones, although they are

somewhat more common in the Ponderosa Pine zone than in most other zones. The relative zone independence of rodent richness compared to richness of other mammal groups is possibly due to the tendency of rodents to speciate horizontally more than other mammal groups. Competitive exclusion along horizontal boundaries is common in rodents (e.g. in ground squirrels).

- Exotic mammal richness (Map 26) is highest along the Puget Trough-Willamette Valley corridor, where development is highest, and is especially high in low-density development.

Columbia Basin-dependent mammals: Twenty native mammal species in Washington are confined mostly to the Columbia Basin. They are:

Merriam' s Shrew (*Sorex merriami*)
Small-footed Myotis (*Myotis ciliolabrum*)
Fringed Myotis *(Myotis thysanodes*)
Western Pipistrelle (*Pipistrellus hesperus*)
Spotted Bat (*Euderma maculatum*)
Pallid Bat (*Antrozous pallidus*)
Black-tailed Jack Rabbit (*Lepus californicus*)
White-tailed Jack Rabbit (*Lepus townsendii*)
Pygmy Rabbit (*Brachylagus idahoensis*)
Nuttall' s Cottontail (*Sylvilagus nuttallii*)
Yellow-bellied Marmot (*Marmota flaviventris*)
Townsend's Ground Squirrel (*Spermophilus townsendii*)
Washington Ground Squirrel (*Spermophilus washingtoni*)
Least Chipmunk (*Tamias minimus*)
Ord' s Kangaroo Rat (*Dipodomys ordii*)
Great Basin Pocket Mouse (*Perognathus parvus*)
Northern Grasshopper Mouse (*Onychomys leucogaster*)
Western Harvest Mouse (*Reithrodontomys megalotis*)
Sagebrush Vole (*Lemmiscus curtatus*)
Badger (*Taxidea taxus)*

Species richness for these Columbia Basin-dependent mammals (Map 27) is highest in uncultivated and undeveloped steppe and particularly high in steppe along the Columbia and Snake Rivers in the Central Arid Steppe and Canyon Grassland zones. The largest contiguous area of high richness occurs in the vicinity of the Yakima Training Center (DoD). Although areas of highest richness for Basin-dependents are adjacent to rivers, riparian areas themselves are not particularly high in richness for these species. (Most mammal species that inhabit wetlands in the Basin are not limited to the Basin, but also occur in forested zones).

Mammal species most at risk of population declines due to human activities: We identified 25 "at-risk" mammalian species (see methods, this chapter, for a discussion of general criteria for selection of these species; for individual species discussions, see the Analysis Based on Land Stewardship and Management chapter):

Pygmy Shrew (*Sorex hoyi*)	State Candidate
Merriam' s Shrew (*Sorex merriami*)	State Candidate
Preble' s Shrew (*Sorex preblei*)	
Keen' s Myotis (*Myotis keenii*)	

Silver-haired Bat (*Lasionycteris noctivagans*)	
Townsend's Big-eared Bat (*Plecotus townsendii*)	State Candidate; Fed. Species of Concern
Black-tailed Jack Rabbit (*Lepus californicus*)	
White-tailed Jack Rabbit (*Lepus townsendii*)	
Pygmy Rabbit (*Brachylagus idahoensis*)	State Endangered
Townsend's Ground Squirrel (*Spermophilus townsendii*)	
Washington Ground Squirrel (*Spermophilus washingtoni*)	State Candidate
Least Chipmunk (*Tamias minimus*)	
Western Gray Squirrel (*Sciurus griseus*)	State Threatened
Mazama Pocket Gopher (*Thomomys mazama*)	State Candidate; Fed. Species of Concern
Northern Grasshopper Mouse (*Onychomys leucogaster*)	
Sagebrush Vole (*Lemmiscus curtatus*)	
Gray Wolf (*Canis lupus)*	State Endangered; Fed. Endangered
Grizzly Bear (*Ursus arctos*)	State Endangered; Fed Threatened
Marten (*Martes americana*)	
Fisher (*Martes pennanti*)	State Candidate; Fed. Species of Concern
Wolverine (*Gulo gulo*)	
Badger (*Taxidea taxus*)	
Lynx (*Lynx canadensis*)	State Threatened; Fed. Species of Concern
Woodland Caribou (*Rangifer tarandus*)	State Endangered; Fed. Endangered
Bighorn Sheep (*Ovis canadensis*)	

We did not include the Northern Pocket Gopher (*Thomomys talpoides*) or the White-tailed Deer (*Odocoileus virginianus*), but both have populations of listed subspecies in Washington. We did not include the Gray-tailed Vole (*Microtus canicaudus*) although it is a State Candidate with a limited distribution because it evidently does well in agricultural areas. Areas of highest species richness for at-risk species (Map 28) in forested zones are mostly in remote areas and are usually in or around large expanses of protected areas or areas of low human population. The northeast Cascades, northeastern Washington (especially the extreme northeast), and low elevations of the northern Olympic Peninsula have high richness of at-risk species. On the west side, these species are mostly associated with mid- and late-seral conifer forests. Uncultivated steppe in parts of the Basin have as high a richness of at-risk species as the richest forested areas, although upland steppe is relatively low in species richness for native mammals in general (Map 16). There is a disproportionate number of at-risk mammals associated with upland steppe habitats because these species have no high elevation habitats to which they can "retreat." The largest contiguous tract of steppe with high richness of at-risk mammals occurs in the west-central Basin in the Hanford Nuclear Reservation/Yakima Training Center area.

Birds

Native bird richness (Map 13) is generally highest in low-elevation forests of the east side (especially in the northeastern part of the State) and in low-elevation wetlands throughout the State. However, the patterns of species richness vary markedly among avian sub-groups:

- Richness of all native non-passerines (Map 29) is highest in wetlands of low-elevation zones, because so many non-passerines are associated with wetlands. Richness is moderately high in low-elevation east-side forests and agricultural areas of the west side. In contrast to richness of passerine species (Map 30), there is no great difference in richness within steppe zones compared to forest zones.

- Native passerine richness (Map 30) is highest in low- and mid-elevation forest zones of both the east and west sides, but is especially high in low-elevation east-side forest zones. Richness is low in steppe zones, and is especially so in dryland agriculture. Richness is also low in developed areas and at high elevations. On the west side, mixed conifer/hardwood forests have higher richness than conifer forest.
- Richness of swimming bird species (loons, grebes, petrels, cormorants, geese, ducks, coots, gulls, terns, murres, auks, and puffins - Map 31) is highest in wetlands of the low-elevation zones of the Puget-Willamette Trough and the Columbia Basin. Richness is moderately high in low-elevation agricultural fields of the west side and irrigated fields of the central Columbia Basin, where many of these species occur in small wetlands (ponds, puddles, creeks, etc.) in the fields. Richness declines in the mid- and high-elevation forest zones where there are few large wetlands.
- Richness of wading bird species (bitterns, herons, egrets, cranes, rails, soras, plovers, sandpipers, avocets, stilts, and oystercatchers - Map 32) is, like that of swimming birds, highest in low-elevation wetlands and agricultural fields, but diversity drops abruptly as elevation increases and, at higher elevations, these species tend to be limited only to the largest wetlands.
- Diurnal raptor species richness (Turkey Vulture, hawks, White-tailed Kite, eagles, and falcons - Map 33) is highest in steppe and low-elevation forest zones. Although raptor richness declines somewhat with agriculture, it is less adversely affected by agriculture than richness of many other groups; many raptors thrive on grain-fed rodents. However, there are notable exceptions, such as the Northern Goshawk.
- Owl richness (Map 34) shows some similarities to raptor richness in that the richness of owl species is low at high elevations and is unaffected or increases in agricultural areas. The highest owl richness occurs in forests of the Ponderosa Pine zone on the east side and mid-elevation forests of the west side. Owl richness declines much more markedly in developed areas of the west side than does raptor richness.
- Woodpecker richness (Map 35) is highest in the low-elevation forest zones of the east-side; it is high through most of the Blue Mountains and the lower slopes of the east Cascades and Okanogan Highlands. On the west side, richness is highest in mid-elevation forests. Not surprisingly, woodpecker richness is low in the Columbia Basin.
- Flycatcher richness (Map 36) is highest in low-elevation forest zones throughout the State and drops abruptly in mid-elevation west-side zones and high-elevation east-side zones. It drops markedly with development.
- Gleaner (kinglet, vireo, warbler) richness (Map 37) is highest in low- to mid-elevation forest zones. Gleaners are virtually non-existent in the Columbia Basin. Gleaner richness is also low in most developed areas, except within parks or in wetlands and forest patches within development.
- Finch richness (Map 38) is low in the Columbia Basin, especially in dryland agriculture, and somewhat sporadically distributed through the forest zones, reflecting the very different habitat requirements of the species in this group, which range from the Gray-crowned Rosy-finch, associated with barren, high elevations, to the American Goldfinch, which thrives in open, weedy areas at low elevations. There is a tendency towards higher richness in forests of low-elevation zones.
- Native sparrow richness (Map 39) is highest in open habitats (e.g., steppe, open forest, and forest clearings) of dry to mesic zones. Richness tends to be lower in closed forest, especially mid- to

late-seral, mesic or wet, conifer forest. Sparrow richness is also low in dryland agriculture of the Columbia Basin. Local concentrations of species are somewhat random, and due mainly to the incidental overlap of the ranges of several species. The Woodland/Prairie Mosaic zone around Fort Lewis, the agricultural lands in the Willamette Valley zone of the Vancouver area, and scattered locations in the Ponderosa Pine zone are areas of high richness, but steppe habitats and many habitats of low- to mid-elevation forests throughout the state have moderately high sparrow richness.

East-side and west-side forest zone-dependent birds: There are 37 native bird species whose ranges are limited primarily to east-side forest zones, and 29 native species whose ranges are limited primarily to west-side forest zones. East-side forest zone-dependents are:

Ring-necked Duck (*Aythya collaris*)
Spruce Grouse (*Dendragapus canadensis*)
Mountain Quail (*Oreortyx pictus*) (western Washington populations are introduced)
Sandhill Crane (*Grus canadensis*)
Flammulated Owl (*Otus flammeolus*)
Great Gray Owl (*Strix nebulosa*)
Boreal Owl (*Aegolius funereus*)
Black-chinned Hummingbird (*Archilochus alexandri*)
Calliope Hummingbird (*Stellula calliope*)
Lewis' Woodpecker (*Melanerpes lewis*)
Red-naped Sapsucker (*Sphyrapicus nuchalis*)
Williamson' s Sapsucker (*Sphyrapicus thyroideus*)
White-headed Woodpecker (*Picoides albolarvatus*)
Black-backed Woodpecker (*Picoides arcticus*)
Dusky Flycatcher (*Empidonax oberholseri*)
Gray Flycatcher (*Empidonax wrightii*)
Ash-throated Flycatcher (*Myiarchus cinerascens*)
Clark' s Nutcracker (*Nucifraga columbiana*)
Mountain Chickadee (*Parus gambeli*)
Boreal Chickadee (*Parus hudsonicus*)
White-breasted Nuthatch (*Sitta carolinensis*)
Pygmy Nuthatch (*Sitta pygmaea*)
Ruby-crowned Kinglet (*Regulus calendula*)
Western Bluebird (*Sialia mexicana*)
Mountain Bluebird (*Sialia currucoides*)
Veery (*Catharus fuscescens*)
Gray Catbird (*Dumetella carolinensis*)
Nashville Warbler (*Vermivora ruficapilla*)
American Redstart (*Setophaga ruticilla*)
Northern Waterthrush (*Seiurus noveboracensis*)
Yellow-breasted Chat (*Icteria virens*)
Lazuli Bunting (*Passerina amoena*)
Green-tailed Towhee (*Pipilo chlorurus*)
Chipping Sparrow (*Spizella passerina*)
Cassin' s Finch (*Carpodacus cassinii*)
White-winged Crossbill (*Loxia leucoptera*)
Lesser Goldfinch (*Carduelis psaltria*)

East-side forest zone-dependents (Map 40) reach their highest richness in the Ponderosa Pine zone. The wettest zones of the east Cascades (the Grand Fir and Interior Western Hemlock zones) have low richness of east-side forest zone dependents, since birds that breed in these zones often also breed in the similar west-side forest zones.

West-side dependents are:

Fork-tailed Storm-Petrel (*Oceanodroma furcata*)
Leach' s Storm-Petrel (*Oceanodroma leucorhoa*)
Brandt' s Cormorant (*Phalacrocorax penicillatus*)
Pelagic Cormorant (*Phalacrocorax pelagicus*)
Green Heron (*Butorides virescens*)
White-tailed Kite (*Elanus leucurus*)
Peregrine Falcon (*Falco peregrinus*)
Snowy Plover (*Charadrius alexandrinus*)
Black Oystercatcher (*Haematopus bachmani*)
Western Gull (*Larus occidentalis*)
Glaucous-winged Gull (*Larus glaucescens*)
Common Murre (*Uria aalge*)
Pigeon Guillemot (*Cepphus columba*)
Marbled Murrelet (*Brachyramphus marmoratus*)
Cassin' s Auklet (*Ptychoramphus aleuticus*)
Rhinoceros Auklet (*Cerorhinca monocerata*)
Tufted Puffin (*Fratercula cirrhata*)
Band-tailed Pigeon (*Columba fasciata*)
Anna's Hummingbird (*Calypte anna*)
Red-breasted Sapsucker (*Sphyrapicus ruber*)
Purple Martin (*Progne subis*)
Western Scrub-Jay (*Aphelocoma californica*)
Bushtit (*Psaltriparus minimus*)
Bewick' s Wren (*Thryomanes bewickii*)
Hutton's Vireo (*Vireo huttoni*)
Black-throated Gray Warbler (*Dendroica nigrescens*)
Hermit Warbler (*Dendroica occidentalis*)
White-crowned Sparrow (*Zonotrichia leucophrys*)
Purple Finch (*Carpodacus purpureus*)

There are fewer bird species confined to west-side forest zones than east-side forest zones, and 11 of the 29 west-side forest zone dependents are ocean-dependent birds (i.e., the terrestrial land cover is relatively unimportant to them as long as they have appropriate shoreline). Richness of west-side forest zone-dependents is highest in mixed conifer/hardwood forests and wetlands at low- to moderate-elevations. The extensive mixed forests of Red Alder, Douglas-fir, and Bigleaf Maple on the west side have no major east-side equivalent, so many birds that thrive in these mixed forests are confined to the west side.

Columbia Basin-dependent birds: There are 42 native bird species with most of their Washington distribution in the Columbia Basin:

Eared Grebe (*Podiceps nigricollis*)

Western Grebe (*Aechmophorus occidentalis*)
Clark' s Grebe (*Aechmophorus clarkii*)
Great Egret (*Ardea alba*)
Black-crowned Night-Heron (*Nycticorax nycticorax*)
Northern Pintail (*Anas acuta*)
Canvasback (*Aythya valisineria*)
Redhead (*Aythya americana*)
Swainson' s Hawk (*Buteo swainsoni*)
Ferruginous Hawk (*Buteo regalis*)
Prairie Falcon (*Falco mexicanus*)
Sage Grouse (*Centrocercus urophasianus*) - a sagebrush dependent
Sharp-tailed Grouse (*Tympanuchus phasianellus*)
Black-necked Stilt (*Himantopus mexicanus*)
American Avocet (*Recurvirostra americana*)
Long-billed Curlew (*Numenius americanus*)
Ring-billed Gull (*Larus delawarensis*)
California Gull (*Larus californicus*)
Forster' s Tern (*Sterna forsteri*)
Caspian Tern (*Sterna caspia*)
Burrowing Owl (*Speotyto cunicularia*)
Long-eared Owl (*Asio otus*)
Short-eared Owl (*Asio flammeus*)
White-throated Swift (*Aeronautes saxatalis*)
Say' s Phoebe (*Sayornis saya*)
Western Kingbird (*Tyrannus verticalis*)
Eastern Kingbird (*Tyrannus tyrannus*)
Horned Lark (*Eremophila alpestris*)
Bank Swallow (*Riparia riparia*)
Black-billed Magpie (*Pica pica*)
Rock Wren (*Salpinctes obsoletus*)
Canyon Wren (*Catherpes mexicanus*)
Sage Thrasher (*Oreoscoptes montanus*) - a sagebrush dependent
Loggerhead Shrike (*Lanius ludovicianus*) - a sagebrush dependent
Brewer' s Sparrow (*Spizella breweri*) - a sagebrush dependent
Vesper Sparrow (*Pooecetes gramineus*)
Lark Sparrow (*Chondestes grammacus*)
Black-throated Sparrow (*Amphispiza bilineata*) - a sagebrush dependent
Sage Sparrow (*Amphispiza belli*) - a sagebrush dependent
Grasshopper Sparrow (*Ammodramus savannarum*)
Western Meadowlark (*Sturnella neglecta*)
Yellow-headed Blackbird (*Xanthocephalus xanthocephalus*)

Areas of highest richness of Columbia Basin-dependents (Map 42) occur in wetlands and steppe in the vicinity of major rivers and lakes. A large contiguous area of high richness occurs on the Yakima Training Center (DoD) and Hanford (DoE) areas, and north along the Columbia River and major canyons. Richness of the six sagebrush-associated species (Map 43) is especially concentrated in these areas, and sagebrush-associated species are unlikely to occur on agricultural lands.

Bird species most at risk of population declines due to human activities: We identified 38 "at-risk" bird species (see methods, this chapter, for a discussion of general criteria for selection of these species;

for individual species discussions, see the Analysis Based on Land Stewardship and Management chapter):

Common Loon (*Gavia immer*)	State Candidate
Western Grebe (*Aechmophorus occidentalis*)	
Clark' s Grebe (*Aechmophorus clarkii*)	
American Bittern (*Botaurus lentiginosus*)	
Canvasback (*Aythya valisineria*)	
Harlequin Duck (*Histrionicus histrionicus*)	
Cooper' s Hawk (*Accipiter cooperii*)	
Northern Goshawk (*Accipiter gentilis*)	State Candidate; Fed. Species of Concern
Ferruginous Hawk (*Buteo regalis*)	State Threatened
Peregrine Falcon (*Falco peregrinus*)	State Endangered; Fed. Endangered
Prairie Falcon (*Falco mexicanus*)	
Sage Grouse (*Centrocercus urophasianus*)	State Candidate
Sharp-tailed Grouse (*Tympanuchus phasianellus*)	State Candidate
Sandhill Crane (*Grus canadensis*)	State Endangered
Snowy Plover (*Charadrius alexandrinus*)	State Endangered; Fed. Threatened
Upland Sandpiper (*Bartramia longicauda*)	State Endangered
Long-billed Curlew (*Numenius americanus*)	
Caspian Tern (*Sterna caspia*)	
Black Tern (*Chlidonias niger*)	
Marbled Murrelet (*Brachyramphus marmoratus*)	State Threatened; Fed. Threatened
Flammulated Owl (*Otus flammeolus*)	State Candidate
Burrowing Owl (*Speotyto cunicularia*)	State Candidate
Spotted Owl (*Strix occidentalis*)	State Endangered; Fed. Threatened
Great Gray Owl (*Strix nebulosa*)	
Short-eared Owl (*Asio flammeus*)	
Lewis' Woodpecker (*Melanerpes lewis*)	State Candidate
White-headed Woodpecker (*Picoides albolarvatus*)	State Candidate
Pileated Woodpecker (*Dryocopus pileatus*)	State Candidate
Purple Martin (*Progne subis*)	State Candidate
Western Bluebird (*Sialia mexicana*)	
Gray Catbird (*Dumetella carolinensis*)	
Sage Thrasher (*Oreoscoptes montanus*)	State Candidate
Loggerhead Shrike (*Lanius ludovicianus*)	State Candidate
Yellow Warbler (*Dendroica petechia*)	
Yellow-breasted Chat (*Icteria virens*)	
Chipping Sparrow (*Spizella passerina*)	
Brewer' s Sparrow (*Spizella breweri*)	
Sage Sparrow (*Amphispiza belli*)	State Candidate

We excluded several State or Federally listed species from our "at-risk" group. The Bald Eagle (*Haliaeetus leucocephalus*), Golden Eagle (*Aquila chrysaetos*) were not included because they have recovered well from former population declines and are apparently stable or increasing in Washington. Vaux' s Swift (*Chaetura vauxi*) is a State Candidate, but the reason is a mystery; it is common and widespread. The Black-backed Woodpecker (*Picoides arcticus*), a State Candidate, is considered uncommon, but is apparently not declining, and much of its high-elevation habitat is protected. The Green-tailed Towhee (*Pipilo chlorurus*), a State Candidate, was not included because it apparently has always been rare and at the edge of its range in Washington, and it apparently is not declining. The Merlin (*Falco columbarius*) was not included because most of its breeding range in Washington is on

Wilderness Areas or National Parks, and its habitat appears to be peripheral in Washington. The State Endangered American White Pelican (*Pelecanus erythrorhynchos*) was not included because we did not model its distribution (Volume 4).

Areas of highest richness (Map 44) for these species show a quite different pattern than for birds in general. While bird richness in general is highest in wetlands, mixed forests, and low-elevation east-side forest zones, richness of these at-risk species is highest in upland steppe, low-elevation east-side forests, and mid- to late-seral, low- to mid-elevation west-side forests. On the east side, the Hanford Nuclear Reservation-Yakima Training Center area and north-central Washington are the largest contiguous areas of high richness. On the west side, the mid- and late-seral conifer forests of the Olympic National Park and Olympic National Forest cover the largest contiguous area of high richness.

Neotropical migrants: The 62 neotropical migrants on the Partners in Flight List "A" (Gauthreaux 1992) that breed in Washington (and that we modeled) are:

Swainson' s Hawk (*Buteo swainsoni*)
Merlin (*Falco columbarius*)
Peregrine Falcon (*Falco peregrinus*)
Upland Sandpiper (*Bartramia longicauda*)
Long-billed Curlew (*Numenius americanus*)
Band-tailed Pigeon (*Columba fasciata*)
Flammulated Owl (*Otus flammeolus*)
Burrowing Owl (*Speotyto cunicularia*)
Common Nighthawk (*Chordeiles minor*)
Black Swift (*Cypseloides niger*)
Vaux' s Swift (*Chaetura vauxi*)
White-throated Swift (*Aeronautes saxatalis*)
Black-chinned Hummingbird (*Archilochus alexandri*)
Calliope Hummingbird (*Stellula calliope*)
Rufous Hummingbird (*Selasphorus rufus*)
Olive-side Flycatcher (*Contopus borealis*)
Western Wood-Pewee (*Contopus sordidulus*)
Willow Flycatcher (*Empidonax traillii*)
Hammond' s Flycatcher (*Empidonax hammondii*)
Dusky Flycatcher (*Empidonax oberholseri*)
Gray Flycatcher (*Empidonax wrightii*)
Pacific Slope/Cordilleran Flycatcher (*Empidonax difficilis/occidentalis*)
Ash-throated Flycatcher (*Myiarchus cinerascens*)
Western Kingbird (*Tyrannus verticalis*)
Eastern Kingbird (*Tyrannus tyrannus*)
Purple Martin (*Progne subis*)
Violet-green Swallow (*Tachycineta thalassina*)
Northern Rough-winged Swallow (*Stelgidopteryx serripennis*)
Bank Swallow (*Riparia riparia*)
Cliff Swallow (*Hirundo pyrrhonota*)
Barn Swallow (*Hirundo rustica*)
House Wren (*Troglodytes aedon*)
Veery (*Catharus fuscescens*)
Swainson' s Thrush (*Catharus ustulatus*)
Gray Catbird (*Dumetella carolinensis*)

Solitary Vireo (*Vireo solitarius*)
Warbling Vireo (*Vireo gilvus*)
Red-eyed Vireo (*Vireo olivaceus*)
Orange-crowned Warbler (*Vermivora celata*)
Nashville Warbler (*Vermivora ruficapilla*)
Yellow Warbler (*Dendroica petechia*)
Black-throated Gray Warbler (*Dendroica nigrescens*)
Townsend's Warbler (*Dendroica townsendi*)
Hermit Warbler (*Dendroica occidentalis*)
American Redstart (*Setophaga ruticilla*)
Northern Waterthrush (*Seiurus noveboracensis*)
MacGillivray' s Warbler (*Oporornis tolmiei*)
Common Yellowthroat (*Geothlypis trichas*)
Wilson's Warbler (*Wilsonia pusilla*)
Yellow-breasted Chat (*Icteria virens*)
Western Tanager (*Piranga ludoviciana*)
Black-headed Grosbeak (*Pheucticus melanocephalus*)
Lazuli Bunting (*Passerina amoena*)
Green-tailed Towhee (*Pipilo chlorurus*)
Chipping Sparrow (*Spizella passerina*)
Brewer' s Sparrow (*Spizella breweri*)
Lark Sparrow (*Chondestes grammacus*)
Grasshopper Sparrow (*Ammodramus savannarum*)
Lincoln' s Sparrow (*Melospiza lincolnii*)
Bobolink (*Dolichonyx oryzivorus*)
Yellow-headed Blackbird (*Xanthocephalus xanthocephalus*)
Bullock' s Oriole (*Icterus bullockii*)

Areas of highest richness for these species (Map 45) are undeveloped and uncultivated habitats in lower-elevation forest zones, especially along the edge of the Columbia Basin. Steppe, mid- and high-elevation west-side, and high-elevation east-side zones are relatively low in neotropical migrant species. These species are also not strongly associated with late-seral forests.

Accuracy Assessment

A true accuracy assessment that tests for errors of omission and commission for each species was beyond our resources. However, in addition to the herpetofauna record locations used to construct draft models, we had a set of record locations that had been added to the database after the modeling process began. We used this additional set of records to test our draft models for errors of omission. The test set included 1,541 amphibian locations and 385 reptile locations. Most of these later records were relatively recent, but some were old records that were found near the end of record accumulation. Many of the newer records of the test set were submitted because the observer knew them to be significant as range extensions, so the test set was somewhat biased towards points outside known ranges. Nevertheless, we used the entire test set in our comparison. For amphibians, the average percentage of test points falling outside the modeled distribution for the appropriate species was 4%, with a range of 0% to 33%. The highest error rate (33%) for a species was based on three test points (i.e., one of the three test points for the species was outside the modeled distribution). For reptiles, the average percentage of test points falling outside the modeled distributions was 5%, with a range of 0%

to 71%. As for amphibians, the highest error rate came from a species with a low number of test points (seven). For both amphibians and reptiles, most of the points that fell outside the modeled distributions were outside the known range limits, rather than on unmodeled land cover types within the range limits. Our consultants for herpetofauna tended to be conservative when establishing range limits and usually did not extend a species' range limits beyond the locations of known specimens, even though some excluded habitats were similar to modeled habitats. After the comparison, the amphibian and reptile models were subsequently modified to account for the test point locations, usually by expanding the range limits of the species. Therefore, the resulting maps were based on all the available information.

This type of comparison of additional data with modeled distributions is useful, but it is not a true accuracy assessment, since only errors of omission are estimated. Errors of commission (i.e., modeling a species where it does not occur) are more difficult to assess, since a lack of records does not prove a species is absent. Obviously, if only errors of omission are measured, a modeler can easily reduce the "error" rate by expanding range limits and including more habitats, thereby increasing the chance that any new point would fall within the predicted distribution. Thus, rather than set aside data for accuracy assessments of dubious usefulness, we ultimately used all available data to improve the models and relied most heavily on expert opinion to assess the quality of each modeled distribution and to advise us on potential modifications.

Limitations and Discussion

The Subjective Nature of Habitat Quality Coding

Assignment of habitat quality codes was obviously subjective. We expected that assigning codes would be difficult and contentious, and initially planned to base our models on presence alone. We moved to habitat quality coding because the ultimate use of the maps was as an aid in biodiversity management, and management objectives should stress protection of the highest quality habitats. Models based on presence alone imply that habitats of obviously different quality are equally important in management. In practice, we found that habitat quality coding was usually easier than anticipated, although subjectivity was certainly present. Lack of confidence in assigned codes was more likely to be based on lack of knowledge than the subjective nature of code assignment.

The Effects of Land Cover Mapping Error and Resolution on Vertebrate Models

Error propagation through data layers is a serious problem in GIS manipulation of data. However, the presumption that error in a cover is equal to the product of the errors in each layer comprising that cover is an over-simplification. The effect of an error in a source layer upon a derived cover depends on what is being derived. The effect of errors in the land cover map on the final error of a vertebrate map is particularly dependent upon the species being modeled. For species that thrive in a wide variety of habitats and zones (e.g., Long-tailed Weasel or Deer Mouse) only the most severe of errors in the land cover map would produce a serious error in the predicted distributions. Other species, however, are dependent on habitat parameters that we could not map (e.g. snag density or the distribution of a particular species of moss). For these species, we could expect to correctly exclude clearly unsuitable habitats, but the remaining included habitat will likely be more extensive than the actual distribution. For

some species, vegetation zone is more important to their distribution than actual cover. In those cases, the accuracy of the modeled distribution will depend on how well the zone boundaries were mapped rather than inaccurate interpretation of the actual cover.

Scale Limitations

While Gap Analysis maps are at a finer level of resolution than most vertebrate distribution maps, they are produced at a 100-hectare minimum mapping unit and are intended for applications at the landscape scale (generally an area of thousands of hectares, or larger). Applications of these data to site- or stand-level analyses (site = a microhabitat, generally 10 to 100 square meters; stand = a single habitat type, generally 0.1 to 1,000 hectares; Whittaker 1977, Stoms and Estes 1993) are likely to be compromised by the finer-grained patterns of environmental heterogeneity that are resolved at the finer scale.

LAND STEWARDSHIP AND CONSERVATION STATUS

Introduction

For Gap Analysis, we compare the mapped distribution of elements of biodiversity with their representation in different categories of land ownership and management. These comparisons do not account for viability of biodiversity elements at any particular location, but are a start to assessing the likelihood of future threats to biotic elements through habitat conversion—the primary cause of biodiversity decline. Stewardship (i.e., the managing entity) is usually more desirable than ownership in determining Conservation Status, because it determines current management practices, but stewardship is fluid, complex, often unknown, and presumably more subject to rapid change than ownership. We used stewardship (if known) to assign Status if the stewardship seemed relatively stable. For example, the Hanford Nuclear Reservation and its surrounding buffer zones are "owned" by the DoE, but part of the buffer zone is under the stewardship of different agencies (USFWS and WDFW) and was assigned Conservation Status based on stewardship. On the other hand, a single category of land ownership/stewardship, such as a national forest, may contain several degrees of management for biodiversity which we lacked the time and information to separate.

The purpose of comparing biotic distribution with ownership/stewardship and Conservation Status is to provide a method by which land owners/stewards can assess their responsibilities, and the relative responsibilities of other owners, for the management of plant communities or vertebrate species. This information may reveal opportunities for cooperative and equitable conservation management and lead to more cohesive management plans. We emphasize, however, that GAP does not differentiate individual tracts or owners on private lands, unless the information was provided voluntarily to recognize a permanent commitment to biodiversity protection (e.g., for lands owned by the Nature Conservancy).

GAP uses a Conservation Status scale of 1-4 to denote relative degree of protection of biodiversity for each tract. Conservation Status "1" (or simply Status 1) denotes the highest, most permanent level of protection, and "4" represents the lowest level of protection. The assignment of Conservation Status is admittedly subjective, and we recognize a variety of limitations to our approach. In particular, finer gradations in the Status categories would allow the differentiation of a greater range of management strategies, but could obscure the landscape perspective with too much detail. Our four-level approach was a compromise between the disadvantages of over-generalization and the advantages of dropping some detail to better visualize the overall conservation picture. The characteristics used to determine Conservation Status are as follows:

- Permanence of protection from conversion of natural land cover to unnatural (human-induced barren, exotic dominated, arrested succession).
- Relative amount of the tract managed for natural cover.
- Inclusiveness of the management, i.e., single feature or species versus all biota.

- Type of management and degree of protection mandated through legal and institutional arrangements.

The four Status categories can be generally defined as follows (after Scott et al. 1993, Crist et al. 1995, Edwards et al. 1995):

Status 1: An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a natural state within which disturbance events (of natural type, frequency, and intensity) are allowed to proceed without interference or are mimicked through management.

Status 2: An area having permanent protection from conversion of natural land cover and a mandated management plan in operation to maintain a primarily natural state, but which may receive uses or management practices that degrade the quality of existing natural communities.

Status 3: An area having permanent protection from conversion of natural land cover for the majority of the area, but subject to extractive uses of either a broad, low-intensity type or localized intense type. It also confers protection to federally listed endangered and threatened species throughout the area.

Status 4: Lack of irrevocable easement or mandate to prevent conversion of natural habitat types to anthropogenic habitat or existence of such restrictions is unknown, allowing for intensive use throughout the tract.

Methods

Public Stewardship Cover

A Washington State digital cover of public land ownership was obtained from the Washington Department of Natural Resources in 1991. Minor corrections were made where errors were found or ownership was known to have changed. Nature Conservancy lands greater than five hectares in size were added to the cover. BLM Areas of Critical Environmental Concern (ACECs) were identified and delineated so they could be treated separately from other BLM lands.

Conservation Status

Using the ownership cover as a base, Conservation Status was assigned as follows:

- Status 1: National Parks; National Monuments; Wilderness Areas.
- Status 2: National Wildlife Refuges; State Wildlife Areas; State Parks; National Recreation Areas; Bureau of Land Management Areas of Critical Environmental Concern (BLM-ACECs); Nature Conservancy lands; Fitzner/Eberhardt Arid Lands Ecology Reserve (FEALE) on the DoE Hanford site.
- Status 3: National Forest multiple use lands; Washington Department of Natural Resources Trust lands; Municipal watersheds; BLM lands other than ACECs.

- Status 4: Private lands, other than TNC lands; Tribal lands; Department of Defense lands; Department of Energy lands (except for buffer zones around the Hanford site that were in Status 2); State lands used as University campuses, penitentiaries, etc.

Results

Major public land ownership is illustrated in Map 46. The resulting transformation of ownership and stewardship data to GAP Conservation Status is illustrated in Map 47. The following table (Table 13) lists the Conservation Status designation by owner (and managing entity if known). Status was based on current owner and general management strategies and not on specific management plans for each site.

Table 13: Conservation Status categories and managing entities.

Managing Entity	Land Type
Status 1	
National Park Service	Three National Parks (Olympic, Mt. Rainier, and North Cascades); Mt. St. Helens National Monument.
US Forest Service	27 Wilderness Areas, mostly at high elevations in mountainous areas.
Bureau of Land Management	Juniper Dunes Wilderness; the only Status 1 land in the steppe zones.
Status 2	
US Fish and Wildlife Service	National Wildlife Refuges. There are 22 NWRs in Washington (excluding Saddle Mountain NWR), but two (Black River and Grays Harbor) were established after the completion of our Status map, and we lacked digital boundaries for three small NWRs along the Columbia River (Pierce, Franz Lake, and Steigerwald Lake).
National Park Service	Four National Recreation Areas (Grand Coulee Dam, Lake Chelan, Mt. Baker, and Ross Lake), plus the San Juan Island National Historic Park
Washington (State) Department of Fish and Wildlife	Approximately 50 (State) Wildlife Areas
US Fish and Wildlife Service and DoE	Saddle Mountain NWR; part of the Hanford Nuclear Reservation buffer zone.
Washington (State) Department of Fish and Wildlife and DoE	Wahluke Slope Wildlife Area; part of the Hanford Nuclear Reservation buffer zone.
DoE	Fitzner/Eberhardt Arid Lands Ecology Reserve (FEALE); part of the Hanford Nuclear Reservation buffer zone.
Washington (State) Parks and Recreation and Washington Department of Natural Resources	Numerous State Parks.
	Areas of Critical Environmental Concern (ACECs).
The Nature Conservancy	TNC parcels (> ~5 hectares).
Washington State University	Kramer Palouse Natural Area.

Managing Entity	Land Type
Washington (State) Department of Natural Resources	Natural Area Preserves and Natural Resource Conservation Area, if known; however, we did not have digital data for most of these sites.
Status 3	
US Forest Service	"Multiple Use" lands (excludes Wilderness Areas).
Washington (State) Department of Natural Resources	Trust lands (excludes State Parks).
Bureau of Land Management	All but ACECs.
Bureaus of Reclamation	All.
Municipal Watersheds	All.
Washington State University	Smoot Hill Research Area.
County	County parks.
Status 4	
Private ownership	All except TNC.
Tribal lands	All.
DoD	All.
DoE	All, except the buffers around the Hanford Nuclear Reservation.
Counties and cities	Most city and county lands, including city parks (but some city parks are semi-natural).
Miscellaneous State	University lands (except known Research Areas and Natural Areas); State Corrections facilities.

Limitations and Discussion

Gap analyses of protection status of vertebrates and land cover were based on these specific lands, therefore lands not identified here (or changes in management plans that would influence the assigned status) will affect the analyses. The major reasons for exclusion of lands was lack of digital data at the time of the analysis. The most significant known omissions were of most of the WDNR Natural Area Preserves (NAPs) and Natural Resource Conservation Areas (NRCAs. There are 45 NAPs covering a total of about 10,500 hectares and 24 NRCAs covering a total of about 20,000 hectares. (Area estimates include estuarine habitats.) As this volume was being prepared for printing, text descriptions and a map of NAPs and NRCAs were obtained. In the Appendix, we estimated the effect that inclusion of these areas would have had on the analysis. US Forest Service Research Natural Areas were also not included.

ANALYSIS BASED ON STEWARDSHIP AND MANAGEMENT STATUS

Introduction

In previous chapters, we have presented the base data layers used in Gap Analysis. In this chapter, we present Gap Analysis for Washington State: an examination of the results of overlaying those data layers, and identification of conservation priorities. The intersection of the Conservation Status layer with land cover allows the evaluation of the status of plant communities, which may also act as surrogates for conservation status of biotic elements not mapped. The intersection of the Status cover with individual vertebrate species distributions and vertebrate richness maps allows an assessment of the conservation status of vertebrates. Vertebrates are politically important elements of biodiversity because they attract the most attention in management, and they are ecologically important because they are comparatively large creatures that, in many cases, require large areas of suitable habitat to sustain viable populations. We also looked for relationships between conservation priorities determined by land cover analysis and priorities determined from vertebrate analyses.

Gap Analysis seeks to identify habitat types and species not adequately represented in the current network of areas managed for biodiversity, but it is unrealistic to create a standard definition of "adequate representation" for either land vegetation types or individual species (Noss et al. 1995). Opinions on adequate representation will differ among users. We report both percentages and absolute area of each vegetation zone and vertebrate species in biodiversity management areas, but generally leave it to the user to determine which types are adequately represented in natural areas. For some Washington State analyses, we compared levels of representation of groups of species by counting the number of species in the group with less than 10% of their distribution on Status 1 and 2 lands.

Land Cover Analysis

Washington State differed slightly from other states in that the land cover analysis was examined within a framework of vegetation zones. Zonal analysis was preferred because:

- Division of states by vegetation zone is more ecologically appropriate than political state boundaries
- Actual vegetation will always be in a continual state of flux. It makes little sense to devise management strategies for, for example, an early-seral forest type, when that type will change within a few years. The actual vegetation within a zone, however, was an integral part of assessment of the ecological state and protection status of the zone.
- Conservation status of vegetation types as they currently exist can give a skewed impression of the actual status of the type if most of it has been already been permanently lost. For example, many of the few small remnants of Palouse grassland are on Status 2 lands, but most of the Palouse zone that was once dominated by Palouse grassland has been converted to agriculture. An assessment of the current status of remaining Palouse grasslands without consideration of status of the entire vegetation zone would give the highly misleading impression that Palouse grassland was a low conservation priority because most of what remains is adequately protected.

Actual land cover within each zone was summarized in the land cover section of this volume (Volume 5) and is discussed in more detail in Volume 1. Here, we present an analysis of land stewardship and Conservation Status by vegetation zone.

Description of the Land Cover Analysis Tables

Tables 14 to 22 summarize the Conservation Status of each vegetation zone. We divided the summaries as follows: steppe zones (Tables 14 and 15), east-side forest zones (Tables 16 and 17), west-side forest zones (Tables 18 and 19), high-elevation zones (Tables 20 and 21), and statewide statistics (Table 22). Tables 23 to 52 provide land stewardship as well as Conservation Status for each zone. In all tables, percentages are given to two decimal places and areas are given to the nearest hectare, but true precision is unknown and unlikely to be that high. Discrepancies in addition are due to rounding.

Table 14: Conservation Status of steppe zones (percent).

Steppe zone	Status 1	Status 2	Status 3	Status 4
Blue Mountains Steppe	0.00	5.91	14.30	79.79
Palouse	0.00	0.09	2.74	97.17
Three-tip Sage	0.00	1.27	12.10	86.64
Klickitat Meadow Steppe	0.00	0.38	6.49	93.13
Bitterbrush	0.00	0.00	6.93	93.07
Central Arid Steppe	0.00	5.91	9.16	84.93
Wheatgrass/Fescue	0.34	0.42	6.01	93.23
Canyon Grassland	0.00	0.59	5.19	94.22
Big Sage/Fescue	0.00	0.06	3.98	95.96
All steppe zones	0.05	3.38	8.45	88.12

Table 15: Conservation Status of steppe zones (hectares).

Steppe zone	Status 1	Status 2	Status 3	Status 4	Total
Blue Mountains Steppe	0	3,833	9,283	51,780	64,896
Palouse	0	416	12,792	454,263	467,471
Three-tip Sage	0	13,761	131,510	941,735	1,087,006
Klickitat Meadow Steppe	0	239	4,089	58,680	63,008
Bitterbrush	0	0	1,696	22,767	24,463
Central Arid Steppe	0	182,423	282,836	2,622,834	3,088,093
Wheatgrass/Fescue	2,987	3,632	52,264	811,384	870,267
Canyon Grassland	0	1,238	10,845	196,999	209,082
Big Sage/Fescue	0	119	8,197	197,407	205,723
All steppe zones	2,987	205,661	513,512	5,357,849	6,080,009

Table 16: Conservation Status of east-side forest zones (percent).

East-side forest zone	Status 1	Status 2	Status 3	Status 4
Oak	0.02	3.36	13.88	82.75
Ponderosa Pine	1.36	2.53	24.69	71.41
Interior Douglas-fir	4.51	3.14	41.46	50.89
Grand Fir	9.52	1.60	54.97	33.92
Interior Redcedar and Interior Western Hemlock	15.32	1.01	57.53	26.13
Subalpine Fir	42.22	1.32	41.45	15.02
Blue Mt, High Open Forest	80.02	0.00	19.97	0.01
Blue Mt, High Ridges	73.18	0.00	26.82	0.00
Low-elevation Lava Flows	0.00	0.00	100.00	0.00
High-elevation Lava Flows	27.71	0.00	33.12	39.17
All east-side forest zones	10.60	2.30	37.99	49.11

Table 17: Conservation Status of east-side forest zones (hectares).

East-side forest zone	Status 1	Status 2	Status 3	Status 4	Total
Oak	30	6,274	25,939	154,699	186,942
Ponderosa Pine	20,991	38,946	380,317	1,099,814	1,540,068
Interior Douglas-fir	62,931	43,753	578,316	709,911	1,394,911
Grand Fir	43,454	7,323	251,025	154,887	456,689
Interior Redcedar and Interior Western Hemlock	77,036	5,097	289,319	131,415	502,867
Subalpine Fir	295,608	9,213	290,220	105,164	700,205
Blue Mt, High Open Forest	7,815	0	1,950	1	9,766
Blue Mt, High Ridges	341	0	125	0	466
Low-elevation Lava Flows	0	0	5,209	0	5,209
High-elevation Lava Flows	527	0	630	745	1,902
All east-side forest zones	508,733	110,606	1,823,050	2,356,636	4,799,025

Table 18: Conservation Status of west-side forest zones (percent).

West-side forest zone	Status 1	Status 2	Status 3	Status 4
Willamette Valley	0.00	2.22	2.79	94.99
Cowlitz River	0.00	0.23	4.38	95.38
Woodland/Prairie Mosaic	0.00	1.54	3.05	95.41
Puget Sound Douglas-fir	0.03	1.10	7.36	91.51
Sitka Spruce	4.34	1.18	10.60	83.89
Olympic Douglas-fir	33.96	0.00	58.83	7.21
Western Hemlock	4.28	0.61	32.93	62.18
Silver Fir	27.83	1.17	53.13	17.87
Mountain Hemlock	59.43	0.86	34.57	5.15
All west-side forest zones	12.34	0.88	28.76	58.01

Table 19: Conservation Status categories of west-side forest zones (hectares)

West-side forest zone	Status 1	Status 2	Status 3	Status 4	Total
Willamette Valley	0	1,551	1,954	66,517	70,022
Cowlitz River	0	214	4,013	87,318	91,545
Woodland/Prairie Mosaic	0	2,414	4,784	149,575	156,773
Puget Sound Douglas-fir	339	12,160	81,098	1,008,842	1,102,439
Sitka Spruce	18,326	4,985	44,781	354,519	422,611
Olympic Douglas-fir	22,919	0	39,701	4,867	67,487
Western Hemlock	111,623	15,968	858,590	1,621,453	2,607,634
Silver Fir	265,963	11,153	507,693	170,748	955,557
Mountain Hemlock	323,819	4,675	188,332	28,034	544,860
All west-side forest zones	742,989	53,120	1,730,946	3,491,873	6,018,928

Table 20: Conservation Status of high-elevation zones (percent).

	Status 1	Status 2	Status 3	Status 4
Alpine/Parkland	81.10	1.77	15.43	1.70
Permanent Ice/Snow	96.12	1.47	0	2.41

Table 21: Conservation Status of high-elevation zones (hectares).

	Status 1	Status 2	Status 3	Status 4	Total
Alpine/Parkland	465,650	10,156	88,613	9,753	574,172
Permanent Ice/Snow	42,446	649	0	1,064	44,159

Table 22: Statewide Conservation Status.

	Status 1	Status 2	Status 3	Status 4	Total
Averages (percent)	10.06	2.17	23.73	64.04	100.00
Averages (hectares)	1,762,805	380,192	4,156,121	11,217,175	17,516,293

Table 23: Conservation Status and stewardship of the Blue Mountains Steppe zone (hectares).

Manager/Owner	Status 1	Status 2	Status 3	Status 4
Private				51,780
USFS			1,695	
BLM			2,710	
WDFW		3,817		
State Parks and Recreation		16		
WDNR Trust			4,878	
Total	**0**	**3,833** (5.91%)	**9,283** (14.30%)	**51,780** (79.79%)

Table 24: Conservation Status and stewardship of the Palouse zone (hectares).

Manager/Owner	Status 1	Status 2	Status 3	Status 4
Private				453,429
NWR		367		
DoD				197
WDNR State Park		28		
WDNR Trust			12,564	
State University, Research			229	
State University, Reserve		12		
State University, other				637
TNC		9		
Total	**0**	**416** (0.09%)	**12,792** (2.74%)	**454,263** (97.17%)

Table 25: Conservation Status and stewardship of the Three-tip Sage zone (hectares).

Manager/Owner	Status 1	Status 2	Status 3	Status 4
Private				763,002
USFS			25,950	
National Recreation Area		1,670		
BLM ACEC		612		
BLM, other			6,830	
WDFW		9,680		
WDNR State Park		1,658		
WDNR Trust			98,731	
Colville Indian Res.				56,502
Yakama Indian Res.				122,231
TNC		142		
Total	**0**	**13,761** (1.27%)	**131,510** (12.10%)	**941,735** (86.64%)

Table 26: Conservation Status and stewardship of the Klickitat Meadow Steppe zone (hectares).

Manager/Owner	Status 1	Status 2	Status 3	Status 4
Private				58,680
BLM			17	
WDFW		239		
WDNR Trust			4,072	
Total	**0**	**239** (0.38%)	**4,089** (6.49%)	**58,680** (93.13%)

Table 27: Conservation Status and stewardship of the Bitterbrush zone (hectares).

Manager/Owner	Status 1	Status 2	Status 3	Status 4
Private				22,724
BLM			125	
WDNR Trust			1,571	
Yakama Indian Res.				43
Total	**0**	**0**	**1,696** (6.93%)	**22,767** (93.07%)

Table 28: Conservation Status and stewardship of the Central Arid Steppe zone (hectares).

Manager/Owner	Status 1	Status 2	Status 3	Status 4
Private				2,167,784
USFS			14,108	
National Recreation Area		554		
NWR (excl. Saddle Mt. NWR)		16,452		
BLM ACEC		4,349		
BLM, other			49,065	
DoE (FEALE, Wahluke Slope, Saddle Mt. NWR)		72,950		
DoE (Hanford core area)				103,600
DoD				107,344
Bureau of Reclamation				241
WDFW		79,528		
WDNR State Park		8,066		
WDNR Trust			219,663	
State University				254
Yakama Indian Res.				204,422
Colville Indian Res.				39,189
TNC		524		
Total	**0**	**182,423** (5.91%)	**282,836** (9.16%)	**2,622,834** (84.93%)

Table 29: Conservation Status and stewardship of the Wheatgrass/Fescue zone (hectares).

Manager/Owner	Status 1	Status 2	Status 3	Status 4
Private				810,693
BLM ACEC		3,134		
BLM Wilderness	2,987			
BLM, other			3,195	
DoE				289
WDFW		284		
State Parks and Recreation		115		
WDNR State Park		100		
WDNR Trust			49,069	
State Dept. of Corrections				403
Total	**2,987** (0.34%)	**3,632** (0.42%)	**52,264** (6.01%)	**811,385** (93.23%)

Table 30: Conservation Status and stewardship of the Canyon Grassland zone (hectares).

Manager/Owner	Status 1	Status 2	Status 3	Status 4
Private				196,999
BLM ACEC		23		
BLM, other			312	
WDFW		364		
State Parks and Recreation		851		
WDNR Trust			10,532	
Total	**0**	**1,238** (0.59%)	**10,845** (5.19%)	**196,999** (94.22%)

Table 31: Conservation Status and stewardship of the Big Sage/Fescue zone (hectares).

Manager/Owner	Status 1	Status 2	Status 3	Status 4
Private				197,407
BLM			64	
WDNR Trust			8,133	
TNC		119		
Total	**0**	**119** (0.06%)	**8,197** (3.98%)	**197,407** (95.96%)

Table 32: Conservation Status and stewardship of the Oak zone (hectares).

Manager/Owner	Status 1	Status 2	Status 3	Status 4
Private				126,750
USFS			6,884	
Wilderness Area	30			
Federal (mgmt. unknown)				91
BLM			3,537	
WDFW		6,210		
State Parks and Recreation		63		
WDNR Trust			15,518	
Yakama Indian Res.				27,859
Total	**30** (0.02%)	**6,274** (3.36%)	**25,939** (13.88%)	**154,699** (82.75%)

Table 33: Conservation Status and stewardship of the Ponderosa Pine zone (hectares).

Manager/Owner	Status 1	Status 2	Status 3	Status 4
Private				743,905
USFS			251,237	
Wilderness Area	20,778			
National Park	212			
National Recreation Area		3,853		
NWR		7,445		
BLM ACEC		226		
BLM, other			5,396	
DoD				1,777
WDFW		23,536		
State Parks and Recreation		3,887		
WDNR Trust			123,608	
University, Research			74	
State (mgmt. unknown)				416
County Parks			2	
Yakama Indian Res.				93,910
Colville Indian Res.				219,936
Kalispell Indian Res.				357
Spokane Indian Res.				39,513
Total	**20,991** (1.36%)	**38,946** (2.53%)	**380,317** (24.69%)	**1,099,814** (71.41%)

Table 34: Conservation Status and stewardship of the Interior Douglas-fir zone (hectares).

Manager/Owner	Status 1	Status 2	Status 3	Status 4
Private				487,892
USFS			445,016	
Wilderness Area	52,937			
National Park	9,995			
National Recreation Area		21,909		
NWR		5,960		
Federal (mgmt. unknown)				167
BLM ACEC		35		
BLM, other			8,262	
WDFW		8,313		
State Parks and Recreation		7,470		
WDNR State Parks		67		
WDNR Trust			124,886	
County Parks			151	
Yakama Indian Res.				37,952
Colville Indian Res.				159,339
Kalispell Indian Res.				577
Spokane Indian Res.				23,984
Total	**62,931** (4.51%)	**43,753** (3.14%)	**578,315** (41.46%)	**709,911** (50.89%)

Table 35: Conservation Status and stewardship of the Grand Fir zone (hectares).

Manager/Owner	Status 1	Status 2	Status 3	Status 4
Private				137,295
USFS			234,126	
Wilderness Area	43,454			
NWR		4,584		
WDFW		2,386		
State Parks and Recreation		353		
WDNR Trust			16,898	
Yakama Indian Res.				16,703
Colville Indian Res.				889
Total	**43,454** (9.52%)	**7,323** (1.60%)	**251,024** (54.97%)	**154,887** (33.92%)

Table 36: Conservation Status and stewardship of the combined Interior Western Hemlock and Interior Redcedar zones (hectares).

Manager/Owner	Status 1	Status 2	Status 3	Status 4
Private				130,466
USFS			262,504	
Wilderness Area	77,036			
NWR		4,900		
BLM			1,944	
WDFW		140		
State Parks and Recreation		57		
WDNR Trust			24,872	
Kalispell Indian Res.				949
Total	**77,036** (15.32%)	**5,097** (1.01%)	**289,320** (57.53%)	**131,415** (26.13%)

Table 37: Conservation Status and stewardship of the Subalpine Fir zone (hectares).

Manager/Owner	Status 1	Status 2	Status 3	Status 4
Private				22,199
USFS			262,750	
Wilderness Area	272,048			
National Park	23,560			
National Recreation Area		7,408		
NWR		792		
BLM			711	
WDFW		1,014		
WDNR Trust			26,759	
Yakama Indian Res.				61,142
Colville Indian Res.				21,823
Total	**295,608** (42.22%)	**9,213** (1.32%)	**290,220** (41.45%)	**105,164** (15.02%)

Table 38: Conservation Status and stewardship of the Blue Mountains High Open Forest zone (hectares).

Manager/Owner	Status 1	Status 2	Status 3	Status 4
Private				1
USFS			1,950	
Wilderness Area	7,815			
Total	**7,815** (80.02%)	**0**	**1,950** (19.97%)	**1** (0.01%)

Table 39: Conservation Status and stewardship of the Blue Mountains High Basalt Ridges zone (hectares).

Manager/Owner	Status 1	Status 2	Status 3	Status 4
USFS			125	
Wilderness Area	341			
Total	**341** (73.18%)	**0**	**125** (26.82%)	**0**

Table 40: Conservation Status and stewardship of the Low-elevation Lava Flow zone (hectares).

Manager/Owner	Status 1	Status 2	Status 3	Status 4
USFS			5,209	
Total	**0**	**0**	**5,209** (100.00%)	**0**

Table 41: Conservation Status and stewardship of the High-elevation Lava Flow zone (hectares).

Manager/Owner	Status 1	Status 2	Status 3	Status 4
USFS			630	
Wilderness Area	527			
Yakama Indian Res.				745
Total	**527** (27.71%)	**0**	**630** (33.12%)	**745** (39.17%)

Table 42: Conservation Status and stewardship of the Willamette Valley zone (hectares).

Manager/Owner	Status 1	Status 2	Status 3	Status 4
Private				66,144
NWR		1,103		
WDFW		196		
State Parks and Recreation		252		
WDNR Trust			1,772	
County Parks			182	
Mgmt./owner unknown				373
Total	**0**	**1,551** (2.22%)	**1,954** (2.79%)	**66,517** (94.99%)

Table 43: Conservation Status and stewardship of the Cowlitz River zone (hectares).

Manager/Owner	Status 1	Status 2	Status 3	Status 4
Private				87,318
State Parks and Recreation		214		
WDNR Trust			4,013	
Total	**0**	**214** (0.23%)	**4,013** (4.38%)	**87,318** (95.38%)

Table 44: Conservation Status and stewardship of the Woodland/Prairie Mosaic zone (hectares).

Manager/Owner	Status 1	Status 2	Status 3	Status 4
Private				114,884
NPS Historic Park		496		
NWR		55		
BLM Historic Park		77		
BLM, other			36	
DoD				32,024
WDFW		463		
State Parks and Recreation		1,322		
WDNR Trust			4,748	
Chehalis Indian Res.				1,517
Swinomish Indian Res.				314
Nisqually Indian Res.				472
Mgmt./owner unknown				365
Total	**0**	**2,414** (1.54%)	**4,784** (3.05%)	**149,575** (95.41%)

Table 45: Conservation Status and stewardship of the Puget Sound Douglas-fir zone (hectares).

Manager/Owner	Status 1	Status 2	Status 3	Status 4
Private				964,082
USFS			1,764	
National Park	317			
Wilderness Area	22			
NPS Historic Park		194		
NWR		953		
DoD				14,561
WDFW		3,912		
State Parks and Recreation		6,870		
WDNR Trust			74,727	
State Dept. of Corrections				875
State University				704
State (mgmt. unknown)				470
County Park			55	
County (mgmt. unknown)				126
Municipal Watershed			3,440	
Lower Elwah Indian Res.				159
Skokomish Indian Res.				72
Lummi Indian Res.				4,017
Swinomish Indian Res.				2,638
Tulalip Indian Res.				8,261
Port Gamble Indian Res.				497
Port Madison Indian Res.				1,344
Squaxin Indian Res.				438
Puyallup Indian Res.				7,485
Muckleshoot Indian Res.				7,459
Nisqually Indian Res.				84
TNC		231		
Park (mgmt. unknown)			1,112	
Mgmt./owner unknown				1,570
Total	**339** (0.03%)	**12,160** (1.10%)	**81,098** (7.36%)	**1,008,842** (91.51%)

Table 46: Conservation Status and stewardship of the Sitka Spruce zone (hectares).

Manager/Owner	Status 1	Status 2	Status 3	Status 4
Private				272,215
USFS			2,962	
National Park	18,326			
NWR		1,962		
BLM			7	
DoD				196
WDFW		1,285		
State Parks and Recreation		1,696		
WDNR Trust			39,873	
State (mgmt. unknown)				398
County Parks			76	
Municipal Watershed			1,863	
Makah Indian Res.				4,962
Ozette Indian Res.				304
Quileute Indian Res.				377
Hoh Indian Res.				188
Quinault Indian Res.				75,742
Shoalwater Indian Res.				138
TNC		42		
Total	**18,326** (4.34%)	**4,985** (1.18%)	**44,781** (10.60%)	**354,519** (83.89%)

Table 47: Conservation Status and stewardship of the Olympic Douglas-fir zone (hectares).

Manager/Owner	Status 1	Status 2	Status 3	Status 4
Private				4,867
USFS			29,841	
Wilderness Area	5,832			
National Park	17,086			
WDNR Trust			9,759	
Municipal Watershed			101	
Total	**22,919** (33.96%)	**0**	**39,701** (58.83%)	**4,867** (7.21%)

Table 48: Conservation Status and stewardship of the Western Hemlock zone (hectares).

Manager/Owner	Status 1	Status 2	Status 3	Status 4
Private				1,603,312
USFS			377,972	
Wilderness Area	13,863			
National Park	88,921			
National Monument	8,839			
National Recreation Area		9,583		
NWR		913		
BLM			50	
DoD				2,891
Federal (mgmt. unknown)				157
WDFW		475		
State Parks and Recreation		4,772		
WDNR Trust			456,216	
County Park			76	
Municipal Watershed			22,493	
Makah Indian Res.				6,067
Quinault Indian Res.				5,395
Skokomish Indian Res.				1,959
Chehalis Indian Res.				257
TNC		227		
Parks (mgmt. unknown)			107	
Experimental Forest			1,676	
Mgmt./owner unknown				1,414
Total	**111,623** (4.28%)	**15,968** (0.61%)	**858,590** (32.93%)	**1,621,453** (62.18%)

Table 49: Conservation Status and stewardship of the Silver Fir zone (hectares).

Manager/Owner	Status 1	Status 2	Status 3	Status 4
Private				169,318
USFS			402,878	
Wilderness Area	64,224			
National Park	175,911			
National Monument	25,828			
National Recreation Area		10,722		
DoD				2
State Parks and Recreation		431		
WDNR Trust			93,002	
Municipal Watershed			11,813	
Quinault Indian Res.				1,428
Total	**265,963** (27.83%)	**11,153** (1.17%)	**507,693** (53.13%)	**170,748** (17.87%)

Table 50: Conservation Status and stewardship of the Mountain Hemlock zone (hectares).

Manager/Owner	Status 1	Status 2	Status 3	Status 4
Private				25,511
USFS			178,488	
Wilderness Area	180,412			
National Park	133,036			
National Monument	10,371			
National Recreation Area		4,360		
State Parks and Recreation		314		
WDNR Trust			9,572	
Municipal Watershed			272	
Yakama Indian Res.				2,523
Total	**323.819** (59,43%)	**4,675** (0.86%)	**188,332** (34.57%)	**28,034** (5.15%)

Table 51: Conservation Status and stewardship of the Alpine/Parkland zone (hectares).

Manager/Owner	Status 1	Status 2	Status 3	Status 4
Private				3,456
USFS			84,023	
Wilderness Area	290,976			
National Park	174,673			
National Recreation Area		9,648		
BLM			106	
WDFW		509		
WDNR Trust			4,485	
Yakama Indian Res.				4,561
Colville Indian Res.				1,738
Total	**465,650** (81.10%)	**10,156** (1.77%)	**88,614** (15.43%)	**9,755** (1.70%)

Table 52: Conservation Status and stewardship of the Permanent Ice/Snow zone (hectares).

Manager/Owner	Status 1	Status 2	Status 3	Status 4
Wilderness Area	20,305			
National Park	22,142			
National Recreation Area		649		
Yakama Indian Res.				1,064
Total	**42,447** (96.12%)	**649** (1.47%)	**0**	**1,064** (2.41%)

Stewardship Analysis

In most steppe zones, the major land stewards are private owners and the Washington Department of Natural Resources (WDNR), but some steppe zones (particularly the Central Arid Steppe) have substantial amounts of their areas on Tribal lands, Department of Defense (DoD) lands, or Department of Energy (DoE) lands. Other significant land holders of steppe are the Yakama and Colville Tribes, the WDFW, and the USFWS. Unlike many western states, little of the grazing land in Washington is under the stewardship of the BLM, but the agency does manage the only designated Wilderness Area within the steppe zones: the Juniper Dunes in Franklin County.

Ownership of forest zones depends greatly upon zone, with private lands dominating within lower-elevation zones; WDNR Trust lands and USFS multiple use lands within mid-elevation zones; and National Parks and Wilderness Areas within high-elevation zones. Some zones have substantial area on Tribal lands. The DoD is a prominent land holder in the Puget Sound Douglas-fir, Woodland/Prairie Mosaic, and Western Hemlock zones.

Conservation Status Analysis

Overview: For the state as a whole, Washington has more than 12% of its terrestrial lands in Status 1 or 2, but the analysis by zone clearly indicates that the distribution of these lands is strongly skewed toward high-elevation zones. All steppe zones have less than 6% of their area in Status 1 or 2 lands. Forest zones with less than 10% of their area in Status 1 or 2 lands are all low to mid-elevation zones. Forest zones with 20% to 50% of their area in Status 1 or 2 lands are mid to high-elevation forest zones. The only zones with greater than 50% of their area in Status 1 or 2 lands are the two minor Blue Mountain zones, the high-elevation Mountain Hemlock zone, the Alpine/Parkland zone, and the Permanent Ice/Snow zone.

Steppe zones: The steppe zones as a group are very poorly represented on Conservation Status 1 lands, poorly represented on Status 2 lands, poorly to moderately well-represented on Status 3 lands, and very well represented on Status 4 lands. The only Status 1 land is the Juniper Dunes Wilderness within the Wheatgrass/Fescue zone. This Wilderness Area accounts for 0.34% of the area in the Wheatgrass/Fescue zone and 0.05% of the total area in all steppe zones combined. An average of 3.38% of the area within the steppe zones is on Status 2 lands, with the percentage within individual zones ranging from 0% to 5.91%. Status 2 lands in the steppe zones consist largely of National Wildlife Refuges, State Wildlife Areas, and the buffer zones around the Hanford Nuclear Reservation which are currently managed by the WDFW and USFWS.

East-side forest zones: The Conservation Status of east-side forest zones varies widely among zones and is strongly dependent on the location of the zone along an elevation gradient. The average percentage of east-side forest zones in Status 1 lands is 10.60%, but in major zones it varies from near zero for the Oak zone to 42.22% for the Subalpine Fir zone. In most east-side forest zones, the percentage of Status 2 lands is relatively low, but in the low-elevation zones (especially Oak and Ponderosa Pine), Status 2 lands comprise most of the area in the zone managed primarily for

biodiversity protection. Most east-side forest zones are well-represented on Status 3 lands, with an average of 37.99%. The percentage of the zone in Status 3 lands generally increases with elevation, while the percentage of each zone in Status 4 lands decreases. The Oak zone has 82.75% of its area in Status 4 lands, while the Subalpine Fir zone has 15.02% of its area in Status 4 lands. The two minor Blue Mountain zones have virtually none of their area in Status 4 lands. The minor Low-elevation Lava Flow zone has all of its area in Status 3 lands and the High-elevation Lava Flow zone is about evenly split among Status 1, 3, and 4 lands.

West-side forest zones: Conservation Status of west-side forest zones varies widely among zones and is also strongly dependent on the location of the zone along an elevation gradient. The average percentage of west-side forest zones in Status 1 lands is 12.34%, but it ranges from zero or near zero for the four Puget-Willamette Trough zones to 59.43% for the Mountain Hemlock zone. In most west-side forest zones, the percentage of Status 2 lands is relatively low, but in the low-elevation zones (especially the four Puget-Willamette Trough zones), Status 2 lands comprise most of the area in the zone managed primarily for biodiversity protection. The mid- to high-elevation west-side forest zones are well-represented on Status 3 lands, while the low-elevation zones are poorly to moderately represented. The percentage of each zone in Status 3 lands generally increases with elevation, while the percentage of each zone in Status 4 lands generally decreases. The four Puget-Willamette Trough zones all have more than 91% of their area in Status 4 lands, while the Mountain Hemlock zone has 5.15% of its area in Status 4.

High-elevation zones: Both the Alpine/Parkland and Permanent Ice/Snow zone are exceptionally well-represented on Status 1 lands, with 81.10% and 96.12%, respectively, of their area in Status 1 lands.

Conservation Priority Index (CPI)

The percentage of a zone in the Conservation Status categories is useful information, but is sometimes misleading and gives no indication of other critical factors in determining conservation priority. For example, the Low-elevation Lava Flow zone is contained entirely within Status 3 lands of the Gifford-Pinchot National Forest and thus has no representation on Status 1 or 2 lands. However, the zone constitutes a very small, specialized type, has not been developed or cultivated, and is unlikely to be developed or cultivated any time in the near future. Other zones, by comparison, may have some representation on Status 1 or 2 lands, but have been almost entirely converted to development or agriculture outside of protected lands. Therefore, we devised a Conservation Priority Index (CPI) that included the percentage of protected land, the percentage of land converted to development or agriculture, and a weighting factor for zone size:

CPI = ((100 - % protected)/(100 - % converted)) * log(total area in the zone).

We wanted to de-emphasize minor zones (since GAP is chiefly concerned with landscape scale, regional issues) and take into account the amount of the zone that had already been semi-permanently converted from natural cover. With this CPI (Table 53, Map 48), the Palouse is ranked, by far, as the zone with the highest conservation priority because of the small percentage of its area on protected land,

its near total conversion to agriculture, and its moderately large size. Two similar zones, Big Sage/Fescue and Wheatgrass Fescue, rank second and third. Much of their area has also been converted to agriculture. The remainder of the steppe zones have moderate to high CPIs as well. The Blue Mountain Steppe and Canyon Grassland zones, because their more rugged topography discourages farming, have the lowest CPIs of the steppe zones, but still have CPIs higher than most east-side forest zones.

The CPIs of the east-side forest zones are generally correlated with zonal position along an elevation gradient, except that the Oak zone has a lower index than the much larger Ponderosa Pine and Interior Douglas-fir zones. The four minor zones (Low- and High-elevation Lava Flows and the Blue Mountain zones) have low or very low CPIs.

On the west side, the four low-elevation zones of the developed Puget-Willamette Trough (the Willamette Valley, Puget Sound Douglas-fir, Cowlitz River, and Woodland/Prairie Mosaic zones) have the highest CPIs. All of these zones have low percentages of their areas on protected lands and have high percentages converted to development and agriculture. The Willamette Valley zone, although small, has the highest CPI of the west-side forest zones and the fourth highest CPI of all zones in the state. Three steppe zones rank higher.

The two highest-elevation zones, Alpine/Parkland and Permanent Ice/Snow, both have very low CPIs. The Permanent Ice/Snow zone has the lowest CPI in the state, which is not surprising. The Alpine/Parkland zone has a higher CPI than the two minor Blue Mountain zones because the latter are so small and both have nearly as high a percentage of their area in Status 1 and 2 lands as the Alpine/Parkland zone.

To compare zones statewide by CPI, we divided them into five groups (high, moderately high, intermediate, moderately low, and low CPI) as follows:

High CPI

Palouse	(a steppe zone)
Big Sage/Fescue	(a steppe zone)
Wheatgrass/Fescue	(a steppe zone)
Willamette Valley	(a west-side forest zone)

Moderately high CPI

Central Arid Steppe	(a steppe zone)
Klickitat Meadow Steppe	(a steppe zone)
Puget Sound Douglas-fir	(a west-side forest zone)
Three-tip Sage	(a steppe zone)
Cowlitz River	(a west-side forest zone)
Woodland/Prairie Mosaic	(a west-side forest zone)
Bitterbrush	(a steppe zone)

Intermediate CPI

Ponderosa Pine	(an east-side forest zone)
Canyon Grassland	(a steppe zone)
Western Hemlock	(a west-side forest zone)
Interior Douglas-fir	(an east-side forest zone)
Blue Mountains Steppe	(a steppe zone)
Sitka Spruce	(a west-side forest zone)
Oak	(an east-side forest zone)
Grand Fir	(an east-side forest zone)
Interior Western Hemlock/Redcedar	(east-side forest zones)

Moderately low CPI

Silver Fir	(a west-side forest zone)
Low-elevation Lava Flows	(an east-side forest zone)
Subalpine Fir	(an east-side forest zone)
Olympic Douglas-fir	(a west-side forest zone)
High-elevation Lava Flows	(an east-side forest zone)
Mountain Hemlock	(a west-side forest zone)

Low CPI

Alpine/Parkland	(a high-elevation zone)
Blue Mt High Open Conifers	(an east-side forest zone)
Blue Mt. High ridges	(an east-side zone)
Permanent Ice/Snow	(a high-elevation zone)

Zones of high or moderately high CPI are all steppe zones or west-side forest zones in the Puget-Willamette Trough (the Puget Sound Douglas-fir, Woodland/Prairie Mosaic, Willamette Valley, and Cowlitz River zones). Since the amount of development and agriculture is a component of the CPI, zones of highest CPI have little remaining undeveloped or uncultivated land (Map 49). Thus, areas of highest CPI also have the fewest options available for future management strategies that seek to improve their conservation status.

Table 53: Conservation Priority Index (CPI) for each zone, sorted in decreasing order within steppe, east-side forest, west-side forest, and high-elevation zones.

Zone	Percent in Status 1, 2	Percent converted	Total area (hectares)	CPI
STEPPE ZONES				
Palouse	0.09	88.87	467,471	50.9
Big Sage/Fescue	0.06	75.40	205,723	21.6
Wheatgrass/Fescue	0.76	70.16	870,267	19.8
Central Arid Steppe	5.91	46.80	3,088,093	11.5
Klickitat Meadow Steppe	0.38	57.28	63,008	11.2
Three-tip Sage	1.27	39.45	1,087,006	9.8
Bitterbrush	0.00	44.82	24,463	8.0
Canyon Grassland	0.59	20.38	209,082	6.6
Blue Mountains Steppe	5.91	23.16	64,896	5.9
EAST-SIDE FOREST				
Ponderosa Pine	3.89	11.94	1,540,068	6.8
Interior Douglas-fir	7.65	5.81	1,394,911	6.0
Oak	3.38	6.15	186,942	5.4
Grand Fir	11.12	2.35	456,689	5.2
Int West Hemlck/Redcedar	16.33	2.05	502,867	4.9
Low-elevation Lava Flows	0.00	0.00	5,209	3.7
Subalpine Fir	43.54	0.00	700,205	3.3
High-elevation Lava Flows	27.71	0.00	1,902	2.4
Blue Mt High Open Forest	80.02	0.00	9,766	0.8
Blue Mt High Basalt Ridge	73.18	0.00	466	0.7
WEST-SIDE FOREST				
Willamette Valley	2.22	66.81	70,022	14.3
Puget Sound Douglas-fir	1.13	43.78	1,102,439	10.6
Cowlitz River	0.23	41.19	91,545	8.4
Woodland/Prairie Mosaic	1.54	39.31	156,773	8.4
Western Hemlock	4.89	3.20	2,607,634	6.3
Sitka Spruce	5.52	5.18	422,611	5.6
Silver Fir	29.00	0.00	955,557	4.2
Olympic Douglas-fir	33.96	0.00	67,487	3.2
Mountain Hemlock	60.29	0.00	544,860	2.3
ALPINE and ICE				

Alpine/Parkland	82.87	0.00	574,172	1.0
Permanent Ice/Snow	97.59	0.00	44,159	0.1

The Role of Status 3 and Status 4 Lands

Biodiversity management is easiest on Status 1 and 2 lands, where biodiversity protection is a major priority. However, the amount of Status 1 and 2 lands is unlikely to substantially increase, and many species have inadequate representation on Status 1 and 2 lands. In fact, nearly a third of breeding terrestrial vertebrate species have 80% of their most suitable habitat on Status 4 lands. In Washington, the major Status 3 lands are WDNR Trust lands and USFS non-Wilderness ("multiple use") lands. Publicly-owned Status 4 lands (excluding Tribal lands) in Washington are primarily DoD and DoE lands.

Among Status 3 land owners, the WDNR has the largest impact on biodiversity management in many of the most poorly protected vegetation types and associated fauna in the State. Vegetation zones in which the combined percentage of Status 1 and 2 lands is less than 10% and WDNR Trust lands are the majority of Status 3 lands (and often the majority public land owner) are: all steppe zones, one east-side forest zone (Oak), and six west-side forest zones (Willamette Valley, Cowlitz River, Woodland/Prairie Mosaic, Puget Sound Douglas-fir, Sitka Spruce, and Western Hemlock). Most of these zones have a high or moderately high CPI, and the four zones with the highest CPI are included in this group. In the Palouse and Big Sage Fescue zones (the two zones with the highest CPIs), plus the Klickitat Meadow Steppe, Bitterbrush, and Cowlitz River zone, the WDNR owns over 90% of all public lands.

The impact of USFS management is most important in low- and mid-elevation forest zones. There are two major zones (Ponderosa Pine and Interior Douglas-fir) and one minor zone (Low-elevation Lava Flows) in which in which the combined percentage of Status 1 and 2 lands is less than 10% and USFS multiple use lands are the majority of Status 3 lands. In all of these zones, the USFS is also the majority public land owner. The Ponderosa Pine zone is the east-side forest zone with the highest CPI.

A few Status 3 lands other than WDNR and USFS lands are also particularly significant. The Cedar River Municipal Watershed (the source of most of the water for the city of Seattle) is a Status 3 land in King County that lies primarily on the Western Hemlock and Silver Fir zones. Municipal watersheds are included in Conservation Status 3 because they are managed primarily as a water supply. However, the Cedar River Watershed has become an important *de facto* reserve for some species because of management policies that restrict public access and are designed to prevent erosion and water pollution. It is also at a lower elevation than most Status 1 and 2 lands of these zones, and it covers nearly an entire functioning watershed. An example of a small, but very significant Status 3 land is the Smoot Hill Research Area (owned by Washington State University), important because it harbors some of the last remnants of Palouse vegetation in the zone with the highest CPI.

DoD Status 4 lands are the majority of public lands in the Woodland/Prairie Mosaic zone, where most of the remaining relatively undisturbed oak woodlands and savannas occur on the Fort Lewis Military Reservation. Most of this zone outside Fort Lewis has been heavily impacted by development and agriculture. The long-term persistence of the native vegetation and fauna of the Woodland/Prairie Mosaic zone depends primarily on land management on Fort Lewis.

Status 4 DoD (Yakima Training Center) and DoE (Hanford Nuclear Reservation) lands in the Central Arid Steppe zone contribute to the formation of the largest block of relatively contiguous undeveloped and uncultivated steppe. The Status 2 lands of the Hanford buffer and several State Wildlife Areas are also part of this large block. Both the Yakima Training Center and Hanford Nuclear Reservation have localized intense use and disturbance, but they also have restricted access and relatively undisturbed areas.

In zones with relatively small amounts of Status 1 and 2 lands, Status 3 and publicly-owned Status 4 lands will often represent the best opportunity to improve biodiversity management. However, privately-owned Status 4 lands constitute the largest area of many zones: all steppe zones, Oak zone, all four Puget-Willamette Trough zones, Sitka Spruce zone, and Western Hemlock zone. In many of these zones (especially steppe zones and Puget-Willamette Trough zones), private land ownership is so high that meaningful biodiversity management will be difficult or impossible without the assistance of private land owners, thus the persistence of many species and vegetation types will continue to depend on management practices on private land.

Limitations of Land Cover Analysis

Ranking vegetation zones by the percentage of a zone in Status 1 and 2 lands is the most basic quantitative method of establishing conservation priorities. We refined the assessment of conservation priority with the addition of two other factors (conversion to development and agriculture, and zone size) to create an alternative quantitative Conservation Priority Index. Many other factors remain unaccounted for, most notably logging and grazing impacts, which are difficult to assess. Another limitation to our CPI is that we have not measured the potential for future conversion to development and agriculture. If, for example, virtually all arable land in a zone has already been cultivated, then the remainder may be at low risk of conversion in the near future. Also, conservation priorities based on vertebrates, such as areas of high vertebrate richness, or locations of rare, threatened, and endangered species, are treated separately.

Predicted Species Distributions Analysis

The conservation status of terrestrial vertebrates was analyzed on an individual species basis and using multiple species overlays to assess the status of areas of high species richness.

Description of the Species Distributions Analysis Tables

The four species distribution tables (Tables 54 to 57; one each for amphibians, reptiles, mammals, and birds) show:

1) the total area of the polygons within which a species is predicted to occur in the primary cover, regardless of habitat quality, i.e., polygons with primary cover of adequate, good, or contingently suitable habitat in either core or peripheral zones ("total modeled distribution on primary cover");
2) the total area of polygons with good or contingently suitable habitat in core zones for the species ("total most suitable habitat");
3) the total most suitable habitat on Status 3 lands;
4) the total most suitable habitat on Status 1 or 2 lands;
5) the percentage of the most suitable habitat on Status 3 lands;
6) the percentage of the most suitable habitat on Status 1 or 2 lands;
7) any Washington State or Federal listing for the species, and whether the species is an exotic. (We use the term "listing" to refer to any State or Federal classification indicating that the species is of conservation concern, including Species of Concern and Candidate Species.)

Distribution versus Percent Representation

Modeled amount of most suitable habitat versus percent representation on Status 1 or 2 lands for each vertebrate taxa are shown in Figures 2 to 5. Species with the majority of their most suitable habitat on Status 1 or 2 lands are usually species restricted to high elevations. In general, species associated with mid and high elevations tend to have more of their distribution on Status 1 or 2 lands than the statewide average (12%), while species associated with low and medium elevations tend to have less of their distribution on Status 1 or 2 lands than the statewide average. Most species in the state have a most suitable habitat of less than four million hectares and less than 20% representation on Status 1 and 2 lands. Of the herpetofauna, only one reptile and no amphibians have most suitable habitats that cover more than ten million hectares. All reptiles have less than 12% of their most suitable habitat on Status 1 or 2 lands, which is a reflection of their association with low-elevation habitats.

Table 54: Amphibian species distribution analysis.

Common name[1]	Scientific name	Total modeled distribution on primary cover (ha)	Total most suitable habitat (ha)[2]	Most suitable habitat on Status 3 lands (ha)	Most suitable habitat on Status 1 or 2 lands (ha)	% of most suitable habitat on Status 3 lands	% of most suitable habitat, Status 1 or 2 lands	State or Federal listing[3]
Tiger Salamander	*Ambystoma tigrinum*	1,766,696	1,425,755	155,294	28,611	10.89%	2.01%	
Northwestern Salamander	*Ambystoma gracile*	4,816,581	4,277,558	1,324,248	560,107	30.96%	13.09%	
Long-toed Salamander	*Ambystoma macrodactylum*	3,729,332	2,793,827	860,637	283,849	30.80%	10.16%	
Cope`s Giant Salamander	*Dicamptodon copei*	1,516,225	1,306,664	557,540	217,902	42.67%	16.68%	
Pacific Giant Salamander	*Dicamptodon tenebrosus*	2,831,648	2,256,193	805,401	150,827	35.70%	6.69%	
Columbia Torrent Salamander	*Rhyacotriton kezeri*	151,358	151,358	36,229	784	23.94%	0.52%	1
Olympic Torrent Salamander	*Rhyacotriton olympicus*	469,238	395,721	150,356	182,601	38.00%	46.14%	
Cascades Torrent Salamander	*Rhyacotriton cascadae*	790,154	572,057	216,425	9,313	37.83%	1.63%	1
Roughskin Newt	*Taricha granulosa*	4,664,465	4,094,456	1,359,623	408,783	33.21%	9.98%	
Dunn`s Salamander	*Plethodon dunni*	374,043	374,043	60,301	747	16.12%	0.20%	1
Larch Mountain Salamander	*Plethodon larselli*	419,148	417,225	300,879	34,765	72.11%	8.33%	2,5
Van Dyke`s Salamander	*Plethodon vandykei*	764,895	720,406	316,421	168,707	43.92%	23.42%	1
Western Redback Salamander	*Plethodon vehiculum*	3,371,572	2,871,852	977,104	188,556	34.02%	6.57%	
Ensatina	*Ensatina eschscholtzii*	3,350,917	1,484,175	651,459	191,744	43.89%	12.92%	
Tailed Frog	*Ascaphus truei*	3,197,478	2,804,866	1,338,859	813,671	47.73%	29.01%	
Great Basin Spadefoot	*Scaphiopus intermontanus*	3,633,029	3,555,622	340,664	187,361	9.58%	5.27%	
Western Toad	*Bufo boreas*	9,795,600	7,624,297	2,923,411	1,002,787	38.34%	13.15%	
Woodhouse`s Toad	*Bufo woodhousei*	613,745	613,745	31,318	44,792	5.10%	7.30%	
Pacific Treefrog	*Hyla regilla*	12,212,753	10,393,312	3,120,034	782,133	30.02%	7.53%	
Red-legged Frog	*Rana aurora*	3,626,527	3,431,520	898,358	173,727	26.18%	5.06%	
Cascades Frog	*Rana cascadae*	1,539,939	1,200,541	428,394	579,452	35.68%	48.27%	
Columbia Spotted Frog	*Rana luteiventris*	4,536,526	4,188,980	1,538,535	399,849	36.73%	9.55%	1,5
Oregon Spotted frog	*Rana pretiosa*	8,942	8,942	683	1,575	7.64%	17.61%	1,6
Northern Leopard Frog	*Rana pipiens*	33,570	30,693	2,562	2,109	8.35%	6.87%	1
Bullfrog	*Rana catesbeiana*	2,457,058	2,277,920	131,035	38,266	5.75%	1.68%	E
Green Frog	*Rana clamitans*	213	213	16	0	7.51%	0.00%	E

[1] There are 26 amphibian species in Washington, 24 native and 2 exotic (introduced).

[2] "Most suitable habitat" includes only polygons with a primary land cover of good or contingently suitable habitat in a core zone for the species.

[3] 1: State Candidate; 2: State Sensitive; 3: State Threatened; 4: State Endangered; 5: Federal Species of Concern; 6: Federal Candidate; 7: Federal Threatened; 8: Federal Endangered; E: exotic.

Table 55: Reptile species distribution analysis.

Common name[1]	Scientific name	Total modeled distribution on primary cover (ha)	Total most suitable habitat (ha)[2]	Most suitable habitat on Status 3 lands (ha)	Most suitable habitat on Status 1 or 2 lands (ha)	% of most suitable habitat on Status 3 lands	% of most suitable habitat, Status 1 or 2 lands	State or Federal listing[3]
Painted Turtle	*Chrysemys picta*	410,903	344,241	25,883	27,961	7.52%	8.12%	
Western Pond Turtle	*Clemmys marmorata*	20,074	20,074	1,606	51	8.00%	0.25%	4,5
Slider	*Trachemys scripta*	169,828	159,785	4,798	2,139	3.00%	1.34%	E
Northern Alligator Lizard	*Elgaria coerulea*	3,147,974	2,142,151	652,468	81,105	30.46%	3.79%	
Southern Alligator Lizard	*Elgaria multicarinata*	418,227	418,227	84,324	22,274	20.16%	5.33%	
Short-horned Lizard	*Phrynosoma douglassii*	2,610,035	2,520,659	289,927	177,886	11.50%	7.06%	
Sagebrush Lizard	*Sceloporus graciosus*	2,238,461	1,597,520	180,952	161,272	11.33%	10.10%	
Western Fence Lizard	*Sceloporus occidentalis*	1,331,529	800,322	310,028	62,031	38.74%	7.75%	
Side-blotched Lizard	*Uta stansburiana*	1,276,458	1,276,458	143,097	151,560	11.21%	11.87%	
Western Skink	*Eumeces skiltonianus*	1,454,098	1,383,356	302,409	79,052	21.86%	5.71%	
Rubber Boa	*Charina bottae*	4,682,642	4,491,780	1,655,096	374,753	36.85%	8.34%	
Racer	*Coluber constrictor*	5,309,249	3,031,227	404,508	187,160	13.34%	6.17%	
Sharptail Snake	*Contia tenuis*	176,768	129,425	55,342	8,916	42.76%	6.89%	
Ringneck Snake	*Diadophis punctatus*	273,162	272,248	27,327	14,390	10.04%	5.29%	
Night Snake	*Hypsiglena torquata*	2,548,623	2,502,680	304,958	184,092	12.19%	7.36%	
California Mountain Kingsnake	*Lampropeltis zonata*	6,393	6,393	922	128	14.42%	2.00%	1
Striped Whipsnake	*Masticophis taeniatus*	1,260,407	1,260,407	139,493	145,432	11.07%	11.54%	1
Gopher Snake	*Pituophis catenifer*	4,026,674	3,893,123	534,843	234,883	13.74%	6.03%	
Western Terrestrial Garter Snake	*Thamnophis elegans*	2,564,887	2,337,504	664,256	114,983	28.42%	4.92%	
Northwestern Garter Snake	*Thamnophis ordinoides*	1,682,430	1,206,969	251,340	28,386	20.82%	2.35%	
Common Garter Snake	*Thamnophis sirtalis*	10,830,752	8,112,726	2,756,229	809,411	33.97%	9.98%	
Western Rattlesnake	*Crotalus viridis*	6,486,366	2,933,619	357,076	189,237	12.17%	6.45%	

[1] There are 22 reptiles in Washington, 21 native and 1 exotic (introduced).

[2] "Most suitable habitat" includes only polygons with a primary land cover of good or contingently suitable habitat in a core zone for the species.

[3] 1: State Candidate; 2: State Sensitive; 3: State Threatened; 4: State Endangered; 5: Federal Species of Concern; 6: Federal Candidate; 7: Federal Threatened; 8: Federal Endangered; E: exotic.

Table 56: Mammal species distribution analysis.

Common Name[1]	Scientific Name	Total modeled distribution on primary cover (ha)	Total most suitable habitat (ha)[2]	Most suitable habitat on Status 3 lands (ha)	Most suitable habitat on Status 1 or 2 lands (ha)	% of most suitable habitat on Status 3 lands	% of most suitable habitat, Status 1 or 2 lands	State or Federal listing[3]
Virginia Opossum	*Didelphis virginiana*	1,911,718	1,841,794	161,935	23,294	8.79%	1.26%	E
Bendire`s Shrew	*Sorex bendirii*	4,075,489	3,335,075	962,817	231,194	28.87%	6.93%	
Masked Shrew	*Sorex cinereus*	5,705,890	4,576,883	2,059,738	1,128,513	45.00%	24.66%	
Pygmy Shrew	*Sorex hoyi*	626,437	620,945	294,465	31,594	47.42%	5.09%	1
Merriam`s Shrew	*Sorex merriami*	1,448,865	669,291	86,475	74,360	12.92%	11.11%	1
Montane Shrew	*Sorex monticolus*	9,697,697	8,407,377	3,083,731	1,774,188	36.68%	21.10%	
Water Shrew	*Sorex palustris*	6,180,758	5,409,569	2,411,660	1,673,362	44.58%	30.93%	
Preble`s Shrew	*Sorex preblei*	14,213	0	0	0			
Trowbridge`s Shrew	*Sorex trowbridgii*	5,311,039	4,148,905	1,344,269	327,509	32.40%	7.89%	
Vagrant Shrew	*Sorex vagrans*	17,319,522	13,888,239	2,871,902	1,196,226	20.68%	8.61%	
Shrew-mole	*Neurotrichus gibbsii*	6,511,851	4,640,335	1,590,228	729,979	34.27%	15.73%	
Coast Mole	*Scapanus orarius*	5,689,823	4,627,510	1,410,404	491,819	30.48%	10.63%	
Townsend`s Mole	*Scapanus townsendii*	1,242,422	1,194,938	140,924	86,218	11.79%	7.22%	
California Myotis	*Myotis californicus*	11,976,614	10,816,239	3,556,575	1,406,740	32.88%	13.01%	
Small-footed Myotis	*Myotis ciliolabrum*	5,309,930	5,091,596	451,318	198,249	8.86%	3.89%	
Long-eared Myotis	*Myotis evotis*	10,848,121	10,789,387	3,568,072	1,417,927	33.07%	13.14%	
Keen`s Myotis	*Myotis keenii*	582,631	582,631	206,582	117,062	35.46%	20.09%	
Little Brown Myotis	*Myotis lucifugus*	11,976,614	10,816,239	3,556,575	1,406,740	32.88%	13.01%	
Fringed Myotis	*Myotis thysanodes*	8,017,721	7,468,773	864,891	264,101	11.58%	3.54%	
Long-legged Myotis	*Myotis volans*	8,642,394	8,210,931	2,909,010	1,265,221	35.43%	15.41%	
Yuma Myotis	*Myotis yumanensis*	9,511,860	9,511,860	2,626,672	518,853	27.61%	5.45%	
Hoary Bat	*Lasiurus cinereus*	10,627,645	8,445,750	2,576,289	516,849	30.50%	6.12%	
Silver-haired Bat	*Lasionycteris noctivagans*	8,661,961	8,237,025	2,914,508	1,285,213	35.38%	15.60%	
Big Brown Bat	*Eptesicus fuscus*	17,447,928	12,238,976	3,652,213	1,451,429	29.84%	11.86%	
Western Pipistrelle	*Pipistrellus hesperus*	771,241	649,961	60,365	74,432	9.29%	11.45%	
Spotted Bat	*Euderma maculatum*	1,006,091	847,786	124,939	39,451	14.74%	4.65%	
Townsend`s Big-eared Bat	*Plecotus townsendii*	14,701,414	14,701,414	3,081,262	714,019	20.96%	4.86%	1,5
Pallid Bat	*Antrozous pallidus*	7,152,791	2,772,216	319,925	198,544	11.54%	7.16%	
Pika	*Ochotona princeps*	4,454,359	2,319,131	955,129	1,081,156	41.18%	46.62%	
Snowshoe Hare	*Lepus americanus*	9,268,824	6,293,564	2,494,047	1,167,987	39.63%	18.56%	

Common Name[1]	Scientific Name	Total modeled distribution on primary cover (ha)	Total most suitable habitat (ha)[2]	Most suitable habitat on Status 3 lands (ha)	Most suitable habitat on Status 1 or 2 lands (ha)	% of most suitable habitat on Status 3 lands	% of most suitable habitat, Status 1 or 2 lands	State or Federal listing[3]
Black-tailed Jack Rabbit	*Lepus californicus*	1,955,038	1,653,915	178,012	158,786	10.76%	9.60%	
White-tailed Jack Rabbit	*Lepus townsendii*	2,431,013	878,147	105,685	14,471	12.04%	1.65%	
Pygmy Rabbit	*Brachylagus idahoensis*	56,352	56,352	11,430	0	20.28%	0.00%	4
Eastern Cottontail	*Sylvilagus floridanus*	950,738	639,740	24,270	4,572	3.79%	0.71%	E
Nuttall`s Cottontail	*Sylvilagus nuttallii*	6,907,345	2,819,843	299,786	195,563	10.63%	6.94%	
European Rabbit	*Oryctolagus cuniculus*	41,542	23,595	676	1,507	2.87%	6.39%	E
Mountain Beaver	*Aplodontia rufa*	6,830,529	4,015,889	1,149,716	143,398	28.63%	3.57%	
Hoary Marmot	*Marmota caligata*	1,426,228	483,814	78,524	397,630	16.23%	82.19%	
Yellow-bellied Marmot	*Marmota flaviventris*	4,575,355	2,882,774	348,891	186,954	12.10%	6.49%	
Olympic Marmot	*Marmota olympus*	164,991	67,025	741	66,250	1.11%	98.84%	
California Ground Squirrel	*Spermophilus beecheyi*	1,163,921	1,163,921	172,601	59,081	14.83%	5.08%	
Columbian Ground Squirrel	*Spermophilus columbianus*	3,057,426	2,354,614	366,243	129,896	15.55%	5.52%	
Golden-mantled Ground Squirrel	*Spermophilus lateralis*	1,691,517	869,719	290,291	39,381	33.38%	4.53%	
Cascade Golden-mantled Ground Squirrel	*Spermophilus saturatus*	2,807,588	1,714,076	645,285	636,607	37.65%	37.14%	
Townsend`s Ground Squirrel	*Spermophilus townsendii*	820,957	717,335	71,298	78,972	9.94%	11.01%	
Washington Ground Squirrel	*Spermophilus washingtoni*	576,812	576,812	62,800	22,358	10.89%	3.88%	1
Yellow-pine Chipmunk	*Tamias amoenus*	5,797,259	2,724,092	872,198	768,283	32.02%	28.20%	
Least Chipmunk	*Tamias minimus*	1,696,498	1,559,518	158,384	129,532	10.16%	8.31%	
Red-tailed Chipmunk	*Tamias ruficaudus*	544,682	396,341	246,811	26,943	62.27%	6.80%	
Townsend`s Chipmunk	*Tamias townsendii*	6,261,698	4,987,420	1,703,504	1,030,510	34.16%	20.66%	
Eastern Gray Squirrel	*Sciurus carolinensis*	258,712	113,928	3,956	466	3.47%	0.41%	E
Western Gray Squirrel	*Sciurus griseus*	456,553	142,886	19,412	5,835	13.59%	4.08%	3
Fox Squirrel	*Sciurus niger*	95,435	48,490	1,132	154	2.33%	0.32%	E
Douglas` Squirrel	*Tamiasciurus douglasii*	5,256,523	4,277,952	1,685,122	904,574	39.39%	21.15%	
Red Squirrel	*Tamiasciurus hudsonicus*	2,511,172	2,441,967	997,337	307,046	40.84%	12.57%	
Northern Flying Squirrel	*Glaucomys sabrinus*	8,374,121	8,202,261	2,892,880	1,258,387	35.27%	15.34%	
Beaver	*Castor canadensis*	10,647,599	9,443,273	3,070,355	773,625	32.51%	8.19%	
Mazama Pocket Gopher	*Thomomys mazama*	92,886	16,107	491	7,462	3.05%	46.33%	1,5
Northern Pocket Gopher	*Thomomys talpoides*	6,665,738	5,518,681	1,135,979	658,704	20.58%	11.94%	1[4]
Ord`s Kangaroo Rat	*Dipodomys ordii*	85,096	85,096	8,142	6,415	9.57%	7.54%	
Great Basin Pocket Mouse	*Perognathus parvus*	4,721,641	4,484,297	433,188	183,465	9.66%	4.09%	

Common Name[1]	Scientific Name	Total modeled distribution on primary cover (ha)	Total most suitable habitat (ha)[2]	Most suitable habitat on Status 3 lands (ha)	Most suitable habitat on Status 1 or 2 lands (ha)	% of most suitable habitat on Status 3 lands	% of most suitable habitat, Status 1 or 2 lands	State or Federal listing[3]
Bushy-tailed Woodrat	*Neotoma cinerea*	17,222,356	12,530,458	3,864,982	2,063,561	30.84%	16.47%	
Northern Grasshopper Mouse	*Onychomys leucogaster*	1,659,173	1,609,029	175,322	158,819	10.90%	9.87%	
Forest Deer Mouse	*Peromyscus keeni*	7,409,119	4,888,009	1,617,601	1,017,380	33.09%	20.81%	
Deer Mouse	*Peromyscus maniculatus*	16,069,927	12,197,170	2,407,021	866,214	19.73%	7.10%	
Western Harvest Mouse	*Reithrodontomys megalotis*	3,651,454	3,525,581	214,113	33,646	6.07%	0.95%	
Gapper`s Red-backed Vole	*Clethrionomys gapperi*	9,534,056	9,534,056	3,491,317	1,824,800	36.62%	19.14%	
Sagebrush Vole	*Lemmiscus curtatus*	1,607,458	1,577,829	177,902	108,292	11.28%	6.86%	
Gray-tailed Vole	*Microtus canicaudus*	36,596	36,596	1,506	189	4.12%	0.52%	1
Long-tailed Vole	*Microtus longicaudus*	10,194,184	9,582,909	3,343,437	1,397,402	34.89%	14.58%	
Montane Vole	*Microtus montanus*	6,123,637	4,471,504	678,992	103,679	15.18%	2.32%	
Creeping Vole	*Microtus oregoni*	7,403,056	6,658,303	2,176,448	1,617,859	32.69%	24.30%	
Meadow Vole	*Microtus pennsylvanicus*	2,559,184	2,551,714	943,364	108,486	36.97%	4.25%	
Richardson`s Vole	*Microtus richardsoni*	4,094,854	2,240,992	887,439	1,097,239	39.60%	48.96%	
Townsend`s Vole	*Microtus townsendii*	902,332	745,457	70,915	97,924	9.51%	13.14%	
Muskrat	*Ondatra zibethicus*	6,912,211	6,884,150	1,425,990	268,863	20.71%	3.91%	
Heather Vole	*Phenacomys intermedius*	5,777,553	3,554,721	1,547,308	1,491,544	43.53%	41.96%	
Northern Bog Lemming	*Synaptomys borealis*	737,144	420,756	144,879	269,786	34.43%	64.12%	
Western Jumping Mouse	*Zapus princeps*	1,831,338	1,568,169	771,691	274,134	49.21%	17.48%	
Pacific Jumping Mouse	*Zapus trinotatus*	6,916,032	6,792,909	2,306,027	1,529,060	33.95%	22.51%	
Porcupine	*Erethizon dorsatum*	9,715,888	9,659,228	3,485,593	1,383,547	36.09%	14.32%	
Nutria	*Myocastor coypus*	799,298	651,535	20,855	5,870	3.20%	0.90%	E
House Mouse	*Mus musculus*	4,247,571	4,247,571	221,782	11,519	5.22%	0.27%	E
Norway Rat	*Rattus norvegicus*	898,158	882,993	23,104	11,234	2.62%	1.27%	E
Black Rat	*Rattus rattus*	359,159	357,963	7,671	6,888	2.14%	1.92%	E
Coyote	*Canis latrans*	17,089,282	11,406,660	1,983,697	1,055,175	17.39%	9.25%	
Gray Wolf	*Canis lupus*	1,800,812	1,800,812	730,563	951,997	40.57%	52.86%	4,8
Red Fox	*Vulpes vulpes*	4,483,978	2,621,134	640,746	460,800	24.45%	17.58%	PE[5]
Black Bear	*Ursus americanus*	10,098,858	10,038,537	3,583,511	1,851,897	35.70%	18.45%	
Grizzly Bear	*Ursus arctos*	1,800,812	1,800,812	730,563	951,997	40.57%	52.86%	4,7
Raccoon	*Procyon lotor*	3,484,415	2,625,321	158,976	53,963	6.06%	2.06%	
Marten	*Martes americana*	5,189,567	4,770,879	2,190,261	1,171,448	45.91%	24.55%	

Common Name[1]	Scientific Name	Total modeled distribution on primary cover (ha)	Total most suitable habitat (ha)[2]	Most suitable habitat on Status 3 lands (ha)	Most suitable habitat on Status 1 or 2 lands (ha)	% of most suitable habitat on Status 3 lands	% of most suitable habitat, Status 1 or 2 lands	State or Federal listing[3]
Fisher	*Martes pennanti*	3,195,233	2,620,635	1,223,898	506,565	46.70%	19.33%	1,5
Ermine	*Mustela erminea*	9,704,032	8,512,545	3,118,095	1,323,414	36.63%	15.55%	
Long-tailed Weasel	*Mustela frenata*	17,047,757	16,859,311	4,137,363	2,062,359	24.54%	12.23%	
Mink	*Mustela vison*	10,769,534	9,357,397	3,074,540	772,173	32.86%	8.25%	
Wolverine	*Gulo gulo*	4,909,156	4,063,125	1,860,323	1,273,430	45.79%	31.34%	
Badger	*Taxidea taxus*	4,255,473	2,916,902	358,291	175,232	12.28%	6.01%	
Striped Skunk	*Mephitis mephitis*	5,939,247	2,717,260	195,087	49,148	7.18%	1.81%	
Spotted Skunk	*Spilogale gracilis*	4,304,414	3,726,772	1,004,885	176,312	26.96%	4.73%	
River Otter	*Lutra canadensis*	375,554	251,576	19,849	23,042	7.89%	9.16%	
Mountain Lion	*Felis concolor*	11,198,731	9,527,446	3,497,751	1,401,737	36.71%	14.71%	
Lynx	*Lynx canadensis*	1,532,173	920,756	560,992	278,162	60.93%	30.21%	3,5
Bobcat	*Lynx rufus*	12,963,429	11,153,749	2,898,997	711,401	25.99%	6.38%	
Elk	*Cervus elaphus*	9,002,673	9,002,673	3,061,618	1,537,300	34.01%	17.08%	
Mule Deer	*Odocoileus hemionus*	13,142,001	10,567,044	3,628,979	1,885,827	34.34%	17.85%	
White-tailed Deer	*Odocoileus virginianus*	4,535,440	1,903,560	592,302	83,029	31.12%	4.36%	4,8[6]
Moose	*Alces alces*	1,476,070	723,101	421,634	138,987	58.31%	19.22%	
Caribou	*Rangifer tarandus*	91,913	80,877	59,071	13,709	73.04%	16.95%	4,8
Mountain Goat	*Oreamnos americanus*	3,703,521	761,387	194,568	512,202	25.55%	67.27%	PE[7]
Bighorn Sheep	*Ovis canadensis*	643,305	643,305	186,555	99,507	29.00%	15.47%	

[1] There are 111 mammal species in Washington, 102 native and 9 exotic (introduced).

[2] "Most suitable cover" are polygons with a primary land cover of good or contingently good habitat in a core zone for the species.

[3] 1: State Candidate; 2: State Sensitive; 3: State Threatened; 4: State Endangered; 5: Federal Species of Concern; 6: Federal Candidate; 7: Federal Threatened; 8: Federal Endangered; E: exotic; PE: some populations exotic.

[4] Only the subspecies *T. t. douglasi* in Clark County is listed.

5 Red Foxes are native along the eastern slope and crest of the Cascades. They have been introduced into lowlands elsewhere.

[6] Only the subspecies *O. v. leucurus* of southwestern Washington is listed.

[7] Mountain Goats are native in the Cascades and Northeast, and introduced in the Olympics.

Table 57: Bird species distribution analysis.

Common Name[1]	Scientific Name	Total modeled distribution on primary cover (ha)	Total most suitable habitat (ha)[2]	Most suitable habitat on Status 3 lands (ha)	Most suitable habitat on Status 1 or 2 lands (ha)	% of most suitable habitat on Status 3 lands	% of most suitable habitat, Status 1 or 2 lands	State or Federal listing[3]
Common Loon	*Gavia immer*	16,030	16,030	611	649	3.81%	4.05%	1
Pied-billed Grebe	*Podilymbus podiceps*	900,954	900,954	37,349	22,900	4.15%	2.54%	
Horned Grebe[4]	*Podiceps auritus*	0	0	0	0			
Red-necked Grebe	*Podiceps grisegena*	38,126	38,126	951	699	2.49%	1.83%	
Eared Grebe	*Podiceps nigricollis*	25,514	25,514	988	4,376	3.87%	17.15%	
Western Grebe	*Aechmophorus occidentalis*	42,034	42,034	2,008	4,671	4.78%	11.11%	
Clark`s Grebe	*Aechmophorus clarkii*	29,385	29,385	1,548	2,633	5.27%	8.96%	
Fork-tailed Storm-Petrel	*Oceanodroma furcata*	44	44	0	43	0.00%	97.73%	
Leach`s Storm-Petrel	*Oceanodroma leucorhoa*	134	134	0	133	0.00%	99.25%	
American White Pelican[4]	*Pelecanus erythrorhynchos*	0	0	0	0			4
Double-crested Cormorant	*Phalacrocorax auritus*	29,241	29,241	718	983	2.46%	3.36%	
Brandt`s Cormorant	*Phalacrocorax penicillatus*	442	442	0	327	0.00%	73.98%	1
Pelagic Cormorant	*Phalacrocorax pelagicus*	629	629	0	505	0.00%	80.29%	
American Bittern	*Botaurus lentiginosus*	108,480	103,383	2,345	6,826	2.27%	6.60%	
Great Blue Heron	*Ardea herodias*	1,918,529	1,901,410	102,713	39,588	5.40%	2.08%	
Great Egret	*Ardea alba*	21,354	21,354	645	3,232	3.02%	15.14%	
Green Heron	*Butorides virescens*	801,304	552,115	20,655	7,986	2.58%	1.00%	
Black-crowned Night-Heron	*Nycticorax nycticorax*	95,899	95,899	3,207	11,283	3.34%	11.77%	
Trumpeter Swan[4]	*Cygnus buccinator*	0	0	0	0			
Canada Goose	*Branta canadensis*	1,636,870	1,631,677	81,333	32,140	4.98%	1.97%	
Wood Duck	*Aix sponsa*	3,559,428	3,091,285	781,971	125,379	25.30%	4.06%	
Green-winged Teal	*Anas crecca*	191,273	191,273	11,852	14,459	6.20%	7.56%	
American Black Duck[4]	*Anas rubripes*	0	0	0	0			E
Mallard	*Anas platyrhynchos*	1,915,848	1,915,848	100,893	45,523	5.27%	2.38%	
Northern Pintail	*Anas acuta*	120,844	120,844	5,011	10,039	4.15%	8.31%	
Blue-winged Teal	*Anas discors*	430,104	430,104	14,340	10,429	3.33%	2.42%	
Cinnamon Teal	*Anas cyanoptera*	774,450	774,450	32,942	27,445	4.25%	3.54%	
Northern Shoveler	*Anas clypeata*	452,787	426,540	14,719	12,726	3.45%	2.98%	
Gadwall	*Anas strepera*	647,018	595,474	19,300	15,228	3.24%	2.56%	
American Wigeon	*Anas americana*	24,607	24,607	598	186	2.43%	0.76%	
Canvasback	*Aythya valisineria*	5,637	5,637	404	566	7.17%	10.04%	

Common Name[1]	Scientific Name	Total modeled distribution on primary cover (ha)	Total most suitable habitat (ha)[2]	Most suitable habitat on Status 3 lands (ha)	Most suitable habitat on Status 1 or 2 lands (ha)	% of most suitable habitat on Status 3 lands	% of most suitable habitat, Status 1 or 2 lands	State or Federal listing[3]
Redhead	*Aythya americana*	114,283	113,762	4,763	9,673	4.19%	8.50%	
Ring-necked Duck	*Aythya collaris*	2,747,281	2,650,367	1,062,916	168,101	40.10%	6.34%	
Lesser Scaup	*Aythya affinis*	1,539	0	0	0			
Harlequin Duck	*Histrionicus histrionicus*	2,993,249	2,993,249	1,304,476	1,019,582	43.58%	34.06%	
Common Goldeneye[4]	*Bucephala clangula*	0	0	0	0			
Barrow`s Goldeneye	*Bucephala islandica*	3,512,171	3,512,171	1,560,840	700,096	44.44%	19.93%	
Bufflehead[4]	*Bucephala albeola*	0	0	0	0			
Hooded Merganser	*Lophodytes cucullatus*	4,945,911	4,945,911	1,478,102	230,387	29.89%	4.66%	
Common Merganser	*Mergus merganser*	374,171	374,171	24,957	32,540	6.67%	8.70%	
Ruddy Duck	*Oxyura jamaicensis*	175,085	175,085	5,804	11,318	3.31%	6.46%	
Turkey Vulture	*Cathartes aura*	6,380,563	6,380,563	1,551,742	183,976	24.32%	2.88%	
Osprey	*Pandion haliaetus*	329,108	329,108	23,377	31,100	7.10%	9.45%	
White-tailed Kite	*Elanus leucurus*	25,904	25,904	772	980	2.98%	3.78%	
Bald Eagle	*Haliaeetus leucocephalus*	3,186,704	3,121,525	603,684	124,290	19.34%	3.98%	3,7
Northern Harrier	*Circus cyaneus*	6,472,071	6,472,071	534,740	213,664	8.26%	3.30%	
Sharp-shinned Hawk	*Accipiter striatus*	6,210,590	6,210,590	2,573,061	1,214,000	41.43%	19.55%	
Cooper`s Hawk	*Accipiter cooperii*	1,466,157	1,466,157	205,731	42,259	14.03%	2.88%	
Northern Goshawk	*Accipiter gentilis*	3,747,537	3,683,488	1,701,885	1,118,511	46.20%	30.37%	1,5
Swainson`s Hawk	*Buteo swainsoni*	5,088,408	5,088,408	395,795	178,886	7.78%	3.52%	
Red-tailed Hawk	*Buteo jamaicensis*	16,892,363	14,616,402	3,156,093	931,135	21.59%	6.37%	
Ferruginous Hawk	*Buteo regalis*	1,034,611	1,034,611	95,777	107,219	9.26%	10.36%	3
Golden Eagle	*Aquila chrysaetos*	4,284,343	3,527,239	914,025	713,547	25.91%	20.23%	1
American Kestrel	*Falco sparverius*	9,114,831	9,114,831	1,338,533	555,216	14.69%	6.09%	
Merlin	*Falco columbarius*	1,058,322	0	0	0			1
Prairie Falcon	*Falco mexicanus*	1,662,579	1,620,420	176,111	160,688	10.87%	9.92%	
Peregrine Falcon	*Falco peregrinus*	633	633	9	430	1.42%	67.93%	4,8
Gray Partridge	*Perdix perdix*	4,233,363	4,233,363	321,266	119,974	7.59%	2.83%	E
Chukar	*Alectoris chukar*	2,299,036	2,299,036	282,029	176,018	12.27%	7.66%	E
Ring-necked Pheasant	*Phasianus colchicus*	7,122,067	7,040,658	707,214	227,449	10.04%	3.23%	E
Spruce Grouse	*Dendragapus canadensis*	954,826	677,481	403,047	181,801	59.49%	26.83%	
Blue Grouse	*Dendragapus obscurus*	8,736,500	8,736,500	3,353,970	1,772,922	38.39%	20.29%	
White-tailed Ptarmigan	*Lagopus leucurus*	332,243	332,243	48,521	277,731	14.60%	83.59%	

Common Name[1]	Scientific Name	Total modeled distribution on primary cover (ha)	Total most suitable habitat (ha)[2]	Most suitable habitat on Status 3 lands (ha)	Most suitable habitat on Status 1 or 2 lands (ha)	% of most suitable habitat on Status 3 lands	% of most suitable habitat, Status 1 or 2 lands	State or Federal listing[3]
Ruffed Grouse	*Bonasa umbellus*	9,841,819	7,146,439	2,219,557	396,900	31.06%	5.55%	
Sage Grouse	*Centrocercus urophasianus*	383,915	383,915	44,831	24,196	11.68%	6.30%	1
Sharp-tailed Grouse	*Tympanuchus phasianellus*	301,099	301,099	33,664	3,163	11.18%	1.05%	1
Wild Turkey	*Meleagris gallopavo*	1,468,793	1,334,393	201,063	32,549	15.07%	2.44%	E
Northern Bobwhite	*Colinus virginianus*	66,365	66,365	2,563	89	3.86%	0.13%	E
Scaled Quail[4]	*Callipepla squamata*	0	0	0	0			E
California Quail	*Callipepla californica*	5,918,038	5,918,038	737,211	253,105	12.46%	4.28%	E
Mountain Quail[5]	*Oreortyx pictus*	338,766	123,673	20,947	4,171	16.94%	3.37%	PE[5]
Virginia Rail	*Rallus limicola*	384,927	378,886	17,668	12,979	4.66%	3.43%	
Sora	*Porzana carolina*	1,244,970	1,241,220	66,024	21,119	5.32%	1.70%	
American Coot	*Fulica americana*	815,510	796,597	25,246	22,465	3.17%	2.82%	
Sandhill Crane	*Grus canadensis*	6,104	6,104	347	1,590	5.68%	26.05%	4
Snowy Plover	*Charadrius alexandrinus*	790	790	0	518	0.00%	65.57%	4,7
Semipalmated Plover[4]	*Charadrius semipalmatus*	0	0	0	0			
Killdeer	*Charadrius vociferus*	6,064,011	6,064,011	493,568	227,587	8.14%	3.75%	
Black Oystercatcher	*Haematopus bachmani*	1,287	1,287	20	680	1.55%	52.84%	
Black-necked Stilt	*Himantopus mexicanus*	27,438	27,438	1,776	3,484	6.47%	12.70%	
American Avocet	*Recurvirostra americana*	74,173	74,173	2,405	9,733	3.24%	13.12%	
Spotted Sandpiper	*Actitis macularia*	414,925	414,925	28,310	41,527	6.82%	10.01%	
Upland Sandpiper	*Bartramia longicauda*	3,448	0	0	0			4
Long-billed Curlew	*Numenius americanus*	1,842,087	1,842,087	202,508	141,309	10.99%	7.67%	
Common Snipe	*Gallinago gallinago*	1,646,147	1,646,147	111,982	29,847	6.80%	1.81%	
Wilson`s Phalarope	*Phalaropus tricolor*	157,923	157,923	5,996	9,746	3.80%	6.17%	
Ring-billed Gull	*Larus delawarensis*	950,504	950,504	62,133	15,439	6.54%	1.62%	
California Gull	*Larus californicus*	908,306	908,306	75,622	14,348	8.33%	1.58%	
Western Gull	*Larus occidentalis*	80,363	80,363	3,321	3,500	4.13%	4.36%	
Glaucous-winged Gull	*Larus glaucescens*	594,828	594,828	25,093	9,862	4.22%	1.66%	
Caspian Tern	*Sterna caspia*	95,813	95,813	2,676	10,974	2.79%	11.45%	
Arctic Tern[4]	*Sterna paradisaea*	0	0	0	0	0.00%		
Forster`s Tern	*Sterna forsteri*	73,748	73,748	1,996	9,593	2.71%	13.01%	
Black Tern	*Chlidonias niger*	99,690	99,690	3,637	4,525	3.65%	4.54%	

Common Name[1]	Scientific Name	Total modeled distribution on primary cover (ha)	Total most suitable habitat (ha)[2]	Most suitable habitat on Status 3 lands (ha)	Most suitable habitat on Status 1 or 2 lands (ha)	% of most suitable habitat on Status 3 lands	% of most suitable habitat, Status 1 or 2 lands	State or Federal listing[3]
Common Murre	*Uria aalge*	59	59	0	58	0.00%	98.31%	
Pigeon Guillemot	*Cepphus columba*	2,465	2,465	30	1,181	1.22%	47.91%	
Marbled Murrelet	*Brachyramphus marmoratus*	1,118,289	1,118,289	492,491	280,100	44.04%	25.05%	3,7
Ancient Murrelet[4]	*Synthliboramphus antiquus*	0	0	0	0			
Cassin`s Auklet	*Ptychoramphus aleuticus*	53	53	0	52	0.00%	98.11%	
Rhinoceros Auklet	*Cerorhinca monocerata*	270	270	0	240	0.00%	88.89%	
Tufted Puffin	*Fratercula cirrhata*	301	301	0	293	0.00%	97.34%	
Rock Dove	*Columba livia*	8,342,889	7,084,317	553,375	217,155	7.81%	3.07%	E
Band-tailed Pigeon	*Columba fasciata*	5,699,873	4,470,176	1,039,989	209,787	23.27%	4.69%	
Mourning Dove	*Zenaida macroura*	7,434,136	7,100,597	723,592	219,956	10.19%	3.10%	
Yellow-billed Cuckoo[4]	*Coccyzus americanus*	0	0	0	0			
Barn Owl	*Tyto alba*	6,418,222	6,418,222	486,098	208,019	7.57%	3.24%	
Flammulated Owl	*Otus flammeolus*	1,247,218	1,247,218	422,607	55,468	33.88%	4.45%	1
Western Screech-Owl	*Otus kennicottii*	6,295,267	6,295,267	1,579,374	297,483	25.09%	4.73%	
Great Horned Owl	*Bubo virginianus*	16,637,458	15,387,097	3,540,609	942,516	23.01%	6.13%	
Northern Pygmy-Owl	*Glaucidium gnoma*	8,892,832	8,892,832	3,418,261	1,365,846	38.44%	15.36%	
Burrowing Owl	*Speotyto cunicularia*	1,498,322	1,498,322	119,042	109,338	7.95%	7.30%	1
Spotted Owl	*Strix occidentalis*	2,695,284	2,654,647	1,179,559	878,873	44.43%	33.11%	4,7
Barred Owl	*Strix varia*	8,237,251	6,745,685	2,478,528	658,912	36.74%	9.77%	
Great Gray Owl	*Strix nebulosa*	220,148	220,148	95,731	110	43.48%	0.05%	
Long-eared Owl	*Asio otus*	6,238,127	6,238,127	539,551	209,231	8.65%	3.35%	
Short-eared Owl	*Asio flammeus*	5,238,364	5,221,402	430,287	198,436	8.24%	3.80%	
Boreal Owl	*Aegolius funereus*	327,875	265,209	123,960	130,604	46.74%	49.25%	
Northern Saw-whet Owl	*Aegolius acadicus*	7,967,154	6,883,402	2,494,543	668,130	36.24%	9.71%	
Common Nighthawk	*Chordeiles minor*	14,170,683	14,170,683	3,062,297	696,577	21.61%	4.92%	
Common Poorwill	*Phalaenoptilus nuttallii*	2,168,952	2,168,600	446,412	125,495	20.59%	5.79%	
Black Swift	*Cypseloides niger*	1,559,168	1,559,168	622,405	719,301	39.92%	46.13%	
Vaux`s Swift	*Chaetura vauxi*	10,249,553	10,236,578	3,472,291	1,403,612	33.92%	13.71%	1
White-throated Swift	*Aeronautes saxatalis*	1,134,909	1,134,909	161,020	113,074	14.19%	9.96%	
Black-chinned Hummingbird	*Archilochus alexandri*	809,069	802,842	219,323	30,533	27.32%	3.80%	
Anna`s Hummingbird	*Calypte anna*	87,460	87,114	1,937	465	2.22%	0.53%	
Calliope Hummingbird	*Stellula calliope*	3,774,341	3,571,057	1,201,585	225,660	33.65%	6.32%	
Rufous Hummingbird	*Selasphorus rufus*	9,313,116	9,276,406	3,082,808	1,788,330	33.23%	19.28%	
Belted Kingfisher	*Ceryle alcyon*	442,901	442,901	27,797	41,152	6.28%	9.29%	

Common Name[1]	Scientific Name	Total modeled distribution on primary cover (ha)	Total most suitable habitat (ha)[2]	Most suitable habitat on Status 3 lands (ha)	Most suitable habitat on Status 1 or 2 lands (ha)	% of most suitable habitat on Status 3 lands	% of most suitable habitat, Status 1 or 2 lands	State or Federal listing[3]
Lewis` Woodpecker	*Melanerpes lewis*	910,502	910,502	247,767	43,824	27.21%	4.81%	1
Acorn Woodpecker[4]	*Melanerpes formicivorus*	0	0	0	0			
Red-naped Sapsucker	*Sphyrapicus nuchalis*	4,512,642	4,287,159	1,765,334	563,156	41.18%	13.14%	
Red-breasted Sapsucker	*Sphyrapicus ruber*	6,002,403	4,505,361	1,446,069	777,678	32.10%	17.26%	
Williamson`s Sapsucker	*Sphyrapicus thyroideus*	1,386,057	1,204,872	614,559	104,325	51.01%	8.66%	
Downy Woodpecker	*Picoides pubescens*	2,993,608	2,993,608	275,427	60,283	9.20%	2.01%	
Hairy Woodpecker	*Picoides villosus*	7,677,928	7,677,928	2,854,893	1,330,433	37.18%	17.33%	
White-headed Woodpecker	*Picoides albolarvatus*	550,005	550,005	164,338	24,298	29.88%	4.42%	1
Three-toed Woodpecker	*Picoides tridactylus*	2,249,964	1,565,620	519,910	898,207	33.21%	57.37%	
Black-backed Woodpecker	*Picoides arcticus*	4,033,316	2,871,005	1,392,925	561,102	48.52%	19.54%	1
Northern Flicker	*Colaptes auratus*	14,931,476	14,540,199	3,896,903	1,805,398	26.80%	12.42%	
Pileated Woodpecker	*Dryocopus pileatus*	7,549,354	5,222,743	2,203,272	902,213	42.19%	17.27%	1
Olive-sided Flycatcher	*Contopus borealis*	9,966,046	9,966,046	3,554,181	1,736,684	35.66%	17.43%	
Western Wood-Pewee	*Contopus sordidulus*	10,016,636	8,042,300	2,527,905	468,452	31.43%	5.82%	
Willow Flycatcher	*Empidonax traillii*	7,954,384	6,555,111	1,924,781	305,808	29.36%	4.67%	
Least Flycatcher[4]	*Empidonax minimus*	0	0	0	0			
Hammond`s Flycatcher	*Empidonax hammondii*	5,737,031	5,081,272	2,201,479	1,075,842	43.33%	21.17%	
Dusky Flycatcher	*Empidonax oberholseri*	2,156,270	1,899,003	621,799	96,604	32.74%	5.09%	
Gray Flycatcher	*Empidonax wrightii*	1,354,784	1,354,784	267,323	68,859	19.73%	5.08%	
Pacific-slope/Cordilleran Flycatcher	*Empidonax difficilis/occidentalis*	6,033,390	5,821,416	2,096,736	630,347	36.02%	10.83%	
Say`s Phoebe	*Sayornis saya*	6,414,132	6,116,245	512,534	206,399	8.38%	3.37%	
Ash-throated Flycatcher	*Myiarchus cinerascens*	78,569	69,631	14,507	5,861	20.83%	8.42%	
Western Kingbird	*Tyrannus verticalis*	7,565,037	7,483,921	852,822	252,427	11.40%	3.37%	
Eastern Kingbird	*Tyrannus tyrannus*	6,692,455	6,418,565	572,792	215,296	8.92%	3.35%	
Sky Lark[4]	*Alauda arvensis*	0	0	0	0			E
Horned Lark	*Eremophila alpestris*	6,313,714	6,313,714	509,607	481,443	8.07%	7.63%	
Purple Martin	*Progne subis*	475,393	475,393	19,440	6,085	4.09%	1.28%	1
Tree Swallow	*Tachycineta bicolor*	9,317,084	9,317,084	3,021,179	683,512	32.43%	7.34%	
Violet-green Swallow	*Tachycineta thalassina*	9,581,099	9,579,828	2,959,401	713,243	30.89%	7.45%	
Northern Rough-winged Swallow	*Stelgidopteryx serripennis*	868,447	868,447	42,280	42,769	4.87%	4.92%	

Common Name[1]	Scientific Name	Total modeled distribution on primary cover (ha)	Total most suitable habitat (ha)[2]	Most suitable habitat on Status 3 lands (ha)	Most suitable habitat on Status 1 or 2 lands (ha)	% of most suitable habitat on Status 3 lands	% of most suitable habitat, Status 1 or 2 lands	State or Federal listing[3]
Bank Swallow	*Riparia riparia*	221,495	214,162	7,316	17,262	3.42%	8.06%	
Cliff Swallow	*Hirundo pyrrhonota*	13,505,262	13,505,262	2,578,352	546,436	19.09%	4.05%	
Barn Swallow	*Hirundo rustica*	13,505,262	13,505,262	2,578,352	546,436	19.09%	4.05%	
Gray Jay	*Perisoreus canadensis*	5,277,945	5,277,945	2,285,691	1,703,134	43.31%	32.27%	
Steller`s Jay	*Cyanocitta stelleri*	11,259,843	9,456,448	3,074,548	772,882	32.51%	8.17%	
Western Scrub-Jay	*Aphelocoma californica*	250,591	106,409	7,782	4,219	7.31%	3.96%	
Clark`s Nutcracker	*Nucifraga columbiana*	1,953,465	1,953,465	650,144	662,529	33.28%	33.92%	
Black-billed Magpie	*Pica pica*	6,489,207	6,489,207	566,941	211,597	8.74%	3.26%	
American/Northwestern Crow	*Corvus brachyrhynchos/caurinus*	7,727,715	7,586,880	1,276,798	230,885	16.83%	3.04%	
Common Raven	*Corvus corax*	16,785,089	16,785,089	4,135,785	2,072,850	24.64%	12.35%	
Black-capped Chickadee	*Parus atricapillus*	3,420,637	1,723,270	192,954	44,065	11.20%	2.56%	
Mountain Chickadee	*Parus gambeli*	3,788,542	2,830,070	1,038,235	388,612	36.69%	13.73%	
Boreal Chickadee	*Parus hudsonicus*	182,483	182,483	101,272	71,084	55.50%	38.95%	
Chestnut-backed Chickadee	*Parus rufescens*	6,326,299	5,711,780	2,099,049	983,071	36.75%	17.21%	
Bushtit	*Psaltriparus minimus*	2,630,276	2,131,188	204,482	19,571	9.59%	0.92%	
Red-breasted Nuthatch	*Sitta canadensis*	8,562,713	7,308,333	2,794,426	1,229,042	38.24%	16.82%	
White-breasted Nuthatch	*Sitta carolinensis*	1,682,129	1,342,013	407,928	66,950	30.40%	4.99%	
Pygmy Nuthatch	*Sitta pygmaea*	1,356,159	941,448	249,729	36,207	26.53%	3.85%	
Brown Creeper	*Certhia americana*	7,792,033	5,255,656	2,201,791	1,174,637	41.89%	22.35%	
Rock Wren	*Salpinctes obsoletus*	2,742,681	2,440,696	322,382	184,502	13.21%	7.56%	
Canyon Wren	*Catherpes mexicanus*	1,409,107	1,409,107	283,169	97,954	20.10%	6.95%	
Bewick`s Wren	*Thryomanes bewickii*	3,043,583	2,949,291	356,420	31,028	12.08%	1.05%	
House Wren	*Troglodytes aedon*	4,473,184	3,877,599	699,094	118,319	18.03%	3.05%	
Winter Wren	*Troglodytes troglodytes*	6,981,474	4,203,649	1,830,739	1,105,053	43.55%	26.29%	
Marsh Wren	*Cistothorus palustris*	575,048	258,668	9,585	15,882	3.71%	6.14%	
American Dipper	*Cinclus mexicanus*	6,961,633	6,934,356	2,588,962	1,202,080	37.34%	17.34%	
Golden-crowned Kinglet	*Regulus satrapa*	7,415,371	6,397,436	2,502,741	1,189,951	39.12%	18.60%	
Ruby-crowned Kinglet	*Regulus calendula*	2,320,659	1,319,260	660,126	388,581	50.04%	29.45%	
Western Bluebird	*Sialia mexicana*	3,208,111	3,189,159	675,124	107,250	21.17%	3.36%	
Mountain Bluebird	*Sialia currucoides*	3,807,031	3,277,203	1,025,959	590,221	31.31%	18.01%	

Common Name[1]	Scientific Name	Total modeled distribution on primary cover (ha)	Total most suitable habitat (ha)[2]	Most suitable habitat on Status 3 lands (ha)	Most suitable habitat on Status 1 or 2 lands (ha)	% of most suitable habitat on Status 3 lands	% of most suitable habitat, Status 1 or 2 lands	State or Federal listing[3]
Townsend`s Solitaire	*Myadestes townsendi*	5,530,552	4,259,222	1,504,226	1,099,622	35.32%	25.82%	
Veery	*Catharus fuscescens*	2,383,286	2,265,870	822,252	93,621	36.29%	4.13%	
Swainson`s Thrush	*Catharus ustulatus*	10,071,770	7,014,564	2,472,801	755,576	35.25%	10.77%	
Hermit Thrush	*Catharus guttatus*	3,369,819	2,076,861	1,012,799	801,625	48.77%	38.60%	
American Robin	*Turdus migratorius*	17,444,273	10,820,494	2,858,931	1,239,291	26.42%	11.45%	
Varied Thrush	*Ixoreus naevius*	5,879,271	5,879,271	2,381,047	1,166,389	40.50%	19.84%	
Gray Catbird	*Dumetella carolinensis*	527,839	326,654	68,055	9,125	20.83%	2.79%	
Northern Mockingbird[4]	*Mimus polyglottos*	0	0	0	0			
Sage Thrasher	*Oreoscoptes montanus*	1,784,767	1,784,767	201,224	164,392	11.27%	9.21%	1
American Pipit	*Anthus rubescens*	573,607	573,607	86,493	465,765	15.08%	81.20%	
Bohemian Waxwing[4]	*Bombycilla garrulus*	0	0	0	0			
Cedar Waxwing	*Bombycilla cedrorum*	9,954,642	8,327,823	2,547,036	477,653	30.58%	5.74%	
Loggerhead Shrike	*Lanius ludovicianus*	930,472	930,472	136,611	114,742	14.68%	12.33%	1
European Starling	*Sturnus vulgaris*	9,932,933	9,932,933	1,140,159	310,768	11.48%	3.13%	E
Solitary Vireo	*Vireo solitarius*	5,299,920	5,299,920	1,899,392	314,516	35.84%	5.93%	
Hutton`s Vireo	*Vireo huttoni*	3,026,297	2,473,729	465,572	34,116	18.82%	1.38%	
Warbling Vireo	*Vireo gilvus*	10,660,815	10,522,418	3,548,266	1,404,104	33.72%	13.34%	
Red-eyed Vireo	*Vireo olivaceus*	122,047	122,047	7,374	7,593	6.04%	6.22%	
Orange-crowned Warbler	*Vermivora celata*	7,747,172	7,079,089	2,014,760	515,845	28.46%	7.29%	
Nashville Warbler	*Vermivora ruficapilla*	2,245,004	2,080,064	783,087	162,978	37.65%	7.84%	
Yellow Warbler	*Dendroica petechia*	9,004,046	8,060,920	2,939,447	716,527	36.47%	8.89%	
Yellow-rumped Warbler	*Dendroica coronata*	8,205,550	7,308,724	2,794,445	1,229,330	38.23%	16.82%	
Black-throated Gray Warbler	*Dendroica nigrescens*	3,650,785	3,149,410	599,827	60,054	19.05%	1.91%	
Townsend`s Warbler	*Dendroica townsendi*	5,181,897	4,002,374	1,725,442	1,125,070	43.11%	28.11%	
Hermit Warbler	*Dendroica occidentalis*	1,873,489	1,070,080	523,967	158,288	48.97%	14.79%	
American Redstart	*Setophaga ruticilla*	1,638,038	1,619,614	568,022	33,914	35.07%	2.09%	
Northern Waterthrush	*Seiurus noveboracensis*	1,386,206	1,386,206	638,075	35,658	46.03%	2.57%	
MacGillivray`s Warbler	*Oporornis tolmiei*	8,523,070	2,151,110	696,484	596,773	32.38%	27.74%	
Common Yellowthroat	*Geothlypis trichas*	4,543,525	4,135,102	979,685	177,939	23.69%	4.30%	
Wilson`s Warbler	*Wilsonia pusilla*	10,047,096	7,395,897	2,515,088	1,235,376	34.01%	16.70%	
Yellow-breasted Chat	*Icteria virens*	906,218	886,895	187,806	43,635	21.18%	4.92%	

Common Name[1]	Scientific Name	Total modeled distribution on primary cover (ha)	Total most suitable habitat (ha)[2]	Most suitable habitat on Status 3 lands (ha)	Most suitable habitat on Status 1 or 2 lands (ha)	% of most suitable habitat on Status 3 lands	% of most suitable habitat, Status 1 or 2 lands	State or Federal listing[3]
Western Tanager	*Piranga ludoviciana*	9,347,846	7,884,514	3,205,382	1,147,065	40.65%	14.55%	
Black-headed Grosbeak	*Pheucticus melanocephalus*	6,861,711	2,735,219	421,609	57,659	15.41%	2.11%	
Lazuli Bunting	*Passerina amoena*	2,562,589	2,325,567	536,229	93,852	23.06%	4.04%	
Green-tailed Towhee	*Pipilo chlorurus*	15,934	0	0	0			1
Spotted Towhee	*Pipilo maculatus*	6,558,536	6,331,740	1,573,338	212,513	24.85%	3.36%	
Chipping Sparrow	*Spizella passerina*	4,538,239	4,292,445	1,440,110	655,419	33.55%	15.27%	
Clay-colored Sparrow[4]	*Spizella pallida*	0	0	0	0			
Brewer`s Sparrow	*Spizella breweri*	2,048,671	2,048,671	239,382	167,420	11.68%	8.17%	
Vesper Sparrow	*Pooecetes gramineus*	5,652,242	2,798,111	331,702	185,745	11.85%	6.64%	
Lark Sparrow	*Chondestes grammacus*	2,296,601	2,296,601	269,174	142,748	11.72%	6.22%	
Black-throated Sparrow	*Amphispiza bilineata*	381,994	0	0	0			
Sage Sparrow	*Amphispiza belli*	911,082	911,082	123,043	123,265	13.51%	13.53%	1
Savannah Sparrow	*Passerculus sandwichensis*	6,759,595	6,604,402	553,411	223,520	8.38%	3.38%	
Grasshopper Sparrow	*Ammodramus savannarum*	2,296,980	2,296,980	237,157	132,569	10.32%	5.77%	
Fox Sparrow	*Passerella iliaca*	3,159,020	3,128,453	1,203,550	1,079,913	38.47%	34.52%	
Song Sparrow	*Melospiza melodia*	9,970,882	9,049,815	2,394,568	447,295	26.46%	4.94%	
Lincoln`s Sparrow	*Melospiza lincolnii*	2,238,807	2,238,807	924,942	1,017,910	41.31%	45.47%	
Golden-crowned Sparrow[4]	*Zonotrichia atricapilla*	0	0	0	0			
White-crowned Sparrow	*Zonotrichia leucophrys*	4,595,415	4,595,415	997,157	556,652	21.70%	12.11%	
Dark-eyed Junco	*Junco hyemalis*	10,372,907	9,545,606	3,509,651	1,822,828	36.77%	19.10%	
Bobolink	*Dolichonyx oryzivorus*	108,996	108,996	2,895	653	2.66%	0.60%	
Red-winged Blackbird	*Agelaius phoeniceus*	14,615,328	14,615,328	3,077,253	700,856	21.05%	4.80%	
Western Meadowlark	*Sturnella neglecta*	6,482,628	6,465,473	569,596	196,992	8.81%	3.05%	
Yellow-headed Blackbird	*Xanthocephalus xanthocephalus*	208,636	207,280	7,695	18,821	3.71%	9.08%	
Brewer`s Blackbird	*Euphagus cyanocephalus*	7,230,119	7,090,243	593,619	221,447	8.37%	3.12%	
Brown-headed Cowbird	*Molothrus ater*	14,274,372	13,298,215	2,476,005	464,138	18.62%	3.49%	
Bullock`s Oriole	*Icterus bullockii*	1,573,659	945,418	40,809	25,763	4.32%	2.73%	
Gray-crowned Rosy-Finch	*Leucosticte tephrocotis*	403,704	403,704	46,194	351,923	11.44%	87.17%	
Pine Grosbeak	*Pinicola enucleator*	1,351,965	1,267,448	353,363	847,228	27.88%	66.85%	
Purple Finch	*Carpodacus purpureus*	4,439,765	4,194,086	1,031,893	208,959	24.60%	4.98%	
Cassin`s Finch	*Carpodacus cassinii*	3,922,855	3,111,942	1,213,652	427,227	39.00%	13.73%	
House Finch	*Carpodacus mexicanus*	2,812,532	2,812,532	148,737	43,559	5.29%	1.55%	

Common Name[1]	Scientific Name	Total modeled distribution on primary cover (ha)	Total most suitable habitat (ha)[2]	Most suitable habitat on Status 3 lands (ha)	Most suitable habitat on Status 1 or 2 lands (ha)	% of most suitable habitat on Status 3 lands	% of most suitable habitat, Status 1 or 2 lands	State or Federal listing[3]
Red Crossbill	*Loxia curvirostra*	7,587,027	6,756,242	2,692,245	1,235,237	39.85%	18.28%	
White-winged Crossbill	*Loxia leucoptera*	824,409	446,208	239,965	160,821	53.78%	36.04%	
Pine Siskin	*Carduelis pinus*	9,964,494	7,611,873	2,838,365	1,246,567	37.29%	16.38%	
Lesser Goldfinch	*Carduelis psaltria*	12,370	12,370	1,721	108	13.91%	0.87%	
American Goldfinch	*Carduelis tristis*	11,717,074	9,251,027	1,655,499	314,907	17.90%	3.40%	
Evening Grosbeak	*Coccothraustes vespertinus*	7,812,438	7,569,781	2,835,267	1,246,507	37.46%	16.47%	
House Sparrow	*Passer domesticus*	4,116,900	4,116,900	209,357	11,183	5.09%	0.27%	E

[1] We modeled the distributions of 230 native and 10 exotic breeding bird species. Another 18 species in this table breed occasionally but were not modeled.
[2] "Most suitable cover" are polygons with a primary land cover of good or contingently good habitat in a core zone for the species.
[3] 1: State Candidate; 2: State Sensitive; 3: State Threatened; 4: State Endangered; 5: Federal Species of Concern; 6: Federal Candidate; 7: Federal Threatened; 8: Federal Endangered; E: exotic; PE: some populations introduced.
[4] Ephemeral, occasional, or highly localized breeder. No habitat predicted.
[5] Mountain Quail are probably native in Klickitat County and the Blue Mountains; elsewhere, they are introduced.

Figure 2. Distribution versus representation on Status 1 or 2 lands - amphibians

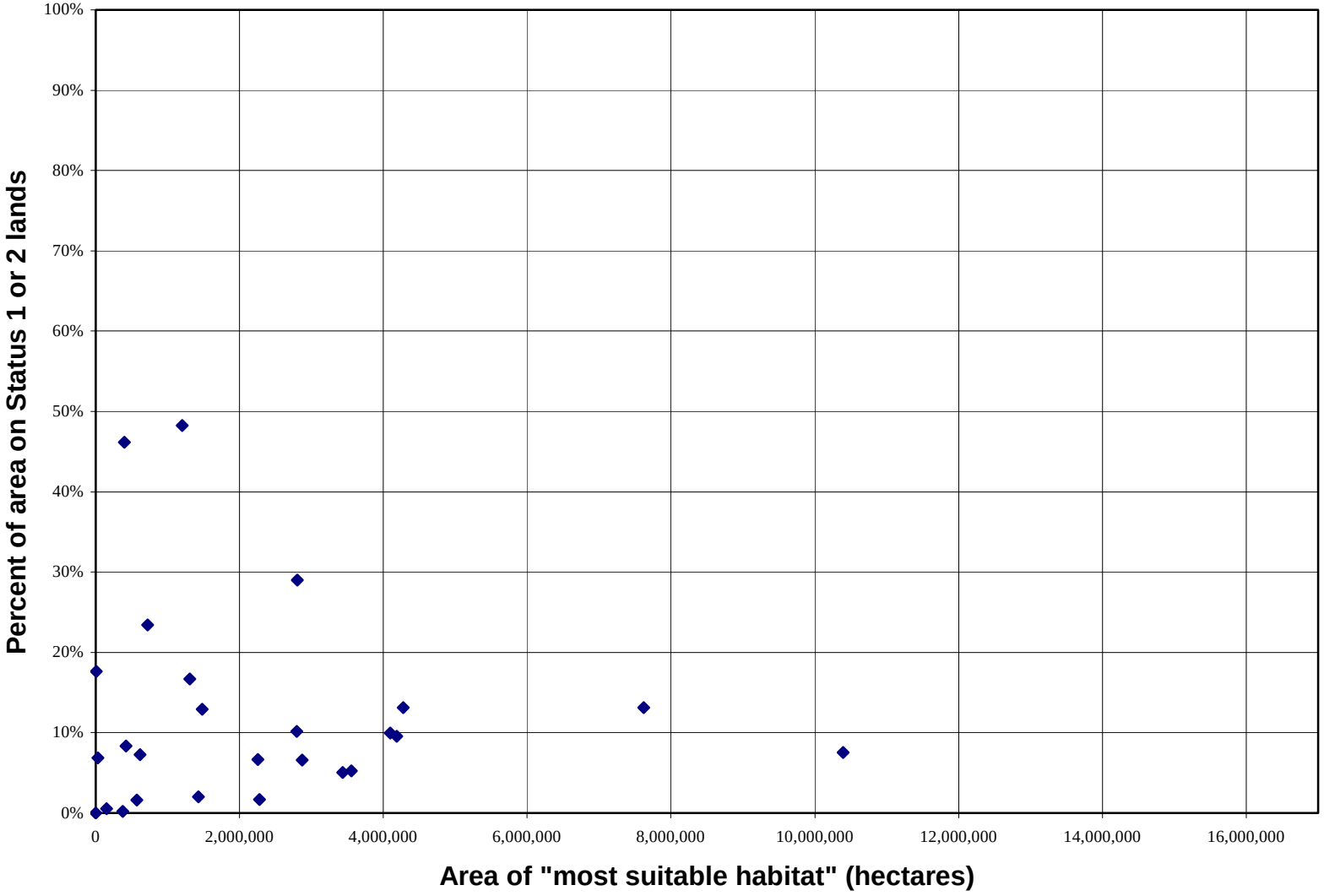


Figure 3. Distribution versus representation on Status 1 or 2 lands - reptiles

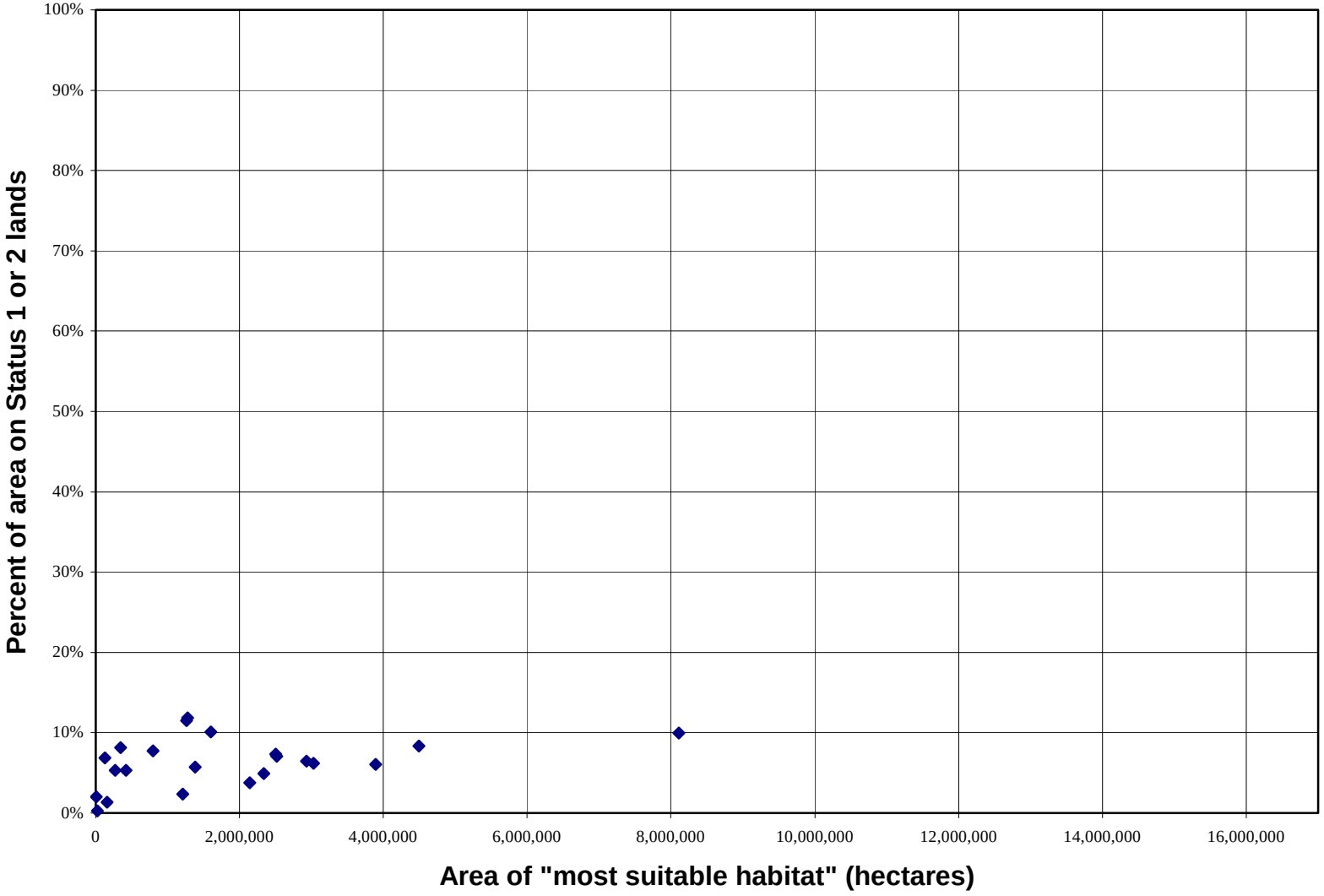


Figure 4. Distribution versus representation on Status 1 or 2 lands - mammals

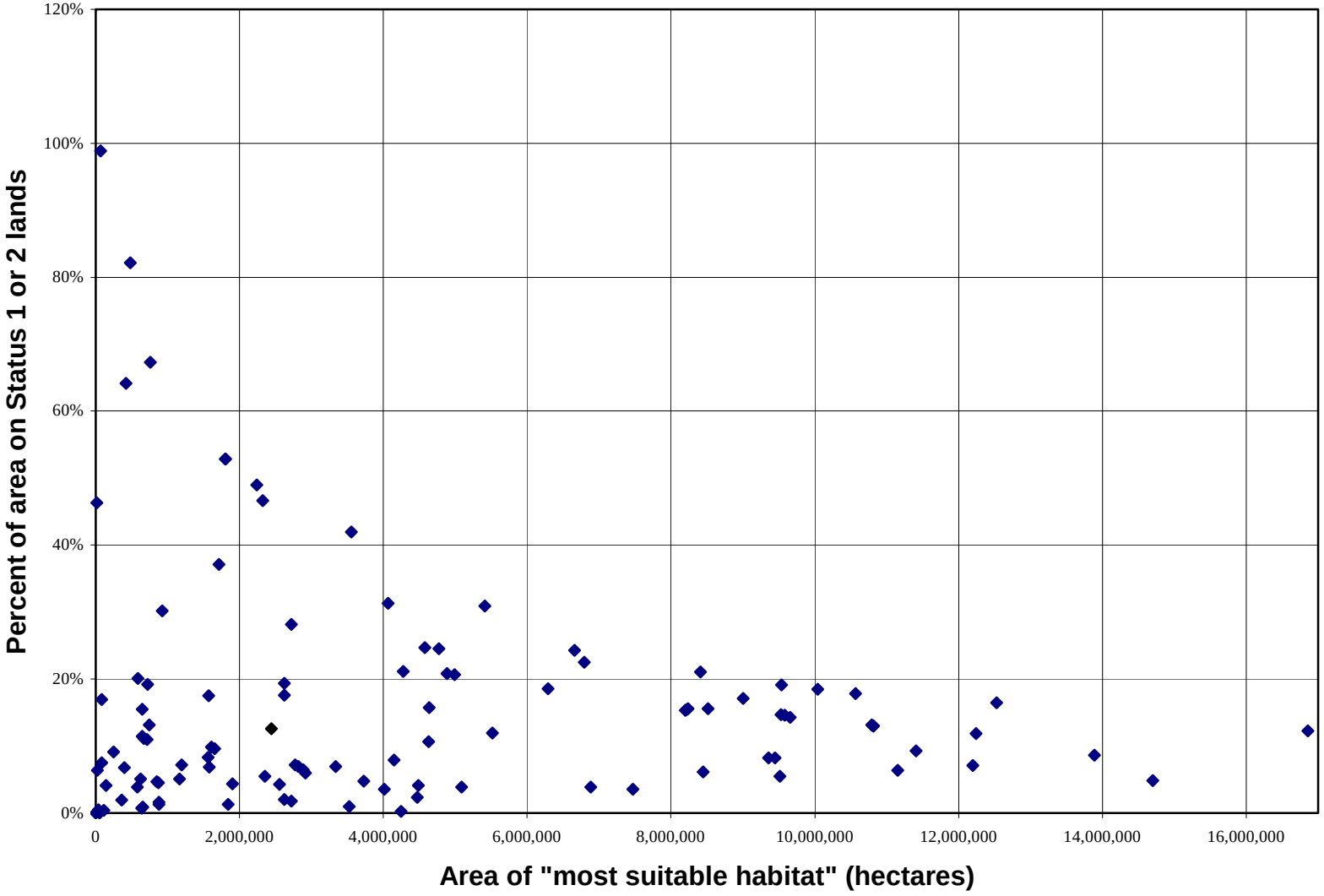
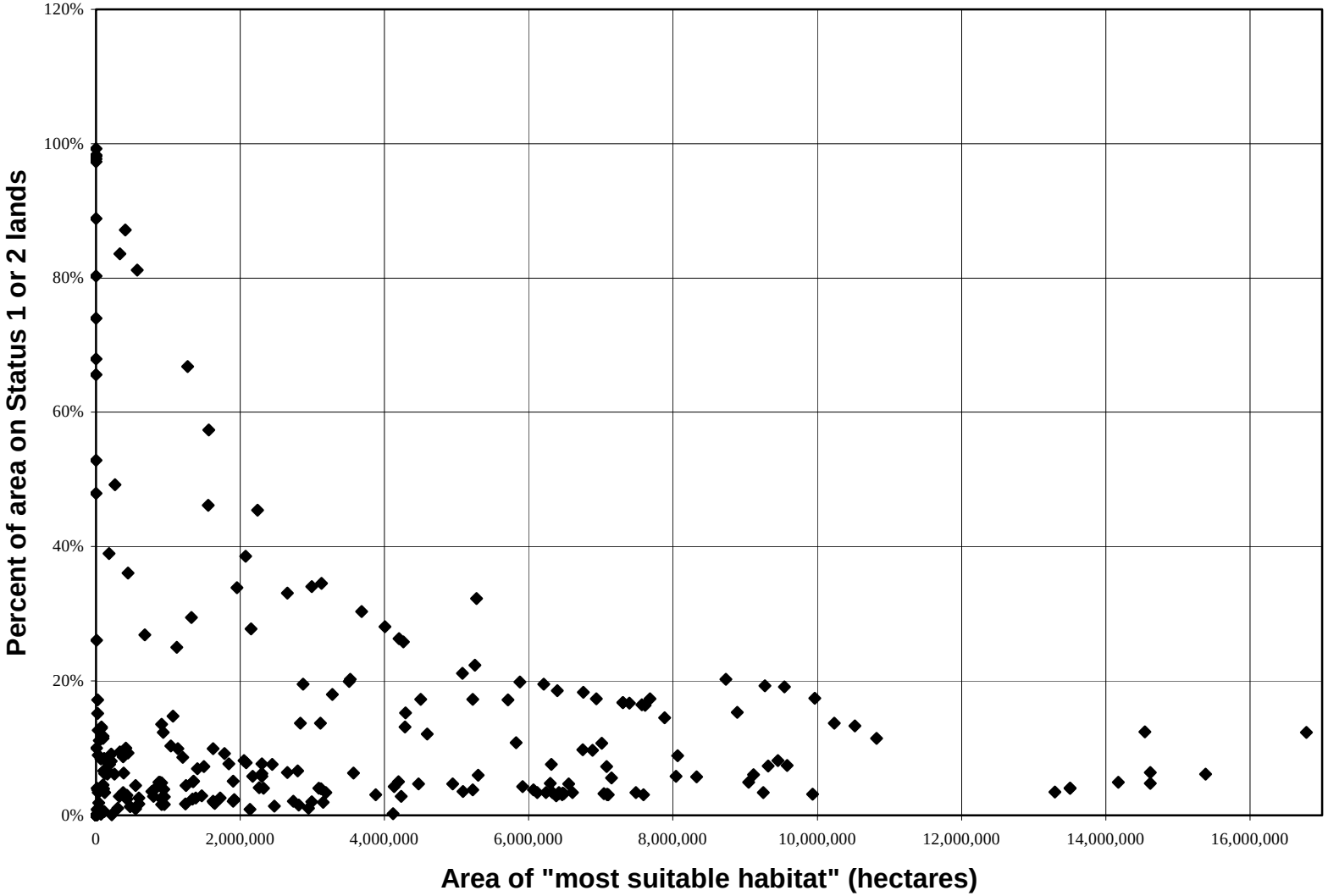


Figure 5. Distribution versus representation on status 1 or 2 lands - birds



Conservation Status of Individual Species and Selected Assemblages

In this section, we used 10% representation on Status 1 and 2 lands as a means of comparing protection status of various groups, however, adequate representation for an individual species is dependent on the species. Species that adapt well to human activities may not require protection (and, in fact, may do poorly in protected areas), while some sensitive species with large area requirements and stringent habitat requirements may require that most of their range be protected. Furthermore, the percentage of a species' current distribution on Status 1 or 2 lands can be misleading, because several species were once more widespread, but have been nearly extirpated outside of Status 1 or 2 lands.

For lists of east-side forest zone-dependent birds, west-side dependent birds, neotropical migrants, Columbia Basin dependents, "at-risk" species, see the chapter on Predicted Animal Distributions and Species Richness. For State or Federal listing status, see Tables 54 to 57.

Amphibians: Based on total most suitable modeled distribution, 14 of 24 (58%) native amphibians have less than 10% of their current distribution on Status 1 or 2 lands. Separated by taxonomic groups (and using only the most suitable modeled distribution), the numbers of species with less than 10% of their distribution on Status 1 or 2 lands are:

Salamanders:	8 of 14 (57%).
Frogs and toads:	6 of 10 (60%).

For other amphibian groups of interest, the numbers are:

Columbia Basin-dependents:	3 of 3 (100%)
At-risk species:	6 of 12 (50%).
Listed species:	6 of 8 (75%).

Reptiles: Based the most suitable modeled distribution, 18 of 21 (86%) native reptiles have less than 10% of their existing distribution on protected lands. Separated by taxonomic groups (and using only the most suitable modeled distribution), the numbers of species with less than 10% of their distribution on Status 1 or 2 lands are:

Turtles:	2 of 2 (100%).
Lizards:	5 of 7 (71%).
Snakes:	11 of 12 (92%).

For other reptilian groups of interest, the numbers are:

Columbia Basin-dependents:	5 of 8 (62%)
At-risk species:	4 of 7 (57%).
Listed species:	2 of 3 (67%).

As a group, the reptiles are the most poorly represented on Status 1 or 2 lands of the four major terrestrial vertebrate taxa in the state.

Mammals: Based on most suitable modeled distribution, 45 of 102 (44%) native mammals have less than 10% of their existing distribution on protected lands. Separated by taxonomic groups (and using only the most suitable modeled distribution), the numbers of species with less than 10% of their distribution on Status 1 or 2 lands are:

Shrews and moles:	5 of 12 (42%).
Bats:	7 of 15 (47%).
Rabbits:	4 of 6 (67%).
Carnivores:	8 of 19 (42%).
Hoofed mammals:	1 of 7 (14%).
Rodents:	20 of 43 (47%).

For other mammalian groups of interest, the numbers are:

Columbia Basin-dependents:	17 of 20 (85%).
At-risk species:	11 of 25 (44%).
Listed species:	7 of 15 (47%).

Birds: Based on most suitable modeled distribution, 138 of 230 (60%) native birds modeled have less than 10% of their existing breeding distribution on protected lands. (There are an additional 15 ephemeral or highly localized native breeders that were not modeled) Separated by taxonomic groups, or combinations of groups (and using only the most suitable modeled distribution), the numbers of species with less than 10% of their distribution on Status 1 or 2 lands are:

Non-passerine:	73 of 120 (61%).
Passerine:	65 of 110 (59%).
Swimmers:	25 of 44 (57%).
(Excluding marine birds):	25 of 35 (71%).
(Geese and ducks):	15 of 19 (79%).
Waders:	9 of 18 (50%).
Predators:	20 of 30 (67%).
Woodpeckers:	4 of 11 (36%).
Flycatchers:	8 of 11 (73%).
Gleaners:	11 of 19 (58%).
Finches:	4 of 11 (36%).
Sparrows:	9 of 17 (53%).

For other avian groups of interest, the numbers (including only modeled species) are:

East-side forest zone-dependents:	23 or 37 (62%).
West-side dependents:	13 of 29 (45%).
Columbia Basin-dependents:	29 of 42 (69%).
At-risk species:	22 of 38 (58%).
Listed species:	11 of 27 (41%).
Neotropical migrants	43 of 62 (69%)

Avian groups with the lowest protection status are swimming birds (especially ducks and geese, and excluding marine birds), flycatchers, Columbia Basin-dependents, and neotropical migrants. These groups are characterized by many species with most or all of their ranges at low-elevations. The neotropical migrant group, although taxonomically diverse, is heavily weighted towards species (e.g., many hummingbirds, flycatchers, swallows, and warblers) that come north to take advantage of insect and/or nectar abundance (often at low elevations) during the spring and summer. Groups with the best protection status overall are woodpeckers and finches. Many members of these groups occur at high-elevations. As a group, the species with State or Federal listing have greater proportions of their ranges protected than bird species in general, but several listed species have very low protection status.

Vertebrate Richness and Location of Status 1 and 2 Lands

To better examine the Conservation Status of areas of high vertebrate richness, we identified areas of high richness and displayed them according to Conservation Status (Maps 49 to 54).

Amphibians (Map 50): Areas of high richness for amphibians are predominately in habitats of mid- to late-seral conifer forests in low- to mid-elevation west-side zones. The largest blocks of Status 1 and 2 lands are on the lowest elevations of the Olympic and Mount Rainier National Parks and their surrounding Wilderness Areas; the lower elevations of the Mount St. Helens National Monument; the upper reaches of the Skagit River where it runs through the Ross Lake Recreation Area (Whatcom/Skagit Counties); and the Trapper Creek Wilderness Area (Skamania County). The largest block of Status 3 land with high amphibian diversity is in the southwest Cascades and lies mostly on the Gifford-Pinchot National Forest. Other large blocks of Status 3 lands are the WDNR Trust lands of the Black Hills Capitol State Forest; WDNR Trust lands and Olympic National Forest lands surrounding the Olympic National Park; and scattered patches of WDNR and National Forest land in the northwestern Cascades and southwestern Washington. Large areas of high-richness Status 4 lands lie in southwestern Washington; in the southwest and west-central Cascades; and, to a lesser extent, in forest fragments in the northwest Cascades and the foothills of the Olympic Mountains.

Reptiles (Map 51): Areas of high reptile richness are dominated by Status 4 lands. Status 3 lands are primarily composed of WDNR Trust lands that often lie in a section-block checkerboard pattern with Status 4 lands or Status 2 State Wildlife Areas. Status 1 and 2 (mostly 2) lands are composed primarily of State Wildlife Areas, NWRs, and the buffer zones around Hanford. The buffer zones around Hanford provide the largest blocks of high-reptile richness Status 2 lands, in the form of the Saddle Mountain NWR to the north and the Fitzner/Eberhardt Arid Lands Ecology Reserve (FEALE) to the

west. The L. T. Murray Wildlife Area on the lower east slope of the Cascades (Kittitas/Yakima Counties) forms the next largest Status 2 area. Unlike Status 4 lands in general, the Status 4 lands that cover the areas of high-reptile richness have a large component of non-private lands including parts of the Yakama Indian Reservation, the Yakima Training Center (DoD), and Hanford Nuclear Reservation (DoE). The largest unfragmented area of high reptile richness lies across eastern Kittitas, northeastern Yakima, northern Benton, and southern Grant Counties. This area is dominated by Status 4 lands of the Yakima Training Center and the Hanford Nuclear Reservation in the center, with large areas of Status 2 and 3 lands on the edges.

Mammals (Map 52): Habitats of high mammal richness tend to be riparian areas and forests in the Western Hemlock and Olympic Douglas-fir zones of the west side, and the Interior Western Hemlock, Interior Redcedar, and Grand Fir zones of the east side. On the east side, areas of high richness lie primarily on Status 3 National Forest lands in the extreme northeast corner and the east-central Cascades, with some adjacent Status 1 lands on Wilderness Areas, especially in the northeast Cascades. On the west slope of the Cascades, areas of high mammal richness are predominantly Status 4 lands, with some blocks of Status 3 lands. The largest area (which is not very large) of Status 1 or 2 land in the west Cascades is along the upper Skagit River in Whatcom County within the Ross Lake Recreation Area. On the Olympic Peninsula, the areas of Status 1, 3 and 4 high-richness lands are about equal, but Status 4 lands tend to be at the lowest elevations.

Birds (Map 53): Habitats of high bird richness tend to be either low-elevation wetlands (including lakes, ponds, marshes, and riparian areas) or low-elevation east-side forests. High richness areas of the west side and Columbia Basin (predominately low-elevation wetlands) lie almost entirely on privately-owned Status 4 lands. The few Status 1 or 2 lands are usually NWRs. Along the east slope of the Cascades, areas of high richness are mostly a mix of Status 3 and Status 4 lands. The Status 3 lands are a mix of National Forest lands and WDNR Trust lands at the edges of the National Forest lands. The largest area of high richness on Status 1 and 2 lands occurs in the valleys of upper Lake Chelan, the Stehekin River, and Agnes Creek, where it lies on parts of the Lake Chelan National Recreation Area, the Glacier Peak Wilderness, and the North Cascades National Park. Areas of high richness in northeastern Washington lie predominately on Status 4 lands of private owners and the Colville and Spokane Indian Reservations. Status 3 lands of the Colville National Forest cover large areas of high-bird richness in northeastern Okanogan and northern Ferry Counties. Scattered Status 2 lands lie on the Little Pend Oreille NWR (Stevens County), Mount Spokane State Park (Spokane County), Riverside State Park (Spokane County), and the Sherman Creek Wildlife Area (Ferry County).

At-risk Species: Map 54 shows high-richness areas of the 12 amphibian, 7 reptile, 25 mammal, and 38 avian at-risk species. The areas of high richness of at-risk species do not always correspond with areas of high richness for species in general (for more details and a list of the selected at-risk species, see the chapter on Predicted Animal Distributions and Species Richness).

Areas of highest richness for all vertebrate at-risk species are uncultivated, mostly upland, steppe habitats; mid- and late-seral, mid-elevation west-side conifer forests; and remote mid- and high-elevation east-side forests in the northeast Cascades and northeastern Washington. The highly

developed Puget-Willamette Trough zones, the very heavily farmed eastern-most steppe zones, and the low-elevation forest zones have few areas of high richness of at-risk species.

A greater percentage of high-richness areas for at-risk species is on Status 1 or 2 lands than for species in general, probably because the ranges of many of the at-risk species have been reduced on unprotected and disturbed lands. High numbers of at-risk species occur on Status 1 or 2 lands in Wilderness Areas and North Cascades National Park in the northeast Cascades, lower elevations of Olympic National Park, the Hanford Nuclear Reservation Buffer zones, and State Wildlife Areas in the west-central Basin. Large areas of high richness on Status 3 lands are located in the southwest Cascades on the Gifford-Pinchot National Forest, the Olympic National Forest and WDNR Trust lands surrounding the Olympic National Park, the northeast Cascades (Wenatchee and Okanogan National Forests and WDNR Trust lands), and the northeast corner (mostly the Colville and Kaniksu National Forests). Areas of high richness on Status 3 lands in the Columbia Basin are mostly WDNR Trust lands. Large areas of high richness on Status 4 lands are found in remaining mid- to late-seral forest patches in southwestern Washington and the Olympic Peninsula, the lower southwest slopes of the Cascades, and in the Columbia Basin.

The Role of Status 3 and Status 4 Lands

Adequate protection for many species may be provided by Status 1 and 2 lands, however, Status 1 and 2 lands are skewed towards higher elevations, and increased protection of substantial amounts of lower elevation zones is unlikely. In addition, our selection of a 10% representation on Status 1 and 2 lands was arbitrary and used primarily as a means of comparing overall protection status among groups. For many species, even those with a large percentage of their distribution on Status 1 and 2 lands, 10% representation is too small because it does not provide sufficient protection in absolute area. A high proportionate amount of current protection on Status 1 and 2 lands may also be the result of extirpation from a previously much larger range that is largely unprotected. Thus, while Status 1 and 2 lands are very important, survival of most species will continue to depend on management of Status 3 or 4 lands.

Status 3 lands occupy 24% of the State and, of the 377 modeled native breeding vertebrates, 50 (13%) have more than 40% of their area on Status 3 lands. This group, however, includes many of the most endangered species, the large mammals, and the "charismatic" species, including: Gray Wolf, Grizzly Bear, Marten, Fisher, Wolverine, Lynx, Caribou, Harlequin Duck, Northern Goshawk, Marbled Murrelet, Spotted Owl, Great Gray Owl, and Pileated Woodpecker. Many of these species require large, contiguous tracts of relatively undisturbed forests and/or large areas free of hunting, trapping, or other sources of human-induced mortality. Also, many of them were once far more widespread, but have been extirpated from much of their former unprotected range and are now limited to remote and/or relatively well-protected areas. Many of these species have a large percentage of their area on Status 1 and 2 lands, but the absolute amount of protected area is too small and/or too fragmented to support viable populations. Their continued survival in the State depends largely on management of National Forests and forested WDNR lands within their ranges.

Status 4 lands occupy 64% of the State, and the majority of most species' distributions are on these lands. Of the 377 modeled native breeding vertebrates, 122 (nearly a third) have more than 80% of

their most suitable habitat on Status 4 lands. This group includes 29 species either State or Federally listed, or that we defined as most at-risk due to human activities: Dunn' s Salamander, Northern Leopard Frog, Western Pond Turtle, Short-horned Lizard, Night Snake, California Mountain Kingsnake, White-tailed Jack Rabbit, Washington Ground Squirrel, Least Chipmunk, Western Gray Squirrel, Sagebrush Vole, Badger, Common Loon, Clark' s Grebe, Western Grebe, American Bittern, Canvasback, Cooper' s Hawk, Ferruginous Hawk, Sage Grouse, Sharp-tailed Grouse, Long-billed Curlew, Caspian Tern, Black Tern, Burrowing Owl, Short-eared Owl, Purple Martin, and Brewer' s Sparrow. Because so much of these species' ranges occur on Status 4 lands, their continued survival will be unlikely to be achieved solely through management on Status 1,2, or 3 lands. For many of them, their ranges have already been reduced to perilously small areas. Some of them have ranges that include substantial areas of publicly-owned Status 4 lands which has provided them some protection from development and agriculture. For example, the best remaining Western Gray Squirrel habitat on the west side is on the Fort Lewis Military Reservation (DoD), and a significant portion of the remaining Ferruginous Hawk habitat is on the Hanford Nuclear Reservation and its surrounding buffer areas (DoE). However, most of these species occur primarily on private lands. They potentially represent future controversy over private land management if measures are not taken soon to assure their populations do not decline.

Special Features Analysis

No special features analyses (e.g., known locations of bat caves) were done.

Analysis of Statewide Endemics

Only a small number of Washington terrestrial vertebrates are endemic or nearly endemic at the species level and all are salamanders. The two endemics are Olympic Torrent Salamander and Van Dyke' s Salamander. The two near-endemics are Cope' s Giant Salamander and Larch Mountain Salamander. All four species are discussed in the following Individual Species Analysis section.

Individual Species Analysis

Individual species protection status is inadequately addressed by comparing representation on Status 1 and 2 lands among groups. We limit our individual species discussion to our list of at-risk species. (See the methods section of the chapter on Predicted Animal Distributions and Species Richness for selection criteria for these species.) We focus on at-risk species because we lack the space to discuss all species, and, although many other species have little representation on Status 1 and 2 lands, most tolerate or adapt well to human activities and are not likely to be in imminent danger of extinction. On the other hand, our at-risk group is larger than the group of listed species; species are usually not listed until they are near extirpation in an area, and the philosophy of GAP is the adoption of a proactive approach to conservation. The at-risk group includes most listed species plus the "next tier" of species that might become a concern. Information on habitat requirements is from Volumes 2, 3, and 4 of this Report. "Distribution" in the following accounts refers to "most suitable modeled habitat" in Washington.

Cope' s Giant Salamander is nearly endemic to Washington. It is known only from western Washington and northwestern Oregon (Leonard et al. 1993). An estimated 17% of its distribution is on Status 1 or 2 lands and 43% is on Status 3 lands.

Olympic Torrent Salamander is thought to rely on mature conifer forests and is endemic to Washington. It occurs only in the Olympic Mountains (Leonard et al. 1993). An estimated 46% of its distribution is on Status 1 or 2 lands (chiefly the Olympic National Park and surrounding Wilderness Areas), which makes it one of the better protected "at-risk" species.

Columbia Torrent Salamander is thought to rely on mature conifer forests and has a limited range. Its distribution covers 151,000 hectares, of which 0.5% is on Status 1 or 2 lands and 23.9% is on Status 3 lands. This State Candidate species occurs only in Washington and Oregon, with about half its range in Oregon (Leonard et al. 1993). Its distribution in Washington lies mostly on private lands in southwestern Washington, with most of its Status 3 lands on WDNR Trust lands. Because less of its distribution lies on public land, there are fewer options for improving its protection status in Washington than for the closely related Cascades Torrent Salamander.

Cascades Torrent Salamander is thought to rely on mature conifer forests and has a limited range. Its distribution covers 572,000 hectares, of which 2% is on Status 1 or 2 lands and 38% is on Status 3 lands. This State Candidate species occurs only in Washington and Oregon, with about 1/3 of its range in Washington (Leonard et al. 1993). Its distribution in Washington lies mostly on a combination of National Forest lands (the Gifford-Pinchot National Forest), WDNR Trust lands, and private lands in the southwest Cascades.

Dunn' s Salamander, with a distribution covering 374,000 hectares, of which 0.2% is on Status 1 or 2 lands and 16% on Status 3 lands. This State Candidate species has a much larger range in Oregon than Washington; it also occurs in California (Leonard et al. 1993). In Washington, its distribution is mostly on private lands in southwestern Washington.

Larch Mountain Salamander is nearly endemic to Washington. It occurs almost entirely in the southwest Cascades, but barely enters Oregon directly south of its Washington distribution. An estimated 8.3% of its distribution is on Status 1 or 2 lands. The primary land holder over most of its range is the Gifford-Pinchot National Forest.

Van Dyke's Salamander, a State Candidate, is a Washington endemic that occurs only in the Olympic Peninsula and southwestern Cascades. An estimated 23% of its distribution is on Status 1 or 2 lands, and 44% on Status 3. Collection locations indicate it does best in mature conifer forests, so, outside of the Olympic National Park, it may suffer from habitat loss.

Tailed Frog is widespread in mountains in Washington, but collection locations suggest it does best in mature forests. Research also indicates that Tailed Frogs show severe declines from logging and road building (Leonard et al. 1993). About 29% of its distribution is on Status 1 or 2 lands and 48% is on Status 3 lands.

Cascades Frog has 48% of its distribution on Status 1 or 2 lands and 36% on Status 3. It occurs mostly at high elevations and does not seem to require late seral forests. It is locally abundant. We included it in our list of at-risk species because some field studies have noted a decline in Cascades Frogs (Nussbaum et al. 1983). The causes and the extent of the decline are unclear.

Columbia Spotted Frog, a State Candidate and Federal Species of Concern, has 10% of its distribution on Status 1 or 2 lands and 37% on Status 3. The Columbia Spotted Frog and Oregon

Spotted Frog were recently split; the Oregon Spotted Frog has shown a dramatic decline in its range, but it is unclear whether the Columbia Spotted Frog is also declining.

Oregon Spotted Frog has a distribution that covers only 9,000 hectares, of which 18% is on Status 1 and 2 lands and 8% is on Status 3 lands. This State and Federal Candidate species is more widespread in Oregon (Leonard et al. 1993), but it has suffered dramatic declines over much of its range in Washington, especially in the Puget-Willamette Trough (see Volume 2). Although a fair proportion of its remaining distribution is on Status 1 or 2 lands, the small area of suitable habitat makes it vulnerable to local extirpations. Populations in Thurston County are especially of concern because of their isolation and the current, rapid development in that county.

Northern Leopard Frog , has a current distribution that covers only 31,000 hectares, of which 7% is on Status 1 or 2 lands and 8.3% is on Status 3 lands. This State Candidate species is widespread across the United States (Leonard et al. 1993) but is apparently declining in Washington and Oregon.

Western Pond Turtle has a distribution covering only 20,000 hectares, of which 0.2% is on Status 1 or 2 lands and 8% is on Status 3 lands. This species, a State Candidate and Federal Species of Concern, is at the northern limit of its range in Washington. It occurs south to Baja California (Storm and Leonard 1995), but is declining throughout its range, particularly in Washington (see Volume 2). In Washington, the species is believed to have been extirpated in the Puget Sound area, and the only known remaining populations are in Skamania and Klickitat Counties along the Columbia River.

Short-horned Lizard, Sagebrush Lizard, Side-blotched Lizard, Night Snake, and **Striped Whipsnake** were included in our at-risk group because all are Columbia Basin-dependents in Washington that do poorly in agricultural areas. However, only the Striped Whipsnake is a State Candidate. They have 5% to 12% of their distributions on Status 1 or 2 lands and 10% to 12% on Status 3 lands (usually WDNR Trust lands).

California Mountain Kingsnake has a distribution covering only 6,000 hectares, of which 2% is on Status 1 or 2 lands and 14% is on Status 3 lands. This State Candidate species is also at the northern limit of its range in Washington, and also occurs south to Baja California (Storm and Leonard 1995). Its Washington distribution is disjunct from the rest of its range. In Washington, it is associated primarily with oak and pine forests and its range in the state is probably limited by the localized distribution of dry oak savanna.

Pygmy Shrew, a State Candidate, occurs in northeastern Washington. Its range and habitat requirements are poorly known because it is either very rare or very difficult to trap. Only 5% of its distribution is an Status 1 or 2 land, but 47% lies on Status 3 land, mostly the Kaniksu and Colville National Forests.

Merriam's Shrew , a State Candidate, occurs in sagebrush and bunchgrass in part of the Columbia Basin. It does not usually occur on agricultural land. About 11% of its modeled distribution lies on Status 1 or 2 lands and 13% on Status 3 lands (usually WDNR Trust lands).

Preble' s Shrew was considered (by WAGAP) to occur only peripherally in Washington (in the Blue Mountains), and thus has no "most suitable habitat" (which includes only habitats in core zones). However, that assumption was made largely because data are so few. This species is very difficult to trap, and little is known about its habitat requirements or range limits. Further evaluation of its status should be made based on more extensive study.

Keen's Myotis is apparently limited mostly to the northern Olympic Peninsula and northern Puget Sound in Washington. It may require mature forests, but its habitat requirements are poorly known. We estimated that 20% of its poorly-known distribution is on Status 1 or 2 lands and 35% is on Status 3 lands.

Silver-haired Bat is widespread in Washington forests. It was included in our at-risk group because there is some evidence it prefers older conifer forests, however, little is known of its habitat requirements in Washington. We estimated that 16% of its distribution is on Status 1 or 2 lands and 35% is on Status 3 lands.

Townsend' s Big-eared Bat, a State Candidate and Federal Species of Concern, is widespread at low elevations. It is a listed species because maternity colonies and hibernating bats are extremely sensitive to disturbance. Its modeled distribution includes habitat occupied by non-breeding and non-hibernating bats; thus its model-based protection status is a poor indication of the protection of its critical habitat features: undisturbed maternity colonies and hibernacula.

Black-tailed Jack Rabbit is a Columbia Basin-dependent. It is apparently doing better than the White-tailed Jack Rabbit, but is generally not associated with agriculture. It is most abundant in warmer steppe. About 10% of its modeled distribution lies on Status 1 or 2 lands and 11% on Status 3 lands.

White-tailed Jack Rabbit occurs in steppe, primarily in cooler steppe around the edge of the Columbia Basin. Its population declined with the widespread conversion of deep-soil grasslands to agriculture. Currently, 2% of its 878,000 hectares of modeled distribution is on Status 1 or 2 lands and 12% is on Status 3 lands.

Pygmy Rabbit, at the time of our analysis, occupied only 56,000 hectares in the Columbia Basin, with none of its modeled distribution on Status 1 or 2 lands, and 20% on Status 3 lands, the latter mostly WDNR Trust lands. However, the WDFW has recently moved to assume management of a WDNR tract with the largest known Pygmy Rabbit population in Washington, so the species' protection status is expected to improve. Pygmy Rabbits are more widespread in the Great Basin outside of Washington. The Washington rabbits represent a disjunct population that has declined because of large-scale conversion of deep soil sagebrush-dominated communities to cropland. The limited distribution and isolated nature of Washington populations make the Pygmy Rabbit in our State very vulnerable to local extirpations. It is recognized as a State Endangered species.

Townsend' s Ground Squirrel is limited to the southwestern Columbia Basin. It has been eliminated from much of its former range in the Yakima Valley by extensive irrigated agricultural fields. An estimated 11% of its current distribution is on Status 1 or 2 lands and 10% is on Status 3 lands.

Washington Ground Squirrel , a State Candidate, is another species whose range has declined due to the cultivation of deep-soil sites in the Columbia Basin. It occurs in dry grasslands or low sage. Nearly 4% of its area is on Status 1 and 2 lands, chiefly parts of National Wildlife Refuges and the Juniper Dunes Wilderness Area in the Basin, but like the other species that rely on deep-soil sites, most of its best habitat has been lost.

Least Chipmunk is a Columbia Basin-dependent with 8% of its distribution on Status 1 or 2 lands and 10% on Status 3 lands. Its limited distribution in Washington has probably been reduced by agriculture.

Western Gray Squirrel is a State Threatened species with several disjunct populations in Washington State. It occurs chiefly in the Woodland/Prairie Mosaic zone of the Puget Trough, the Oak zone of

the southeast Cascades, and parts of the Ponderosa Pine zone along the east Cascades. In the Ponderosa Pine zone, it is mostly limited to parts of the zone adjacent to the Oak zone, where oaks occur within the Ponderosa Pine zone, or where groves of nut-bearing trees (walnuts, pecans, etc.) have been planted. In western Washington, loss of oak savanna and possibly competition with the non-native Eastern Gray Squirrel have led to a decline of the Western Gray Squirrel. About 4% of its distribution is on Status 1 or 2 lands and 14% is on Status 3 lands. The Western Gray Squirrel also occurs in Oregon and California, where oak forests are more extensive. Its continued occurrence in western Washington depends on management of Fort Lewis, where it is likely that most of the western Washington population now occurs.

Mazama Pocket Gopher has 46% of its most suitable habitat is on Status 1 or 2 lands, but it has several subspecies in Washington. The protection status of these subspecies varies, and we did not consider them separately in our analysis. One subspecies occurs in alpine and subalpine meadows of the Olympic Mountains. Its range is within the Olympic National Park, and it accounts for almost all of the Status 1 or 2 lands for the species in Washington. All of the other subspecies occur as scattered populations in the lowlands of western Washington with little of their ranges on Status 1 or 2 lands and most are declining as west-side prairies are disappearing. If the subspecies in the Olympic Mountains is excluded, 3% of the remaining distribution is on Status 1 or 2 lands and 5% is on Status 3 lands.

Northern Grasshopper Mouse is a Columbia Basin-dependent whose distribution and possibly range limits has been reduced by agriculture. It is either rare or difficult to catch and records are sparse. More information is needed about its current range limits. An estimated 10% of its distribution is on Status 1 or 2 lands and 11% is on Status 3 lands.

Sagebrush Vole is a Columbia Basin-dependent whose distribution has probably been reduced by agriculture. An estimated 7% of its current distribution is on Status 1 or 2 lands and 11% is on Status 3 lands.

Gray Wolf, a Federal Endangered species, has a poorly defined range in Washington and an extremely low population. It has over 50% of its range on Status 1 or 2 lands, but is a top-level carnivore that requires a very large area to maintain a viable population. The percentages of its current distribution on protected lands is misleading, because it was once much more widespread in the State and is now limited to remote, mostly rugged, high-elevation environments.

Grizzly Bear, a Federal Threatened species, has a range and protection status similar to that of the Gray Wolf. It is also a top-level carnivore that requires a very large area to maintain a viable population. It was also once much more widespread in the State and is now limited to remote, mostly rugged, high-elevation environments.

Marten is widespread in mountainous areas of Washington and occurs up to high elevations, but its status is uncertain. It has been extirpated from part of its former range by overtrapping for the fur trade, but it seems to have recovered better than the Fisher. An estimated 25% of its distribution is on Status 1 or 2 lands and 46% is on Status 3 lands.

Fisher, a State Candidate and Federal Species of Concern, has declined due to logging and overtrapping for the fur trade. Its current status in Washington is unclear, but it seems to be very rare. It probably once occurred over a larger range as well. On the west side, it is limited to low elevations, which reduces its protection status there. An estimated 20% of its statewide distribution is on Status 1 or 2 lands and 47% on Status 3 lands.

Wolverine is extremely rare in Washington, where it was previously nearly or completed extirpated. Its numbers are probably increasing now, but little is known of its current status. About 31% of its current poorly-known range is on Status 1 or 2 lands and 46% is on Status 3 lands.

Badger is a Columbia Basin-dependent affected by deliberate killing because its burrows are often considered a nuisance. An estimated 6% of its distribution is on Status 1 or 2 lands and 12% is on Status 3 lands.

Lynx, a State Threatened and Federal Species of Concern, is limited to high elevations in north central and northeastern Washington. An estimated 30% of its distribution is on Status 1 or 2 lands and 61% is on Status 3 lands. The primary land owner within its distribution is the USFS.

Woodland Caribou , a Federal Endangered subspecies of the Caribou, occupies 81,000 hectares in extreme northeastern Washington on mostly National Forest and Wilderness Areas, of which 17.0% lies on Status 1 or 2 lands. Although the percentage of Status 1 or 2 lands exceeds 10%, this species is vulnerable because it is a large herbivore that moves up and downhill with the seasons, in and out of protected areas.

Bighorn Sheep has a patchy distribution that covers 640,000 hectares, of which 15% is on Status 1 or 2 lands and 29% on Status 3 lands. It is adversely affected by human disturbance and diseases carried by domestic sheep.

Common Loon is a State Candidate species that requires quiet lakes for breeding. With 4.0% of its breeding distribution on Status 1 or 2 lands, 3.8% on Status 3 lands, and the popularity of most water bodies for recreation, improvement of its protection status will be a challenge. A recent search of loons in the State yielded only 21 lakes where loon breeding was probable or confirmed.

Western Grebe and **Clark' s Grebe** are colonial breeders limited to a few large water bodies in the central Basin. Their colonial breeding habits and limited distribution render them vulnerable to human disturbance. Both species have 5% of their distribution on Status 3 lands; they have 8% to 11% of their distributions on Status 1 or 2 lands.

American Bittern occurs in dense marshes at low elevations. About 6% of its distribution is on Status 1 or 2 lands and only 2% on Status 3 lands. Little is known of its current status because bitterns are secretive and difficult to find.

Canvasback is declining across the country and possibly in Washington as well. It is limited to a few water bodies in the Columbia Basin. About 10% of its current distribution is on Status 1 or 2 lands and 7% is on Status 3 lands.

Harlequin Duck occurs in mountainous habitats not generally developed or cultivated, but is apparently rare, poorly known, and seem to be decreasing, even though 34% of their distribution occurs on Status 1 or 2 lands and 44% occurs on Status 3 lands.

Cooper' s Hawk is poorly known, but seems to occur mainly at low elevations and may require mature forests. It is uncommon, and has 3% of its distribution on Status 1 or 2 lands and 14% on Status 3 lands.

Northern Goshawk , a State Candidate and Federal Species of Concern, is uncommon in mature forests. About 30% of its distribution occurs on Status 1 or 2 lands and 46% on Status 3 lands.

Ferruginous Hawk and **Prairie Falcon** are both uncommon Columbia Basin-dependents. Prairie Falcons appear to be stable, but Ferruginous Hawks are declining and listed as State Threatened. Both have about 10% of their distribution on Status 1 or 2 lands and 9% to 11% on Status 3 lands.

Peregrine Falcon is a State and Federal Endangered species whose populations were severely reduced by the use of DDT. It is slowly recovering but is still very rare and patchily distributed in Washington. An estimated 68% of its current breeding distribution occurs on Status 1 or 2 lands because most of the current breeding population occurs along the outer coast of the northern Olympic Peninsula within the Olympic National Park or the offshore National Wildlife Refuges. However, the Peregrine Falcon was once more widespread.

Sage Grouse , a State Candidate species, is uncommon, very local, and declining. About 6% of its current distribution is on Status 1 or 2 lands and 12% on Status 3 lands, but is was once much more widespread in the Columbia Basin.

Sharp-tailed Grouse , a State Candidate species, breeds in the northern Columbia Basin, mostly in the Okanogan Valley, northern Douglas County, and central Lincoln County. Its numbers have declined since European settlement with the conversion of grasslands on deep soil to agriculture. With only 1% of its remaining distribution on Status 1 or 2 lands and 11% on Status 3 lands (primarily WDNR Trust lands), this species is a conservation priority, and a challenge.

Sandhill Crane , a State Endangered species, nests at only two locations in Washington: Conboy Lake NWR (Klickitat County) and Signal Peak on the Yakama Indian Reservation (Yakima County). An estimated 26% of its small breeding area is on Status 2 lands (Conboy Lake NWR), and 6% is on Status 3 lands.

Snowy Plover, a State Endangered species, is known to nest on sandy beaches at two locations in Washington: Leadbetter Point (Pacific County) and Damon Point (Grays Harbor County). It is easily disturbed by human activities when breeding. Since the current Leadbetter Point nesting site lies on the Willapa NWR, 66% of its breeding habitat was estimated to lie on Status 1 or 2 land.

Upland Sandpiper, a State Endangered species, has probably been extirpated in Washington. It recently nested in grassy fields in the Spokane Valley, but numbers have been declining, probably because of encroaching development. The last sighting there was in 1993.

Long-billed Curlew was once widespread and common in the Columbia Basin. It became rare from overhunting and conversion of grasslands to agriculture. Currently, numbers have rebounded and it is fairly common on uncultivated steppe. This Columbia Basin-dependent has 8% of its distribution on Status 1 or 2 lands and 11% on Status 3 lands (mostly WDNR Trust lands)

Caspian Tern is a colonial breeder that appears to be sensitive to human disturbance. Most of its colonies are on large water bodies in the central Columbia Basin. About 11% of its distribution is on Status 1 or 2 lands and 3% on Status 3 lands.

Black Tern usually nests in small colonies and is most common in northeastern Washington. Nationwide, numbers are stable or decreasing slightly (DeGraaf et al., 1991). Its protection status is poor, with 5% of its distribution on Status 1 or 2 lands, and 4% on Status 3 lands.

Marbled Murrelet , a State Threatened and Federal Threatened species, requires mature conifer forests within daily flying distance of the ocean for breeding. Its former distribution has been reduced by logging; it rarely occurs on private lands anymore, where most large tracts of mature forest have been logged. About 25% of its current distribution is on Status 1 or 2 lands and 44% on Status 3 lands.

Flammulated Owl, a State Candidate species, is uncommon and local in mature Ponderosa Pine in Douglas-fir forest. Because it is limited to mostly low-elevation east-side forests, only 4% of its distribution is on Status 1 or 2 lands. About 34% is on Status 3 lands.

Burrowing Owl, a State Candidate species, is a Columbia Basin-obligate. Although it can evidently coexist with agriculture, it requires burrows for nesting. In most areas, numbers are seriously declining. About 7% of its current patchy distribution is on Status 1 or 2 lands and 8% is on Status 3 lands.

Spotted Owl, a State Endangered and Federal Threatened species, needs little introduction, as it has been the highly-visible source of much controversy over logging. The Spotted Owl requires large, unfragmented mature conifer forests for successful nesting and its distribution has declined with logging. Little suitable habitat remains on private land. We estimated that 33% of its current distribution is on Status 1 or 2 lands and 44% is on Status 3 lands.

Great Gray Owl has only recently been discovered to breed in the State, with known breeding occurring in eastern Okanogan County. Its modeled distribution covers 220,000 hectares, of which only 0.05% is on Status 1 or 2 lands and 44% is on Status 3 lands. The Status 3 lands are primarily part of the Colville National Forest. The large percentage of this species' known range on Status 3 lands with a single steward might help simplify management decisions; conversely, the large area of suitable habitat required to maintain a viable population of a large predator presents a management challenge.

Short-eared Owl breeds mostly in the Columbia Basin, but there are records of breeding on the west side. Although it hunts in agricultural areas, its numbers appear to be declining because of loss of nesting sites to cultivation and overgrazing. It nests on the ground. About 4% of its distribution is on Status 1 or 2 lands and 8% is on Status 3 lands.

Lewis' Woodpecker, a State Candidate species, occurs in open forests and woody riparian corridors in the Ponderosa Pine zone and at the edge of steppe. It once occurred in burns and prairies of western Washington but has been extirpated there. It is vulnerable to clearing of vegetation and development along streams. Competition for nests sites with European Starlings has also contributed to its decline. About 5% of its current distribution is on Status 1 or 2 lands and 27% is on Status 3 lands.

White-headed Woodpecker, a State Candidate species, is a pine-obligate and rarely occurs outside of Ponderosa Pine forests. It apparently requires large trees for nesting and declines with logging. About 4% of its current patchy distribution occurs on Status 1 or 2 lands and 30% on Status 3 lands.

Pileated Woodpecker, a State Candidate species, requires large snags for nesting. Its numbers are believed to be declining due to logging, but it can apparently tolerate a broad range of forest types and seral stages if large snags remain. About 17% of its distribution lies on Status 1 or 2 lands and 42% on Status 3 lands.

Purple Martin, a State Candidate which breeds in lowlands on the west side, is a species that increased in number with the arrival of Europeans (and their structures), then declined dramatically with the introduction of the European Starling and resulting nest-site competition. Purple Martin conservation issues cannot be addressed by habitat conservation only, since habitat availability is not the critical factor in their decline.

Western Bluebird is vulnerable to nest site competition from House Sparrows and European Starlings. Aggressive nest box campaigns have caused its numbers to increase in some areas. About 3% of its distribution is on Status 1 or 2 lands and 21% is on Status 3 lands.

Gray Catbird breeds in shrubby and riparian areas at the ecotone between steppe and forest, and is especially common in northeastern Washington. This species, which has no State or Federal listing, has shown a significant population declines in Washington in recent years. Only 3% of its most suitable breeding distribution lies on Status 1 or 2 lands, but another 21% lies on Status 3 (WDNR and National Forest) lands.

Sage Thrasher, a State Candidate species and Columbia Basin-dependent, lost much of its pre-European distribution to cultivation in the Basin. It rarely nests in anything but sagebrush. About 9% of its distribution is on Status 1 or 2 lands and 11% is on Status 3 lands.

Loggerhead Shrike, a State Candidate species, is an uncommon Columbia Basin-dependent that occurs on relatively undisturbed steppe, mostly in the central Basin. About 12% of its distribution is on Status 1 or 2 lands and 15% on Status 3 lands.

Yellow Warbler is most abundant in low-elevation riparian zones in eastern Washington, but also occurs at mid elevations and in riparian areas of western Washington. Numbers have declined significantly in recent years in many areas (DeGraaf et al. 1991), including Washington. It is frequently victimized by cowbird parasitism, and its occurrence at low-elevations makes it especially vulnerable. About 9% of its distribution is on Status 1 or 2 lands and 36% on Status 3 lands.

Yellow-breasted Chat is currently common in shrubby habitats at the ecotone between forest and steppe. It was included in our at-risk group because it is vulnerable to land clearing and development as human populations increase around the perimeter of the Columbia Basin. It once occurred in small numbers in western Washington but is now very rare there. About 5% of its distribution is on Status 1 or 2 lands and 21% on Status 3 lands.

Chipping Sparrow occurs in dry, open forest mostly in eastern Washington and sporadically in open areas in western Washington. It is common but has declined significantly in recent years, especially in western Washington. It is a frequent cowbird host and is very susceptible to cowbird predation when it nests near agriculture or development. About 15% of its distribution is on Status 1 or 2 lands and 34% on Status 3 lands.

Brewer's Sparrow is a Columbia Basin-dependent that has lost much of its former sagebrush habitat to cultivation and sagebrush clearing. About 8% of its distribution is on Status 1 or 2 lands and 12% on Status 3 lands.

Sage Sparrow, a State Candidate species, is a Columbia Basin-dependent that has lost much of its former sagebrush habitat to cultivation and sagebrush clearing. It is possibly still declining. About 14% of its distribution is on Status 1 or 2 lands and 14% on Status 3 lands

There are several breeding terrestrial vertebrate species in Washington that have generally stable or increasing populations in the State, but localized at-risk subspecies populations (e.g., Northern Pocket Gopher, White-tailed Deer, and Horned Lark). We did not separate subspecies for our analysis, and, thus did not include these at-risk species in our at-risk group. However, these subspecies should not be overlooked in conservation planning.

Ecoregional Analysis

Olympic Peninsula ecoregions (including southwestern Washington): Mid- to late-seral forests of the Western Hemlock zone of these regions are high in amphibian richness. Forests and/or wetlands of

the Sitka Spruce, Western Hemlock and Olympic Douglas-fir zones are high in mammal (especially shrew and mole, bat, and carnivore) richness. Mid- to late-seral conifer forests of all but the highest zones are high in numbers of at-risk species. Most Status 1 lands of high richness are where the Olympic National Park and its associated Wilderness Areas encompass the mid- or low-elevation zones. Most of the areas of high richness in southwestern Washington are on privately-owned Status 4 lands and have little protection.

Puget Sound and Willamette Valley ecoregions: These highly developed regions have changed since European settlement from conifer-dominated forests to a heterogeneous landscape of shrubs, development, farms, and hardwood, mixed, and early-seral conifer forests. Consequently, few at-risk species remain, except in the prairies and woodlands of the southern Puget Sound. However, these regions do have high richness of other birds and mammals, especially those associated with wetlands and hardwood or mixed forest. Most of the area of these regions is Status 4 land, and consequently, areas of high richness have little protection. The Status 4 land is primarily privately-owned, but some of the most unique ecological areas have been semi-protected on DoD lands, most notably oak woodlands on the Fort Lewis Military Reservation.

West Cascades ecoregions: The Southwest Cascades has large blocks of high amphibian richness, most of them on Status 3 land in the south and Status 4 land in the northern part of the region. Mid- to late-seral conifer forests of the Western Hemlock zone have high richness of at-risk species. The Northwest Cascades region has more rugged topography and a colder climate than the Southwest Cascades region. Relatively undisturbed, low- to mid-elevation forests occur in small patches among logged areas, and squeezed between the heavily developed, logged, and farmed Puget Trough and the high-elevation, rugged terrain characteristic of the North Cascades. These patches are rich in amphibian species and at-risk species. Riparian areas and mixed forests of the low- to mid-elevation zones are high in mammal and bird richness.

East Cascades ecoregions: The lower elevations of the east Cascades regions are rich in bird and reptile species. The mid-elevation mesic forest zones support a large number of mammal species. The forests of the northeast Cascades have high numbers of at-risk species associated with the large, contiguous area of remote, rugged Wilderness Areas and National Forests..

Columbia Basin ecoregion: The Columbia Basin supports a large number of reptile species. Its wetlands are high in bird richness. Columbia Basin-dependent species of all taxa are generally poorly represented on Status 1 or 2 lands, which is a reflection of the low percentage of Status 1 or 2 lands in the Basin. A disproportionate number of at-risk species occur in upland steppe habitats in the Basin. These species, which are poorly adapted to anthropogenic changes, have no higher-elevation habitats into which they can "retreat" as the human population in the Basin increases.

Northeast Corner and Okanogan Highlands ecoregions: The extreme northeastern corner is high in mammal richness in general and at-risk species (e.g., Gray Wolf, Grizzly Bear, and Caribou) in particular. Many at-risk species have "retreated" into this remote and relatively undeveloped area. Bird richness in the low- to mid-elevation forest zones is high almost everywhere in these regions. Several

bird and mammal species enter the State only in these regions. These regions are generally low in amphibian and reptile richness, except that reptile richness is high along some of the major rivers.

Blue Mountains ecoregion: The Blue Mountains have moderately high to high bird richness. This region also supports many species that occur nowhere else in the State, for example, the Green-tailed Towhee and Preble's Shrew.

Limitations and Discussion

Gap Analysis is designed to identify species and groups poorly represented on areas managed primarily for biodiversity, but a number of other factors are important in assessing whether a species is a conservation priority. A few of the more important include:

- Species' range outside of the state. A species' range within a state may be small because it is at the edge of its range. Its total range might be very large.
- Area required to maintain a viable population. The distribution of species at different trophic levels, of species in environments of differing productivity, or of poikilotherms ("cold-blooded animals") versus homeotherms ("warm-blooded animals") are not easily compared. A large, top-level mammalian carnivore in a subalpine forest will generally require far more area to maintain a viable population than an herbivorous reptile of low-elevation wetlands. Population estimates provide a better means of comparisons than area alone.
- Artifacts of the mapping scale. In particular, the inclusion of "contingently suitable habitat" complicates comparisons of the modeled areas of species' distributions. For example, a species associated with large wetlands would have a modeled distribution including only mapped wetlands. A species associated with small ponds in forests would have a modeled distribution including all forests in suitable zones, because small ponds would not have been mapped; the forests would have been coded as "contingently suitable." Thus, the second species would have an apparent modeled area much larger than the first. While the number of small ponds would be expected to exceed the number of large lakes, the estimated suitable area for the second species would be disproportionately large. Another, more subtle, artifact of the modeling occurs because only primary cover was used in assessing protection status. For species associated with habitats more likely to be secondary covers the most suitable habitat will be more likely to be underestimated compared to species in general. For example, lakes would be more likely to be a secondary or tertiary cover than a primary cover, because they are often below our mapping unit, but a forest would be as likely to be a primary cover as a secondary cover. Therefore, the most suitable habitat for a species associated only with lakes would be more likely to be underestimated than the most suitable habitat for a species associated only with forest.
- Effect of changes in historic range on apparent protection status. Some species (notably the Gray Wolf and Grizzly Bear) have a large percentage of their current range on Status 1 or 2 lands because they have been largely exterminated over the remainder of their formerly extensive range. Thus, although a species' protection status may appear good, it may only reflect the near extirpation of the species outside of Status 1 or 2 lands.

We took many of these factors into account in compiling our list of at-risk species, but each species deserves more in-depth analysis than we had the resources to provide. We hope that, in the future, others will be inspired to do more.

CONCLUSIONS AND MANAGEMENT IMPLICATIONS

The overall picture of Washington that emerges from our analyses is of a state with large amounts of unevenly and poorly distributed Status 1 and 2 lands, but a state with great potential for improved conservation management because of its large amount of other, more favorably distributed public lands. The data clearly point to general conservation priorities, but specific solutions should draw on more detailed mapping and must consider cost/benefit analyses. We also emphasize that our list of conservation priorities should not be interpreted to mean that species or communities not on our list are of little or no conservation concern.

Highest Conservation Priorities

Vegetation zones of highest conservation priority are those that have been most profoundly affected by agriculture and development. These zones typically have a low percentage of their areas in Status 1 and 2 lands. Species of highest priority are those that rely on such zones, but which adapt poorly to anthropogenic changes.

Steppe Zones and Columbia Basin-dependents

The most glaring gaps in the protection of biodiversity in Washington are in the steppe zones. The three vegetation zones with the highest Conservation Priority Indices (CPI) are steppe zones, and seven of nine steppe zones have a high or moderately high CPI. Vertebrate species that rely on steppe usually have a correspondingly low percentage of their distribution on areas managed primarily for biodiversity. Steppe landscapes tend to lack the scenic qualities that inspire conservation efforts, and most species associated with upland steppe (reptiles, small mammals, nondescript birds) make poor poster children for conservation support. The problem of managing steppe for biodiversity is further magnified by the low productivity of upland steppe habitats, which implies that large areas are needed to maintain viable populations, at least for "warm-blooded" vertebrates. The high CPI of steppe zones and the low representation of Basin-dependents on Status 1 and 2 lands makes the fate of the lands surrounding the Hanford Nuclear Reservation (DoE) particularly critical. The buffer areas around Hanford that are currently managed as refuges are the Saddle Mountain National Wildlife Refuge, the Fitzner/Eberhardt Arid Lands Ecology Reserve, and the Wahluke Wildlife Area. These three reserves combined comprise 35% of all Status 1 and 2 lands in the Columbia Basin and their removal from the reserve system (which is under consideration) would have a considerable negative impact on the conservation status of the Columbia Basin and on most Basin-dependent species. The DoD is another large public landholder in the Columbia Basin whose land management policies can have considerable impacts on Basin dependents. The Yakima Training Center (DoD) is a large, contiguous area of steppe that serves as a *de facto* reserve, although DoD lands are classified as Status 4. Most mammalian and reptilian Basin-dependents are associated with upland steppe, but some of the wetlands in steppe are among the areas of highest bird richness. The zone with the highest CPI in the State is the Palouse, a mesic steppe zone in which almost all upland areas have been converted to dryland agriculture. The existing reserves

are very small and isolated, but contain some of the few remnants of Palouse grassland that might be used as a source for restoration.

The Puget-Willamette Trough Zones

These zones include the Puget Sound Douglas-fir, Woodland/Prairie Mosaic, Willamette Valley, and Cowlitz River zones. All have been heavily converted to both agriculture and development. The remaining forests are now a patchwork of hardwood, mixed, and early-seral conifer forests. There are only a few small areas of moderate richness of at-risk species (notably the prairies and woodlands of the southern Puget Sound), as most species sensitive to anthropogenic impacts have been extirpated from these zones. However, the wetland habitats (riparian areas, marshes, and lakes) of these zones have especially high richness of other bird and mammal species. Although some of the species in these zones thrive around people, increasing development is likely to cause even some of the tolerant species to decline. The amount of Status 1 and 2 lands encompassing these high-richness wetland areas is low and consists primarily of National Wildlife Refuges, State Wildlife Areas, and State Parks. A major priority of these zones are the handful of vertebrate species or subspecies that cannot "retreat" into the less-developed higher-elevation zones, for example, the Western Pond Turtle and various subspecies of the Mazama Pocket Gopher.

Moderately High Priorities

Zones of moderately high priority are those that have not been as severely impacted by development and agriculture as the highest priority zones, but that have low protection status and have had, or might soon experience, widespread changes in disturbance regimes as a result of human activities. Vertebrate species of moderately high priority are those that occur outside the most severely impacted zones, but that are least adapted to human-induced changes in disturbance regimes or other anthropogenic impacts.

The Ponderosa Pine and Oak Zones

These lowest elevation east-side forest zones have moderately high CPIs. Both have less than 4% of their areas in Status 1 and 2 lands. They are zones of high reptile and bird (especially owl, woodpecker, flycatcher, finch, and sparrow) diversity. In these zones, reduction in natural disturbance via fire suppression is a significant conservation problem (see Volume 1 for more discussion of this issue and references). Because of increasing development in these fire-prone zones, fire suppression is likely to increase. The difficulties of trying to maintain a natural fire regime in an area where houses are mixed with dry forest are obvious. Any attempt to allow a natural fire regime in these zones will likely require a substantial firebreak between "naturally" maintained areas and areas with housing. Restoration of a natural fire regime virtually requires public land, since all but the largest private land-holders are unlikely to be able to adopt a "let it burn" policy on their property. In addition to the small amount of Status 1 and 2 lands, the Ponderosa Pine zone has 25% of its area on Status 3 lands and the Oak zone has 14% of its area on Status 3 lands. The greater percentage of Status 3 lands on the Ponderosa Pine zone allows more options than for the Oak zone, but both zones have most of their area on Status 4 lands.

The Sitka Spruce and Western Hemlock Zones

These wet to mesic, west-side forest zones have relatively little of their areas in development or agriculture, but logging has been extensive in these zones of naturally very low fire frequency. They are zones of high amphibian and mammal (especially bat) richness, and their remaining mid- to late-seral forests are high in richness of amphibian, mammal, and bird species that adapt poorly to anthropogenic disturbance. Our data indicate that less than 8% of the Sitka Spruce zone and less than 10% of the Western Hemlock zone remains in late-seral forest; an additional 14% of the Sitka Spruce zone and 20% of the Western Hemlock zone were estimated to be in mid-seral forest. Logging in these zones has been the focus of some of the most bitter and longest-running conservation battles in the Pacific Northwest, and we will not even pretend to offer any advice on how to resolve these conflicts. The forests of these zones are unquestionably being logged faster than they can regenerate, but the economic value of their timber provides a powerful incentive to continue current practices.

The Role of Status 3 and Status 4 Lands

Biodiversity management is easiest on Status 1 and 2 lands, where biodiversity protection is a major priority. However, the amount of Status 1 and 2 lands is unlikely to substantially increase, and many species have inadequate representation on Status 1 and 2 lands. In fact, nearly a third of breeding terrestrial vertebrate species have 80% of their most suitable habitat on Status 4 lands. In Washington, the major Status 3 lands are WDNR Trust lands and USFS non-Wilderness ("multiple use") lands. Publicly-owned Status 4 lands (excluding Tribal lands) in Washington are primarily DoD and DoE lands.

Among Status 3 land owners, the WDNR has the largest impact on biodiversity management in many of the most poorly protected vegetation types and associated fauna in the State. Zones in which the combined percentage of Status 1 and 2 lands is less than 10% and WDNR Trust lands are the majority of Status 3 lands are: all steppe zones, one east-side forest zone (Oak), and six west-side forest zones (Willamette Valley, Cowlitz River, Woodland/Prairie Mosaic, Puget Sound Douglas-fir, Sitka Spruce, and Western Hemlock). The major zones in which the combined percentage of Status 1 and 2 lands is less than 10% and USFS multiple-use lands are the majority of Status 3 lands are the Ponderosa Pine and Interior Douglas-fir zones. Some Status 3 lands do not cover large percentages of zones, but are nonetheless significant for biodiversity management. The Status 3 Cedar River Watershed occupies a small percentage of the Western Hemlock zone compared to other Status 3 lands, but it encompasses nearly an entire watershed on which access is restricted, and is a *de facto* reserve for many species. The Smoot Hill Research Area (owned by Washington State University), is an example of a very small but significant Status 3 area; it is important because it harbors some of the last remnants of Palouse vegetation in the zone with the highest CPI.

The most significant publicly-owned Status 4 lands for biodiversity management are the Fort Lewis Military Reservation (DoD) in the Woodland/Prairie Mosaic zone, and the Yakima Training Center (DoD) and the Hanford Nuclear Reservation core (DoE) of the Central Arid Steppe zone. Fort Lewis

includes most of the remaining tracts of native upland vegetation of the Woodland/Prairie Mosaic zone. The Status 4 DoD and DoE lands in the Central Arid Steppe zone are a component of the largest remaining relatively contiguous and uncultivated block of land in that zone.

In zones with relatively small amounts of Status 1 and 2 lands, Status 3 and publicly-owned Status 4 lands will often represent the best opportunity to improve biodiversity management. However, the majority of land in most low-elevation zones is privately owned, and the persistence of many species and vegetation types will continue to depend on management practices on private lands.

DATA USE AND AVAILABILITY

How To Obtain the Data

Hard-copy

The Final Report of the Washington Gap Analysis Project (WAGAP) is a five volume set. This volume, Volume 5, describes the results of Gap Analysis for Washington State. The preceding four volumes present the data layers upon which this analysis is based. Volume 1 (land cover) includes more detailed information on vegetation zones, actual land cover, and the Conservation Status of each zone. Volumes 2, 3, and 4 are vertebrate atlases for herpetofauna, mammals, and birds, respectively, that include a brief summary of habitat information for each species, how each species distribution in the state was modeled, and a map showing the modeled distribution and the location data for each species. Copies of the five volumes may be purchased from:

Washington Cooperative Fish and Wildlife Research Unit
School of Fisheries
Box 357980
University of Washington
Seattle WA 98195
206-543-6475

Digital Data Sets

Final digital WAGAP data sets are available to individuals outside the University of Washington through the Washington Department of Fish and Wildlife (WDFW). Digital copies of the data may be requested by contacting the Department data release number, 360-902-2543. Faculty, staff and students at the University of Washington and its branch campuses can obtain copies of the digital data by contacting the University of Washington Libraries, Map Collection and Cartographic Information Services (206-543-9392; e-mail: maplib@u.washington.edu.). Data will be available on a cost reimbursable basis. Data identified as sensitive by WDFW will be made available in accordance with the Agency' s policy "Public Disclosure of Sensitive Wildlife Information." Sensitive data concerns are typically related to point locations of listed or candidate species.

Digital data sets include:

Spectrally-clustered TM Satellite Imagery (16 scenes 1991, one 1992); 500Mb
Polygon Land Cover Map Version 5 (February 1996); 20Mb
Polygon Land Cover Map Version 6 (June 1996); 20 Mb
Habitat Matrices for Breeding Vertebrates; 4 Mb
Range Limits (ARC Files) for Breeding Vertebrates; 400 Mb

INFO Files to Create Vertebrate Distribution Maps from Polygon Land Cover Map Version 5; l0 Mb

Associated AML (Arc Macro Language) Files for Display of Satellite Imagery, Land Cover Maps and Vertebrate Distributions; 1 Mb

Combination of the above as individual covers for each veterbrate species; 4,000 Mb total

Custom map products or analyses may be requested from the Remote Sensing Applications Laboratory (RSAL) at the University of Washington (206-543-4912; e-mail: fwest@u.washington.edu). Special products/analyses will be developed on a cost-negotiated contractual or other basis, contingent upon faculty and staff availability.

Minimum GIS Required for Data Use

GIS files were created in ARCINFO. Any GIS system with similar capabilities and able to import a file in ARCINFO format should be sufficient. Most of the files are large and complex. Therefore, the capabilities of the computer system (size and speed) may be more of a limitation than the GIS. A PC with an operating speed of 200 megahertz is probably the smallest system able to handle the files efficiently. Staff are not available to subset parts of coverages to accommodate smaller systems.

Disclaimer

These data have been processed successfully on a Sun Sparc 2 workstation at the University of Washington (UW). No warranty expressed or implied is made regarding the utility of the data on any other system, nor shall the act of distribution constitute any such warranty. This disclaimer applies both to individual use of the data and aggregate use with other data. It is strongly recommended that these data be directly acquired from a server for WAGAP (WDFW or UW as specified above) and not indirectly through other sources that may have altered the data. It is also strongly recommended that careful attention be paid to the metadata file associated with these data. The Washington Cooperative Fish and Wildlife Research Unit, University of Washington, Washington Department of Fish and Wildlife, or the US Geological Survey shall not be held liable for improper use of the data described and/or contained in the hard copy volumes or the digital databases. It is the responsibility of each data user to determine if GAP data can answer the question being asked, and if GAP data are the best tool to answer the question.

Metadata

Metadata are information about data, i.e., information about the source(s), lineage, content, structure, and availability of a data set. Metadata also describe intended uses, potential applications, as well as limitations, allowing for the informed and appropriate application of the data. Gap Analysis metadata have been closely matched to the Federal Geographic Data Committee' s (FGDC) standards (FGDC 1994, 1995). Appropriate metadata are contained in the hard copy volumes or attached to each digital data layer.

WAGAP data were compiled with regard to the following standards:

Minimum mapping unit: 100 hectares, 40 hectares for wetlands.

Primary data source for land cover mapping: 1991 Thematic Mapper satellite data.

Animal species modeled: All terrestrial native and exotic vertebrate species breeding in Washington State, with the exception of birds known to have bred less that 3 times between 1987 and 1996.

Land cover classification system: There was no standard Gap classification system when the Washington State project began, so we developed our own with the assistance of our State cooperators. For regional (multi-state) analyses, our classification was cross-walked to the GAP standard.

Accuracy assessment of the land cover map: An expected accuracy of 80% for all cover types. In practice, we lacked sufficient funding to conduct an accuracy assessment.

Format: Arc/Info, version 7.

Appropriate Uses

WAGAP data were produced with an intended application to large geographic areas, areas of several hundred thousand to millions of hectares in size. They allow a coarse-filter approach to analyses, meaning that not every occurrence of every vegetation type or animal habitat is mapped. Appropriate applications include: regional, statewide and county biodiversity planning; resource management planning within large geographic areas; coarse-filter evaluation of potential impacts or benefits of major projects or initiatives on biodiversity, such as utility or transportation corridors, wilderness area proposals, regional open space and recreation proposals; determining relative amounts of management responsibility for specific biological resources to facilitate cooperative management and planning; identification of specific species, groups of species in need of additional research; and natural resource education at all levels including students, the general public, as well as resource management professionals. We refer readers to examples of the application of WAGAP data and GAP data from other states described in the following publications: Dvornich et al. 1995, Scott et al. 1996, Cassidy et al. 1997, and Westerlund 1998.

LITERATURE CITED

Cassidy, K. M., M. R. Smith, C. E. Grue, and R. E. Johnson. 1997. The role of Washington State' s National Wildlife Refuges in conserving the State' s biodiversity. Washington Cooperative Fish and Wildlife Research Unit, University of Washington, Seattle, 86 pp.

Colville National Forest. 1978?. Unpublished map titled: Colville National Forest 1974 Habitat Types. Cartographer uncertain, possibly L. Day.

Crist, P. J., Thompson, B., and J. Prior-Magee. 1995. A dichotomous key of land management categorization. Unpublished report by the New Mexico Cooperative Fish and Wildlife Research Unit, Las Cruces, New Mexico.

Csuti, B., S. Polasky, P. H. Williams, R. L. Pressey, J. D. Camm, M. Kershaw, A. R. Kiester, B. Downs, R. Hamilton, M. Huso, and K. Sahr. 1997. A comparison of reserve selection algorithms using data on terrestrial vertebrates in Oregon. Biological Conservation 80:83-97.

Csuti, B. 1994. Methods for developing terrestrial vertebrate distribution maps for Gap Analysis (version 1). Pages 2.1-2.52 *in* A handbook for Gap Analysis (J. M. Scott and M. D. Jennings, eds.). Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho, Moscow.

Daubenmire, R. 1970. Steppe vegetation of Washington. Originally Agriculture Experiment Station Publication XT0062. Reprinted in 1988 as EB1446, U.S. Department of Agriculture and Home Economics, Washington State University, Pullman, 132 pp.

DeGraaf, R. M., V. E. Scott, R. H. Hamre, L. Ernst, and S. H. Anderson. 1991. Forest and rangeland birds of the United States: Natural history and habitat use. USDA Forest Service Agriculture Handbook 688, 625 pp.

Diamond, J. 1986. The design of a nature reserve system for Indonesian New Guinea. Pages 485-503 *in* Conservation biology: The science of scarcity and diversity (M. E. Soulé, ed.). Sinauer Associates, Sunderland, MA.

Driscoll, R. S., D. L. Merkel, D. L. Radloff, D. E. Snyder, and J. S. Hagihara. 1984. An ecological land classification framework for the United States. Miscellaneous Publication 1439. U.S. Department of Agriculture, Forest Service, Washington, D.C.

Driscoll, R. S., D. L. Merkel, J. S. Hagihara, and D. L. Radloff. 1983. A component land classification for the United States: Status report. Technical Note 360. U.S. Department of the Interior, Bureau of Land Management, Denver.

Dvornich, K. M., M. Tudor, and C. E. Grue. 1995. NatureMapping: Assisting management of natural resources through public education and public participation. Wildlife Society Bulletin 23:609-614.

Edwards, T. C., Jr., C. H. Homer, S. D. Bassett, A. Falconer, R. D. Ramsey, and D. W. Wight. 1995. Utah Gap Analysis: An environmental information system. Technical Report 95-1, Utah Cooperative Fish and Wildlife Research Unit, Utah State University, Logan, Utah.

Federal Geographic Data Committee. 1994. Content standards for digital geospatial metadata. 8 June 1994. Federal Geographic Data Committee, Washington, D.C.

Federal Geographic Data Committee. 1995. Content standards for digital geospatial metadata workbook. Federal Geographic Data Committee, Washington, D.C.

Franklin, J. F. 1993. Preserving biodiversity: Species, ecosystems, or landscapes? Ecological Applications 3:202-205.

Franklin, J. F., and C. T. Dyrness. 1973. Natural vegetation of Oregon and Washington. Originally published by US Forest Service. Reprinted 1988 by Oregon State University Press, 452 pp.

Gauthreaux, S. A. 1992. Preliminary list of migrants for Partners in Flight neotropical migratory bird conservation program. Partners in Flight Newsletter 2:30 (winter 1992).

Grossman, D., K. L Goodin, X. Li, C. Wisnewski, D. Faber-Langendoen, M. Anderson, L. Sneddon, D. Allard, M. Gallyoun, and A. Weakley. 1994. Standardized national vegetation classification system. Report by The Nature Conservancy and Environmental Systems Research Institute for the NBS/NPS Vegetation Mapping Program. National Biological Service, Denver, Colorado.

Harris, G. A., and M. Chaney. 1984. Washington State grazing land assessment. Printed by the Washington State University Cooperative Extension for the Washington Rangeland Committee and Washington Conservation Commission, 137 pp.

Jennings, M. D. 1993. Natural terrestrial cover classification: Assumptions and definitions. Gap Analysis Technical Bulletin 2. Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho, Moscow, 28 pp.

Leonard, W. P., H. A. Brown, L. L. C. Jones, K. R. McAllister, and R. M. Storm. 1993. Amphibians of Washington and Oregon. Seattle Audubon Society, Seattle, Washington, 168 pp.

Levin, S. A. 1981. The problem of pattern and scale in ecology. Ecology 73:1942-1968.

Lins, K. F., and R. L. Kleckner. 1996. Land use and land cover mapping in the United States: An overview and history of the concept. Pages 57-65 *in* Gap Analysis: A landscape approach to biodiversity planning (J. M. Scott, T. H. Tear, and F. W. Davis, eds.). American Society for Photogrammetry and Remote Sensing, Bethesda, Maryland.

Mueller-Dombois, D., and H. Ellenberg. 1974. Aims and methods of vegetation ecology. John Wiley & Sons, New York, 547pp.

Murray, M. P. 1996. Standardizing terrestrial vegetation from GAP in the western U.S. Unpublished report of the Idaho Cooperative Fish and Wildlife Research Unit, University of Idaho, Moscow, 17 pp.

Noss, R. F. 1987. From plant communities to landscapes in conservation inventories: A look at The Nature Conservancy (USA). Biological Conservation 41:11-37.

Noss, R. F. 1990. Indicators for monitoring biodiversity: A hierarchical approach. Conservation Biology 4:355-364.

Noss, R. F., E. T. LaRoe III, and J. M. Scott. 1995. Endangered ecosystems of the United States: A preliminary assessment of loss and degradation. Biological Report 28, National Biological Service, Washington, D.C, 58 pp.

Nussbaum, R. A., E. D. Brodie, Jr., and R. M. Storm. 1983. Amphibians and reptiles of the Pacific Northwest. University of Idaho Press, Moscow, Idaho, 332 pp.

Pressey, R. L., C. J. Humphries, C. R. Margules, R. I. Vane-Wright, and P. H. Williams. 1993. Beyond opportunism: Key principles for systematic reserve selection. Trends in Ecology and Evolution 8:124-128.

Scott, J. M., F. Davis, B. Csuti, R. Noss, B. Butterfield, C. Groves, H. Anderson, S. Caicco, F. D'Erchia, T. C. Edwards, Jr., J. Ulliman, and G. Wright. 1993. Gap analysis: A geographic approach to protection of biological diversity. Wildlife Monographs 123: 1-41.

Scott, J. M., T. H. Tear, and F. W. Davis, eds. 1996. Gap Analysis: A landscape approach to biodiversity planning. American Society for Photogrammetry and Remote Sensing, Bethesda, Maryland, 320 pp.

Stoms, D., and J. Estes. 1993. A remote sensing research agenda for mapping and monitoring biodiversity. International Journal of Remote Sensing 14:1839-1860.

Storm, R. M., and W. P. Leonard, eds. 1995. Reptiles of Washington and Oregon. Seattle Audubon Society, Seattle, Washington, 174 pp.

UNESCO. 1973. International classification and mapping of vegetation. UNESCO, Paris, 93 pp.

Westerlund, F. W. 1998. Wildlife corridors and landscape linkages: An approach to biodiversity planning for Spokane County, Washington. Department of Urban Design and Planning, University of Washington, Seattle, 91 pp.

Williams, P. H., D. Gibbons, C. Margules, A. Rebelo, C. Humphries, and R. Pressey. 1996. A comparison of richness hotspots, rarity hotspots, and complementary areas for conserving diversity of British birds. Conservation Biology 10:155-174.

Whittaker, R. H. 1977. Species diversity in land communities. Evolutionary Biology 10:1-67.

ABBREVIATIONS

ACEC	Area of Critical Environmental Concern, a designation used for some BLM lands
BBA	Breeding Bird Atlas (of Washington State)
BLM	Bureau of Land Management
BRD-USGS	Biological Resources Division of the US Geological Survey
CPI	Conservation Priority Index (developed by WAGAP)
DoD	Department of Defense
DoE	Department of Energy
FEALE	Fitzner/Eberhardt Arid Lands Ecology Reserve, a part of the Hanford Nuclear Reservation buffer zone
GAP	National Gap Analysis Program
GIS	Geographical Information System
NAP	Natural Area Preserve
NBS	National Biological Service (now the BRD-USGS)
NPS	National Park Service
NRCA	Natural Resource Conservation Area
NWR	National Wildlife Refuge
PLS	Public Land Survey
TM	Thematic Mapper
TNC	The Nature Conservancy
UNESCO	United Nations Educational, Scientific, and Cultural Organization
USFS	US Forest Service
USFWS	US Fish & Wildlife Service
UTM	Universal Transverse Mercator
WAGAP	Washington State Gap Analysis Project
WDFW	Washington (State) Department of Fish and Wildlife
WDNR	Washington (State) Department of Natural Resources

GLOSSARY

aerial videography - video images of the land surface taken from an airplane

algorithm - a procedure to solve a problem or model a solution (In GAP, this term typically refers to a GIS procedure used to model an animal distribution)

alliance level - a land unit made up of an "alliance" of natural communities that have the same dominant or co-dominant plant species or, in the absence of vegetation, have the same dominant land cover typically described according to the Anderson land cover classification (see "Natural Community Alliance" in Grossman et al. 1995)

anthropogenic - caused by man

band, spectral - a segment of the electromagnetic spectrum defined by a range of wavelengths (e.g. blue, green, red, near infrared, far infrared) that comprise the Landsat TM imagery

biodiversity - (or biological diversity) generally, the variety of life and its interrelated processes

classification, digital - a computer-assisted approach to developing land cover maps from digital imagery, in which image pixels are classified based on statistical differences in spectral characteristics (see **supervised** and **unsupervised classification**)

classification, visual or visual interpretation - classification of imagery based on human interpretation, as opposed to digital or computer-assisted classification (see **classification, digital**)

coarse filter - the general conservation activities that conserve the common elements of the landscape matrix, as opposed to the "fine filter" conservation activities that are aimed at special cases such as rare elements (see Jenkins 1985)

community - a group of interacting plants and animals

cover type - a non-technical, higher-level floristic and structural description of vegetation cover

cross-walking - matching equivalent land cover categories between two or more classification systems

delineate - identifying the boundaries between more or less homogenous areas on remotely sensed images as visible from differences in tone and texture

digitization - entering spatial data digitally into a Geographic Information System

distribution, species - in a GAP context, this refers to a computer-modeled map of a species' potential distribution for a given area, based on parameters such as range (see **range**) and habitat associations (see **habitat** and **wildlife habitat relationship model**)

ecoregion - a large region, usually spanning several million hectares, characterized by having similar biota, climate, and physiography (topography, hydrology, etc)

ecosystem - a biological community (ranging in scale from a single cave to millions of hectares), its physical environment, and the processes through which matter and energy are transferred among the components

edge-matching - the process of connecting polygons at the boundary between two independently created maps, either between TM scenes or between state GAP data sets

element - a plant community or animal species mapped by GAP, may also be referred to as "element of biodiversity"

error of commission - the occurrence of a species (or other map category) is erroneously predicted in an area where it is in fact absent

error of omission - when a model fails to predict the occurrence of a species that is actually present in an area

fine filter - see **coarse filter**

floristic - pertaining to the plant species that make up the vegetation of a given area

gap analysis - a comparison of the distribution of elements of biodiversity with that of areas managed for their long-term viability to identify elements with inadequate representation

geographic information systems (GIS) - computer hardware and software for storing, retrieving, manipulating, and analyzing spatial data

ground truthing - verifying maps by checking the actual occurrence of plant and animal species in the field at representative sample locations

habitat - the physical structure, vegetational composition, and physiognomy of an area, the characteristics of which determine its suitability for particular animal or plant species

hectare - a metric unit of area of 10,000 square meters and equal to 2.47 acres

hexagon - typically refers to the EPA EMAP hexagonal grid of 635 square kilometer units

latilong - a geographic unit, one degree latitude by one degree longitude

metadata - information about data, e.g., their source, lineage, content, structure, and availability

minimum mapping unit (MMU) - the smallest area that is depicted on a map

pixel - the smallest spatial unit in a raster (cell-based) data structure

polygon - an area enclosed by lines in a vector-based Geographic Information System data layer or a region of contiguous homogeneous pixels in a raster system

range - the geographic limit of a species

registration, spatial - matching different images to each other by finding points on the images that can be matched to known points on the ground

remote sensing - deriving information about the earth's surface from images acquired at a distance, usually relying on measurement of electromagnetic radiation reflected or emitted from the feature of interest

resolution - the ability of a remote sensing system to record and display fine detail in a distinguishable manner, or the smallest feature that can be distinguished or resolved on a map or image, such as a TM pixel

riparian - areas adjacent to streams and rivers where vegetation is strongly influenced by the presence of water. Saturation by water does not necessarily have to be an existing factor as in the definition of wetlands given by Cowardin (1992)

scale, map - the ratio of distance on a map to distance in the real world, expressed as a fraction; the smaller the denominator, the larger the scale, e.g., 1:24,000 is larger than 1:100,000

species richness - the number of species of a particular interest group found in a given area

supervised classification - a type of digital classification of imagery, whereby pixels of unknown identity are classified using samples of known identity (i.e., pixels already assigned to informational classes by ground truthing or registration with known land cover) as training data

Thematic Mapper - a sensor on LANDSAT 4 and 5 satellites that records information in seven spectral bands, has a spatial resolution of about 30 m x 30 m, and represents digital values in 256 levels of brightness per band

transect - a transversely cut line along which physical and biological observations are made

unsupervised classification - a type of digital classification of satellite imagery involving the identification and mapping of natural groups, or classes, of spectral values within an image based on uniformity of brightness in several spectral channels.

visual interpretation - see **classification, visual**

wetland - an environment where standing or moving water is present or where saturation by water is the key factor controlling the ecology of the area; includes bogs, swamps, marshes, ponds, lakes and in some definitions also includes riparian areas (see **riparian**)

wildlife habitat relationship model - a method of linking patterns of known habitat use by animal species with maps of existing vegetation, thereby identifying the spatial extent of important habitat features for use in conservation and management

ACRONYMS

BCD	Biological Conservation Database (TNC)
BCNRA	Bighorn Canyon Nation Recreation Area
CA-GAP	California Gap Analyis Project
CO-GAP	Colorado Gap Analysis Project
BLM	Bureau of Land Management
DEM	Digital Elevation Model (USGS)
DLG	Digital line graph (USGS)
DTNM	Devil's Tower National Monument
EMAP	Environmental Monitoring & Assessment Program (EPA)
EPA	Environmental Protection Agency
FGDC	Federal Geographic Data Committee
GAP	Gap Analysis Program
GIS	Geographic Information System
GYE	Great Yellowstone Ecosystem
ID-GAP	Idaho Gap Analysis Project
MIPS	Map and Image Processing System
MMU	Minimum mapping unit
NBII	National Biological Information Infrastructure
NBS	National Biological Service
NM-GAP	New Mexico Gap Analysis Project
NPS	National Park Service
NWI	National Wetlands Inventory (USFWS)
PLSS	Public Land Survey System
RIS	Resource Inventory System (USFS)
RMS	Root mean square error
SCS	Soil Conservation Service (Natural Resource Conservation Service)
SDVC	Spatial Data and Visualization Cluster
SPOT	Système Pour l'Observation de la Terre

APPENDIX

Effect of Natural Area Preserves and Natural Resource Conservation Areas on Vegetation Zone Conservation Status Analysis

We were unable to include most WDNR-owned Natural Area Preserves (NAPs) and Natural Resource Conservation Areas (NRCAs) in the analysis because the relevant information was unavailable when we were analyzing our other data. As this volume was being prepared for printing, we obtained text descriptions and a map of NAPs and NRCAs (personal communication, Pene Speaks WDNR). Here, we assess the effect NAPs and NRCAs would have had on the conservation status of each vegetation zone if they had been included. A list of NAPs and NRCAs, with size and the zone(s) in which they primarily occur, is given in Table A1.

NAPs and NRCAs are considered Conservation Status 2 lands. We did not have digital data for NAP and NRCA boundaries. To assess the impact these lands would have had on the analysis of conservation status for each zone, we assumed that NAPs and NRCAs occurring on more than one zone were evenly distributed on those zones, with the exceptions that Camas Meadows NAP was assumed to lie entirely within the Interior Douglas-fir zone and the Clearwater Corridor NRCA was assumed to lie entirely within the Western Hemlock zone. We combined the Puget Sound Douglas-fir and Woodland/Prairie Mosaic zones because these two zones are closely intermixed. Some of the coastal NAPs and NRCAs (especially in the Sitka Spruce zone) included estuarine land and open ocean that was not included in our terrestrial-based analysis, so the estimated effect of those lands on the analysis will be a slight overestimate. The amount and percentage of Status 2 land, and the combined percentage of Status 1 and 2 lands in each zone were recalculated to include the areas of NAPs and NRCAs. Results are shown in Table A2.

Inclusion of NAPs and NRCAs did not change our conservation priorities or recommendations, although these lands are often in areas of high conservation priority. The largest contribution of NAPs and NRCAs to the absolute amount of Status 1 and 2 lands occurs in west-side zones (particularly in the Silver Fir and Western Hemlock zones). However, in terms of relative increase in Status 1 and 2 lands, their greatest impacts are in selected steppe zones where the amount of Status 1 and 2 lands is so small that even a small increase can equal or exceed the amount already in Status 1 or 2 lands. The most extreme example is the Bitterbrush zone, which had no Status 1 or 2 lands in the previous analysis. Two NAPs (Badger Gulch and Cleveland Shrub Steppe) lie partly on the Bitterbrush zone, bringing the amount of Status 1 and 2 land to about 146 hectares, and increasing the percentage of Status 1 and 2 lands from 0% to 0.60%. However, the conservation status of the Bitterbrush zone is still very poor. On the west side, the greatest impact of NAPs and NRCAs is in the Puget Sound Douglas-fir and Woodland/Prairie Mosaic zones, where their inclusion (chiefly because of the protection of Cypress Island) increases the total Status 1 and 2 lands by nearly 20%. NAPs and NRCAs in mid- and high-elevation zones have a relatively minor effect on overall conservation status because these zones already have a moderate to substantial percentage of their areas in Status 1 and 2 lands. However, many of the NAPs and NRCAs protect unique communities and their contribution to conservation in the zone cannot be measured solely by the area they cover. Olivine Bridge NAP, for example, lies on an unusual

serpentine soil formation. Trout Lake NAP improves the protection of the Oak zone, but is most significant because it protects one of the few remaining Washington populations of the Oregon Spotted Frog.

Table A1: NAPs and NRCAs, and the vegetation zones in which they occur.

NAP or NRCA	Size (ha)	County	Zone(s)
East Side			
Castle Rock NAP	33	Grant	Three-tip Sage
Entiat Slopes NAP	259	Chelan	Three-tip Sage
Spring Creek Canyon NAP	95	Lincoln	Three-tip Sage, Ponderosa Pine
Badger Gulch NAP	32	Klickitat	Bitterbrush, Oak
Cleveland Shrub Steppe NAP	259	Klickitat	Bitterbrush, Oak
Davis Canyon NAP	119	Okanogan	Central Arid Steppe
Methow Rapids NAP	27	Okanogan	Central Arid Steppe
Riverside Breaks NAP	14	Okanogan	Central Arid Steppe
Selah Cliffs NAP	26	Yakima	Central Arid Steppe
The Two Steppe NAP	144	Douglas	Central Arid Steppe
Upper Dry Gulch NAP	130	Chelan	Central Arid Steppe
Barker Mountain NAP	49	Okanogan	Central Arid Steppe, Ponderosa Pine
Kahlotus Ridgetop NAP (included in original analysis)	97	Franklin	Wheatgrass/Fescue
Columbia Hills NAP	~1417	Klickitat	Canyon Grassland, Klickitat Meadow Steppe, Oak
Marcellus Shrub Steppe NAP	49	Adams	Big Sage/Fescue
Trout Lake NAP	~200	Klickitat	Oak
White Salmon Oak NRCA	129	Klickitat	Oak
Pinecroft NAP	40	Spokane	Ponderosa Pine
Dishman Hills NRCA	210	Spokane	Ponderosa Pine
Klickitat Scenic River NRCA	190	Yakima	Ponderosa Pine
Camas Meadows NAP	459	Chelan	Interior Douglas-fir (small amounts of Ponderosa Pine and Three-tip Sage)
Little Pend Oreille River NAP	102	Stevens	Interior Western Hemlock
Chopaka Mountain NAP	1119	Okanogan	Subalpine Fir, Alpine/Parkland
West Side			
Cypress Highlands NAP	435	Skagit	Puget Sound Douglas-fir and/or Woodland/Prairie Mosaic
Cypress Island NRCA	1457	Skagit	Puget Sound Douglas-fir and/or Woodland/Prairie Mosaic
Dabob Bay NAP	76	Jefferson	Puget Sound Douglas-fir and/or Woodland/Prairie Mosaic
Kennedy Creek NAP	23	Mason	Puget Sound Douglas-fir and/or Woodland/Prairie Mosaic
Mima Mounds NAP	180	Thurston	Puget Sound Douglas-fir and/or

NAP or NRCA	Size (ha)	County	Zone(s)
			Woodland/Prairie Mosaic
Oak Patch NAP	7	Mason	Puget Sound Douglas-fir and/or Woodland/Prairie Mosaic
Point Doughty NAP	23	San Juan	Puget Sound Douglas-fir and/or Woodland/Prairie Mosaic
Rocky Prairie NAP	14	Thurston	Puget Sound Douglas-fir and/or Woodland/Prairie Mosaic
Sand Island NAP	3	Grays Harbor	Puget Sound Douglas-fir and/or Woodland/Prairie Mosaic
Skookum Inlet NAP	43	Mason	Puget Sound Douglas-fir and/or Woodland/Prairie Mosaic
Cattle Point NRCA	38	San Juan	Puget Sound Douglas-fir and/or Woodland/Prairie Mosaic
Hat Island NRCA	37	Skagit	Puget Sound Douglas-fir and/or Woodland/Prairie Mosaic
Lake Louise NRCA	55	Whatcom	Puget Sound Douglas-fir and/or Woodland/Prairie Mosaic
Lummi Island NRCA	268	Whatcom	Puget Sound Douglas-fir and/or Woodland/Prairie Mosaic
Woodard Bay NRCA	243	Thurston	Puget Sound Douglas-fir and/or Woodland/Prairie Mosaic
Clearwater Bogs NAP	204	Jefferson	Sitka Spruce
Bone River NAP	989	Pacific	Sitka Spruce
Carlisle Bog NAP	126	Grays Harbor	Sitka Spruce
Chehalis River Surge Plain NAP	934	Grays Harbor	Sitka Spruce
Goose Island NAP	5	Grays Harbor	Sitka Spruce
Niawiakum River NAP	322	Pacific	Sitka Spruce
North Bay NAP	267	Grays Harbor	Sitka Spruce
Whitcomb Flats NAP	2	Grays Harbor	Sitka Spruce
Elk River NRCA	~1417	Grays Harbor	Sitka Spruce
Shipwreck Point NRCA	191	Clallam	Sitka Spruce
South Nemah NRCA	588	Pacific	Sitka Spruce
South Nolan NRCA	86	Jefferson	Sitka Spruce
Teal Slough NRCA	3	Pacific	Sitka Spruce
West Tiger Mountain/ Tradition Plateau NRCA	1821	King	Western Hemlock
Table Mountain/ Greenleaf Peak NRCA	1133	Skamania	Western Hemlock
Merrill Lake NRCA	46	Cowlitz	Western Hemlock
Clearwater Corridor NRCA	940	Jefferson	Western Hemlock (with some Sitka Spruce)
Willapa Divide NAP	111	Pacific	Western Hemlock
Bald Hill NAP	121	Thurston	Western Hemlock
Columbia Falls NAP	208	Skamania	Western Hemlock
Kings Lake Bog NAP	125	King	Western Hemlock
Olivine Bridge NAP	60	Skagit	Western Hemlock
Skagit Bald Eagle NAP	626	Skagit	Western Hemlock
Snoqualmie Bog NAP	32	King	Western Hemlock
Mount Si NRCA	~3239	King	Western Hemlock, Silver Fir

NAP or NRCA	Size (ha)	County	Zone(s)
Dailey Prairie NAP	85	Whatcom	Silver Fir
Rattlesnake Mountain Scenic Area NRCA	717	King	Silver Fir
Granite Lake NRCA	244	Skagit	Silver Fir, Mountain Hemlock
Grieder Ridge NRCA	2214	Snohomish	Silver Fir, Mountain Hemlock
Morning Star NRCA	3172	Snohomish	Silver Fir, Mountain Hemlock
Mount Pilchuck NRCA	3846	Snohomish	Silver Fir, Mountain Hemlock

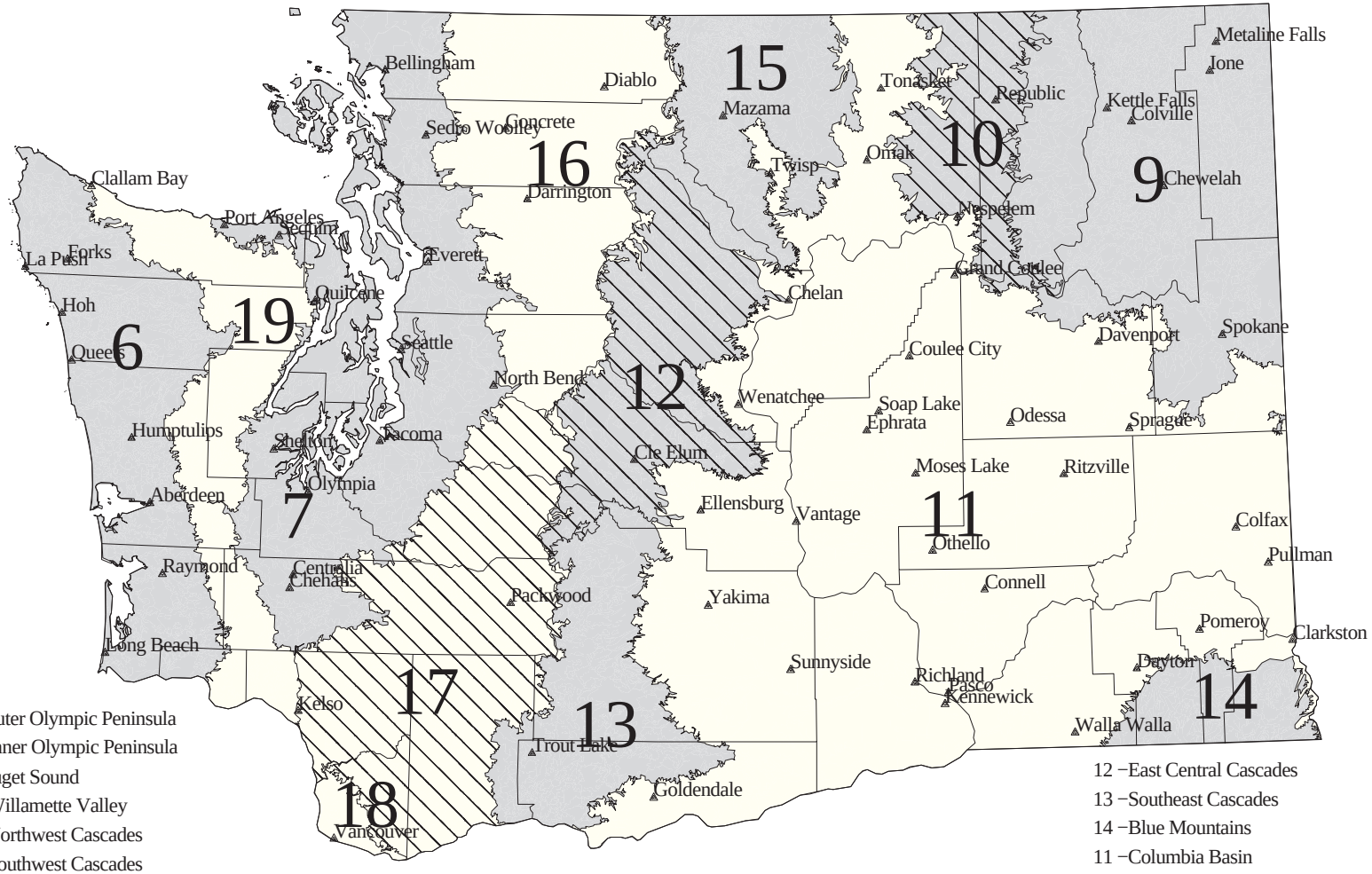
Table A2: Effect of inclusion of NAPs and NRCAs on vegetation zone conservation status.

Zone	Previous total area of Status 1 and 2 lands (ha)	Estimated additional Status 2 area (ha)*	Previous percentage of Status 1 and 2 lands	Recalculated percentage of Status 1 and 2 lands
Three-tip Sage	13,761	339	1.27%	1.30%
Bitterbrush	0	146	0%	0.60%
Klickitat Meadow Steppe	239	472	0.38%	1.13%
Central Arid Steppe	182,423	685	5.91%	5.93%
Canyon Grassland	1,238	472	0.59%	0.82%
Big Sage/Fescue	119	97	0.06%	0.10%
Oak	6,294	947	3.38%	3.87%
Ponderosa Pine	59,937	512	3.89%	3.92%
Interior Douglas-fir	106,684	459	7.65%	7.68%
Interior Western Hemlock/Redcedar	82,133	102	16.33%	16.35%
Subalpine Fir	304,821	559	43.54%	43.61%
Combined Puget Sound Douglas-fir and Woodland/Prairie Mosaic	14,913	2,902	1.18%	1.41%
Sitka Spruce	23,331	5,134	5.52%	6.73%
Western Hemlock	127,591	6,843	4.89%	5.16%
Silver Fir	277,116	7,160	29.00%	29.75%
Mountain Hemlock	328,494	4,738	60.29%	61.16%
Alpine/Parkland	475,806	559	82.87%	82.97%

*For NAPs and NRCAs that occur in more than one zone, we assumed they are evenly distributed on those zones, except that Camas Meadows NAP was assumed to lie entirely in the Interior Douglas-fir zone and the Clearwater Corridor NRCA was assumed to lie entirely in the Western Hemlock zone.

MAPS

Map 1. Ecoregions

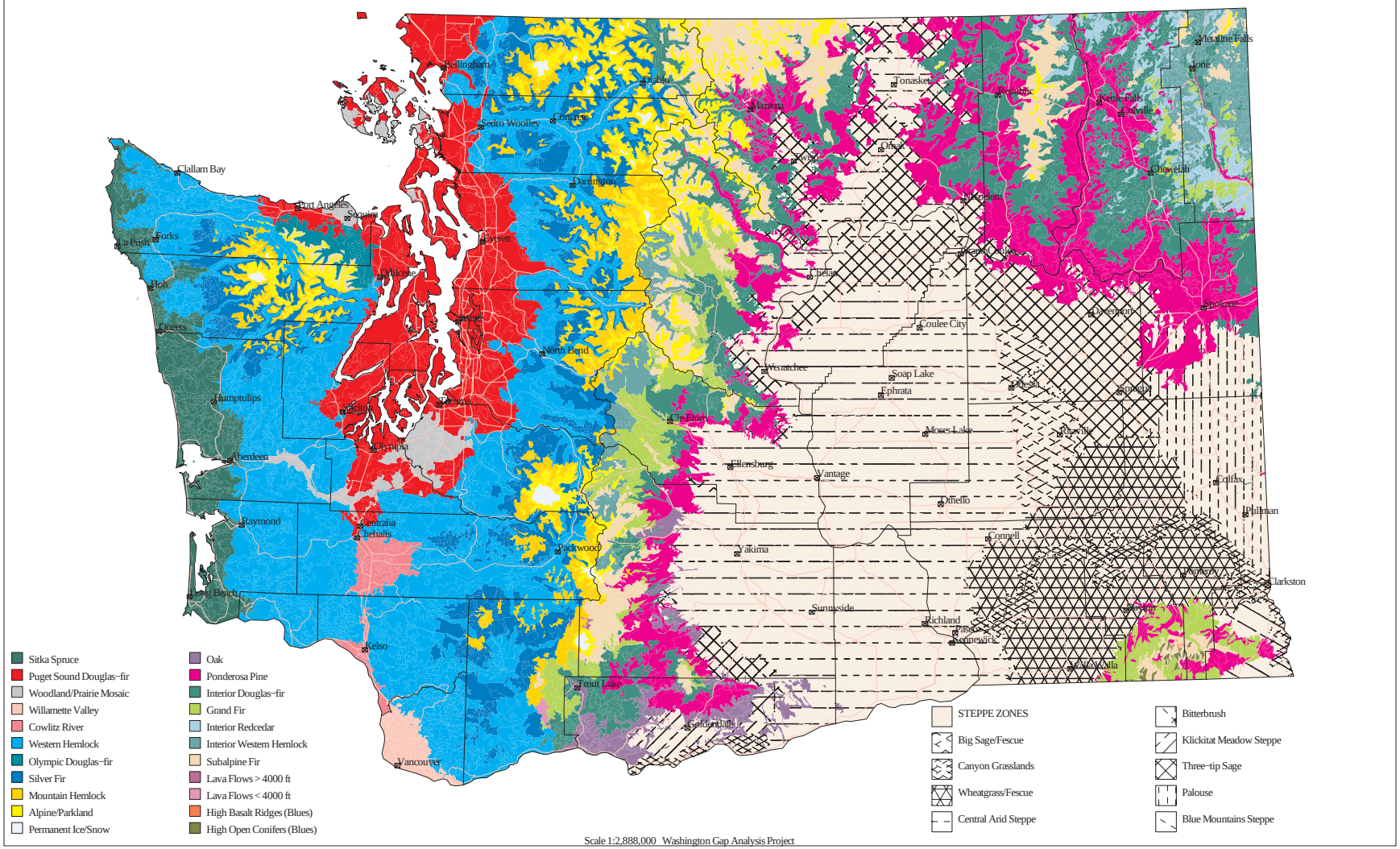


6 −Outer Olympic Peninsula
19 −Inner Olympic Peninsula
7 −Puget Sound
18 −Willamette Valley
16 −Northwest Cascades
17 −Southwest Cascades
15 −Northeast Cascades

Region map and numbering scheme adapted from a map developed by Jan Henderson (USFS) for Washington and Oregon.

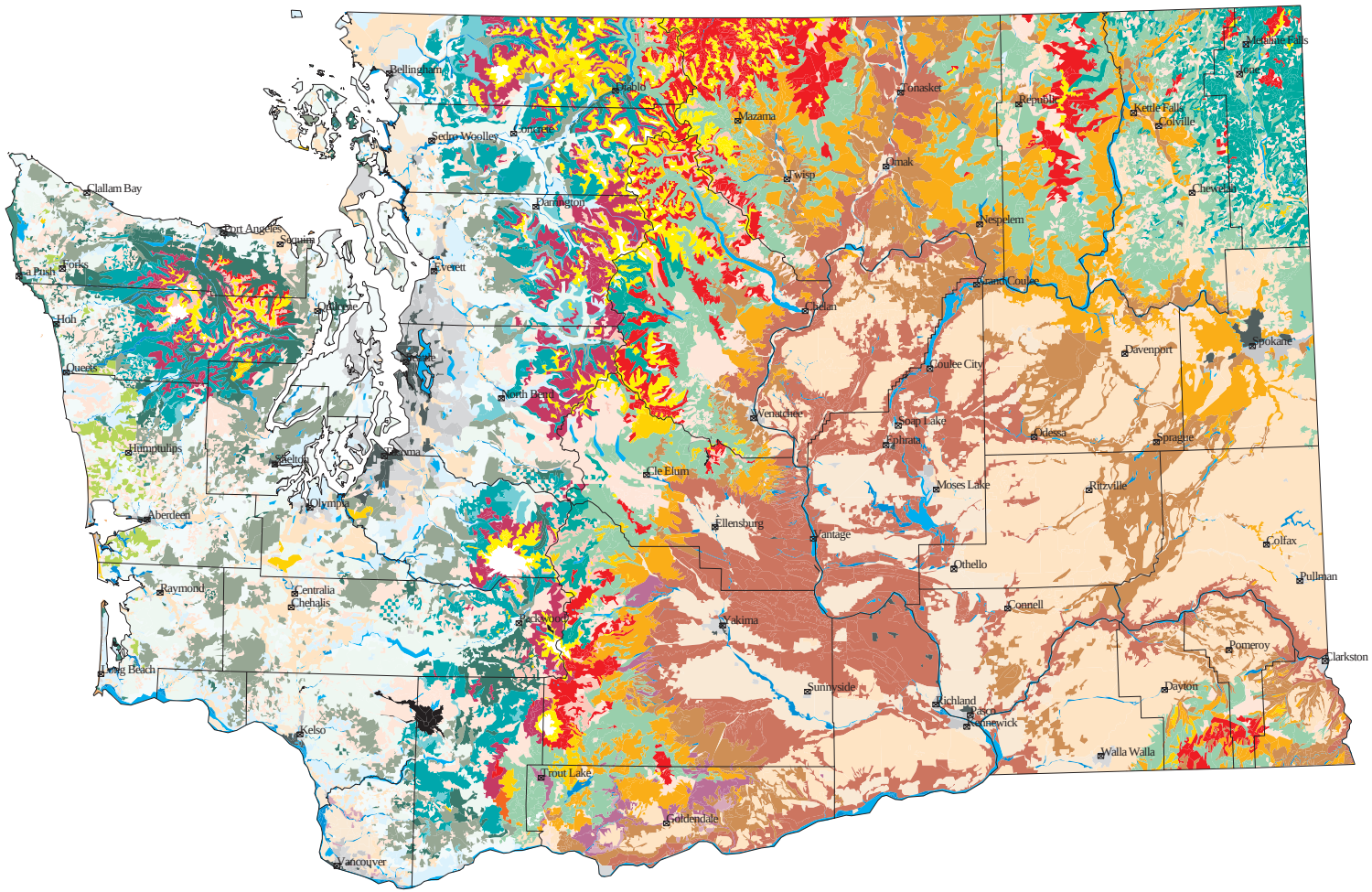
12 −East Central Cascades
13 −Southeast Cascades
14 −Blue Mountains
11 −Columbia Basin
9 −Northeast Corner
10 −Okanogan Highlands

Map 2. Vegetation zones



Scale 1:2,888,000 Washington Gap Analysis Project

Map 3. Land cover, Version 6, August 1996. The key is on the following page.



Scale 1:2,888,000 Washington Gap Analysis Project

Map 3 (continued). Land cover key.

State-wide Types

- Bare ground
- Ice and snow
- Developed, high-density
- Developed, mid-density
- Developed, low-density
- Open fresh water
- Estuary
- Coastline, sandy beaches, rocky islands
- Freshwater riparian and marshes

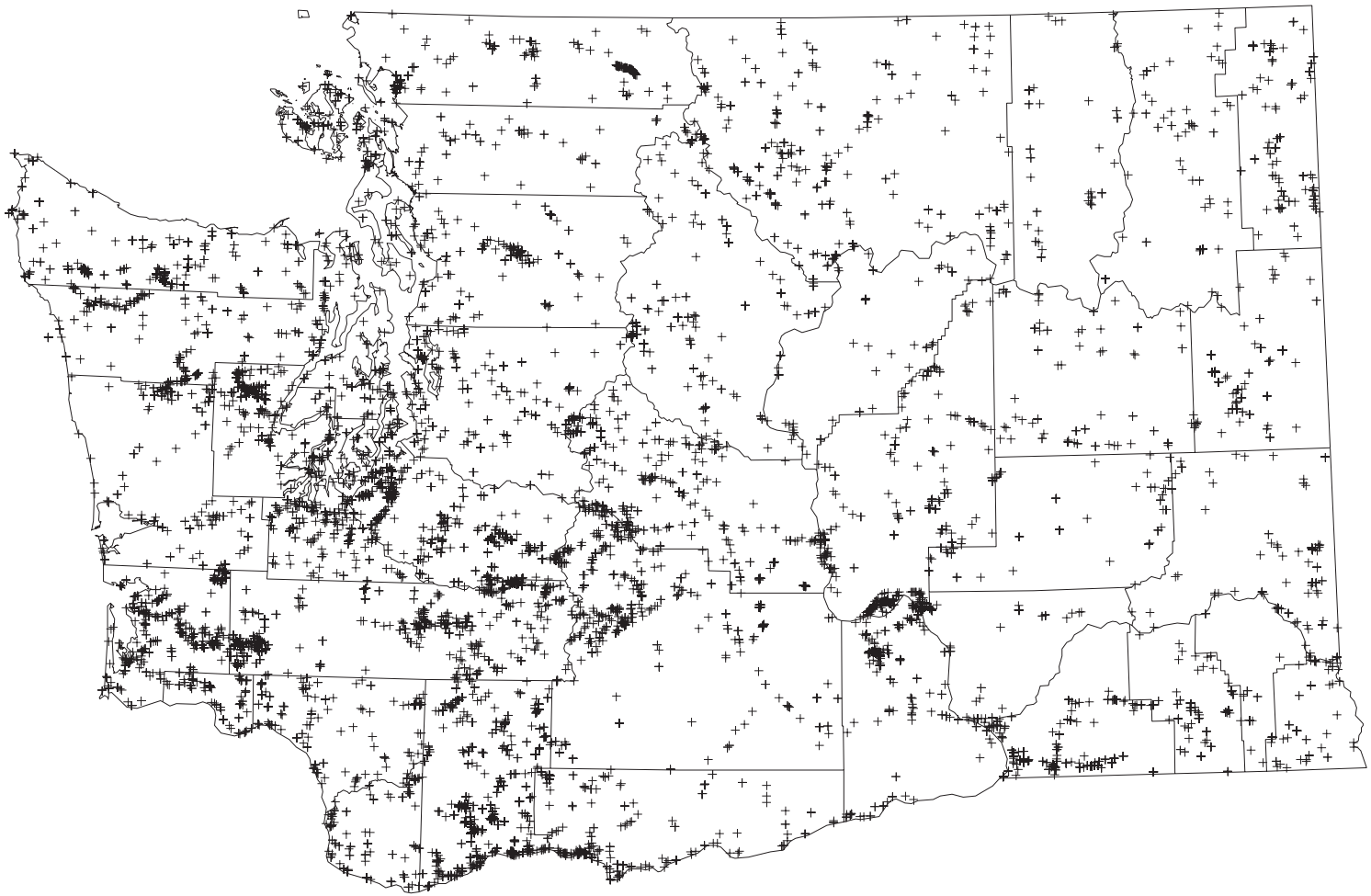
West-side Types

- Agriculture; non-irrigated and mixed/unknown irrigation status
- Agriculture; irrigated
- Non-forested; shrubfields and meadows in low−to mid-elevation forests;
- Non-forested, disturbed; recent burns and logged areas
- Hardwood forests; mostly Red Alder, Bigleaf Maple, Black Cottonwood, willows, some Garry Oak, Oregon Ash; also some young Douglas-fir mixed with tall brush
- Mixed hardwood/conifer forest; mostly Red Alder and Douglas-fir mix, some Oak, Madrone, and Douglas-fir woodlands
- Mixed harwood/conifer forest; mostly Oak/Douglas-fir, or open, dry conifer forest interspersed with dry meadows
- Conifer forest, early-seral, in the Sitka Spruce, Puget-Willamette Trough, Olympic Douglas-fir, and Western Hemlock zones; usually Douglas-fir or Western Hemlock dominated
- Conifer forest, mid-seral, in the Sitka Spruce zone
- Conifer forest, late-seral, in the Sitka Spruce zone
- Conifer forest, mid-seral, in the west-side Puget-Willamette Trough, Olympic Douglas-fir, and Western Hemlock zones; usually Douglas-fir or Douglas-fir/Western Hemlock dominated
- Conifer forest, late seral, in the west-side Puget-Willamette Trough, Olympic Douglas-fir, and Western Hemlock zones; usually Douglas-fir or Western Hemlock/Douglas-fir dominated
- Conifer forest, early seral, Silver Fir zone; usually Western Hemlock and Silver Fir dominated
- Conifer forest, mid and late seral, Silver Fir zone; usually Silver Fir and Western Hemlock dominated
- Conifer forest, all stages, Mountain Hemlock zone; usually Mountain Hemlock and Silver Fir dominated
- Conifer forest, all stages, Subalpine Fir zone in the Olympics; usually Subalpine Fir dominated
- Open subalpine woodland and parkland, and subalpine meadows and openings in subalpine forest types
- Alpine and high subalpine meadows

East-side Types

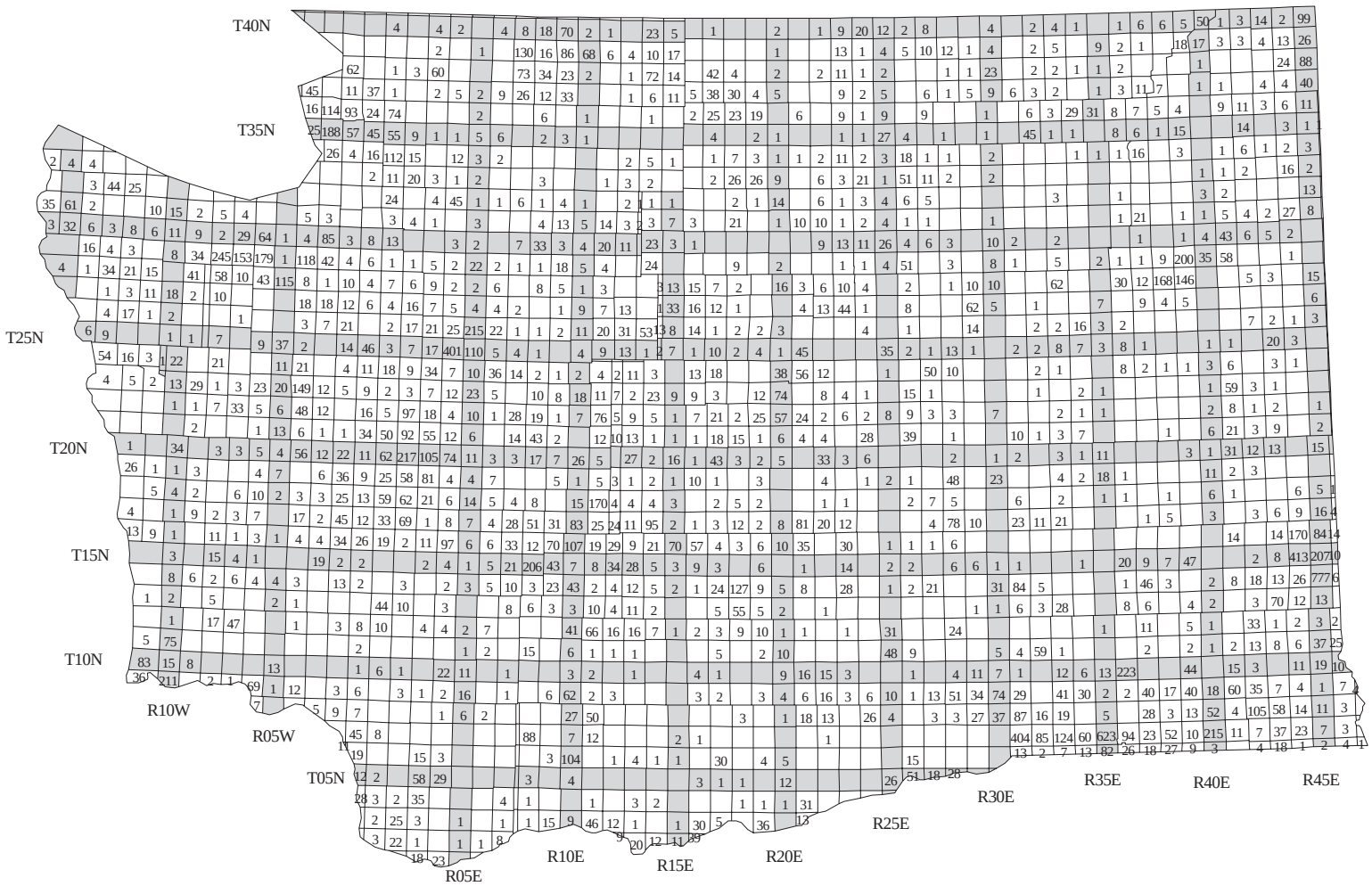
- Agriculture; non-irrigated
- Agriculture; irrigated and mixed irrigation status
- Arid steppe; includes steppe grassland and shrubland in the Central Arid Steppe and Canyon Grassland zones
- Mesic steppe and grass/shrub meadows in low, open forest; includes grassland, shrubland, and tree savanna in Ponderosa Pine, Oak, and all steppe zones except Central Arid Steppe and Canyon Grassland zones
- Non-forested; shrubfields and meadows in Interior Douglas-fir, Grand Fir, Interior Western Hemlock, and Interior Redcedar forests;
- Non-forested, disturbed; recent burns and logged areas in all forest zones
- Hardwood forests; mostly Willows, Black Cottonwood along rivers
- Hardwood forests; Garry Oak dominated
- Mixed hardwood/conifer forest; usually along rivers
- Mixed harwood/conifer forest; mostly Garry Oak with Douglas-fir and/or Ponderosa Pine
- Conifer forest, low-elevation, open; usually Ponderosa Pine dominated
- Conifer forest in the Douglas-fir and Grand Fir zones; usually Douglas-fir, Douglas-fir/Grand Fir, Western Larch, Lodgepole Pine, or Douglas-fir/Lodgepole Pine/Western Larch
- Confer forest in the Interior Western Hemlock and Interior Western Redcedar zones
- Conifer forest, Subalpine Fir zone; usually Subalpine Fir/Lodgepole Pine/Engelmann Spruce
- Conifer forest; open Lodgepole Pine forest on Low Elevation Lava Flows
- Open subalpine woodland and parkland, and subalpine meadows and openings in subalpine forest types
- Alpine and high subalpine meadows

Map 4: Record locations for amphibians and reptiles.

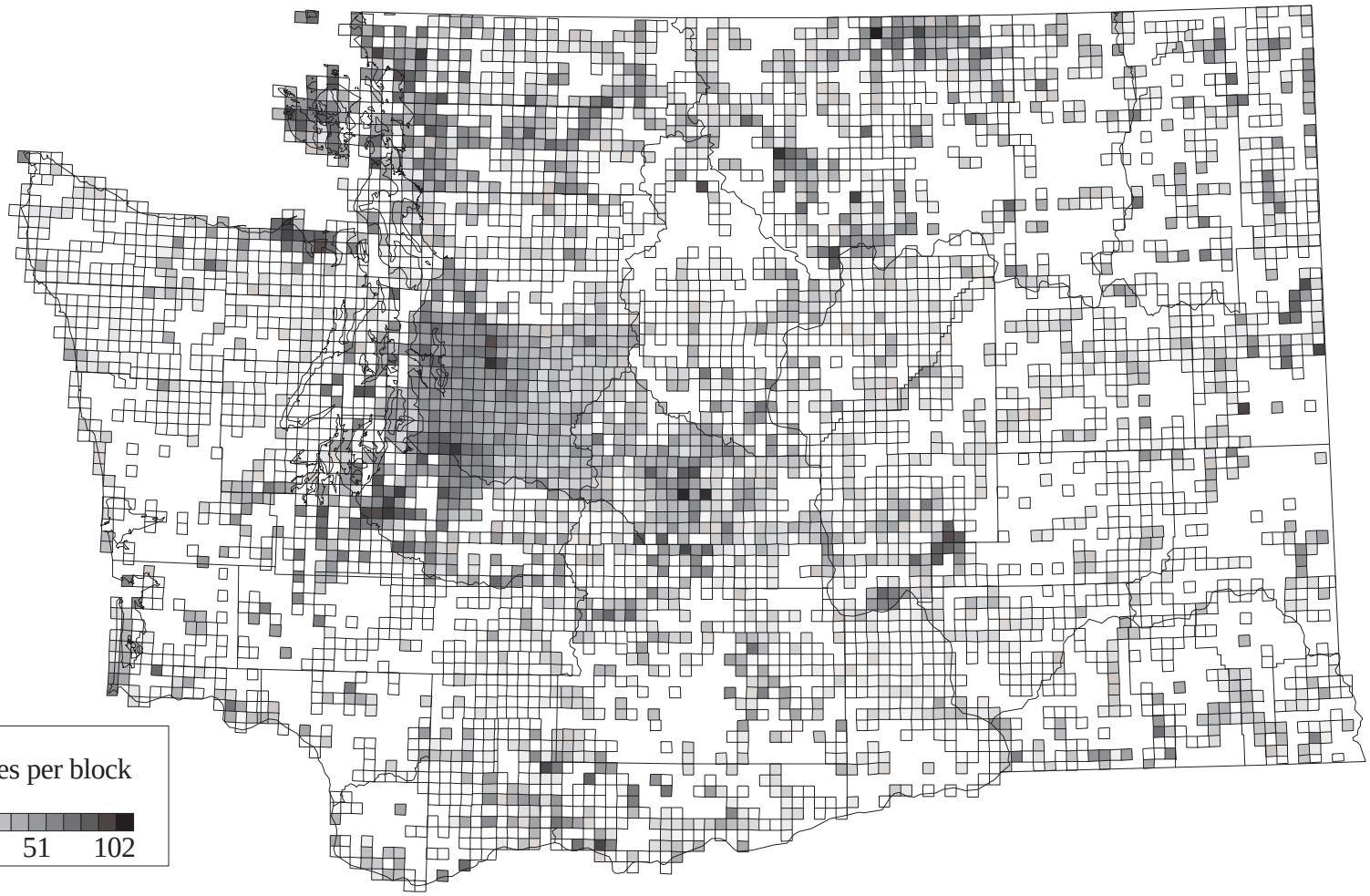


Washington Gap Analysis Project 1997

Map 5. Mammal record frequency by township/range

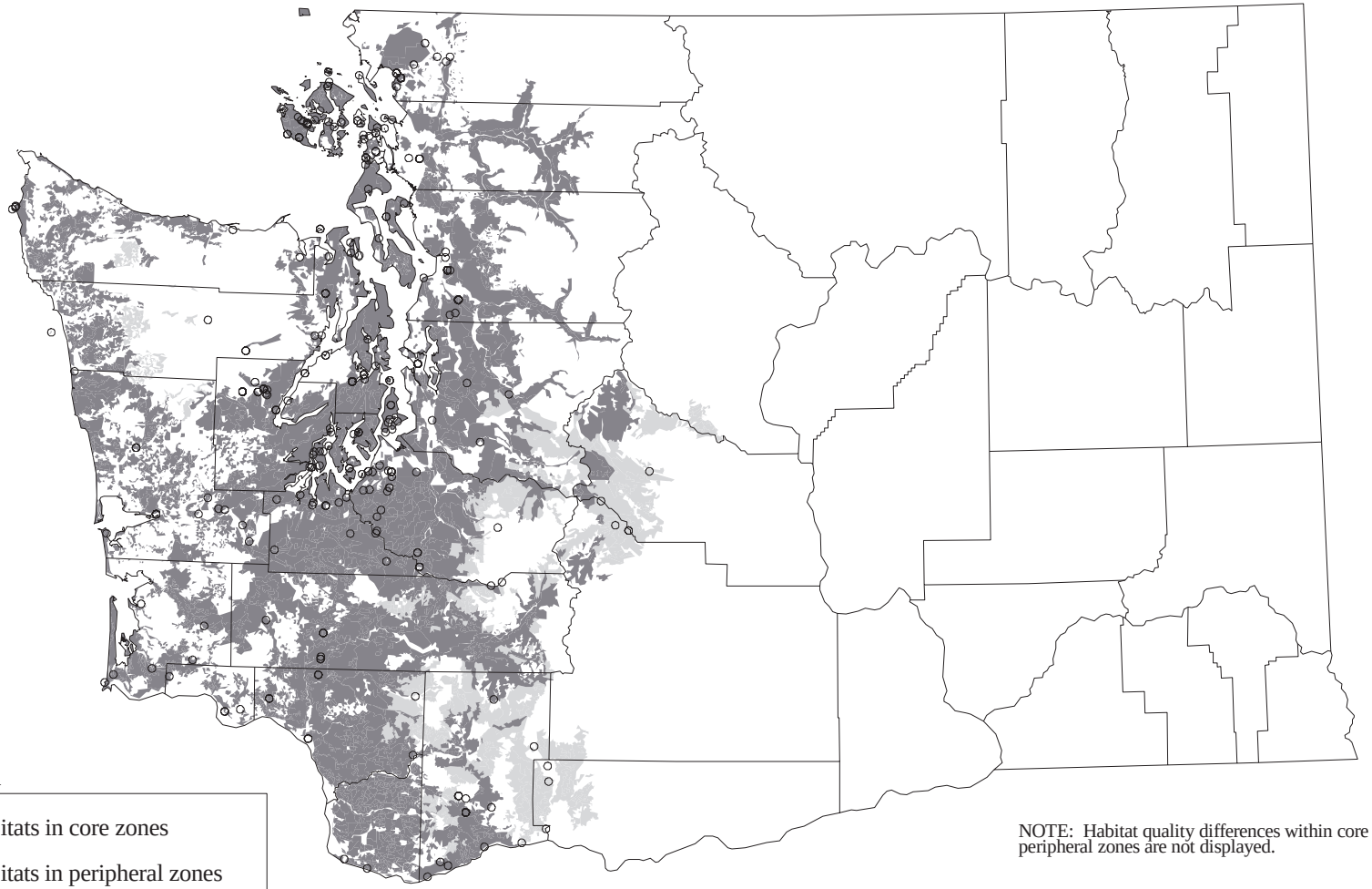


Map 6. Number of bird species recorded at the ‘Possible Breeding‘ level for each Breeding Bird Atlas block between 1987 and 1996.



Map 7. Sample herpetofauna map.

Thamnophis ordinoides - **Northwestern Garter Snake**



Legend

- Habitats in core zones
- Habitats in peripheral zones
- Point locations

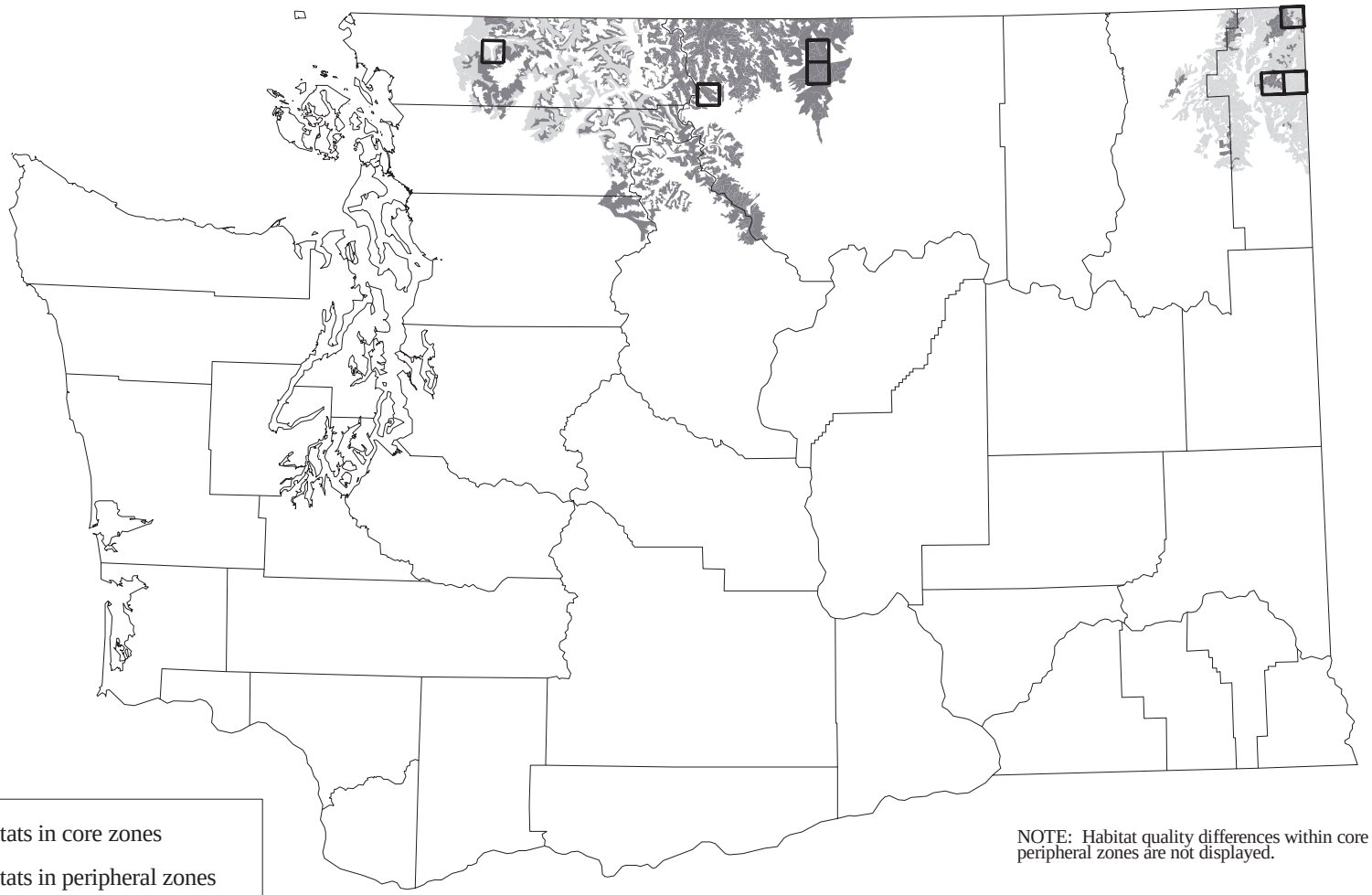
NOTE: Habitat quality differences within core and peripheral zones are not displayed.

(Scale 1:2,888,000)

Washington Gap Analysis Project 1997

Map 8. Sample mammal map.

Synaptomys borealis - **Northern Bog Lemming**



Legend

- Habitats in core zones
- Habitats in peripheral zones
- Township/Range with a record

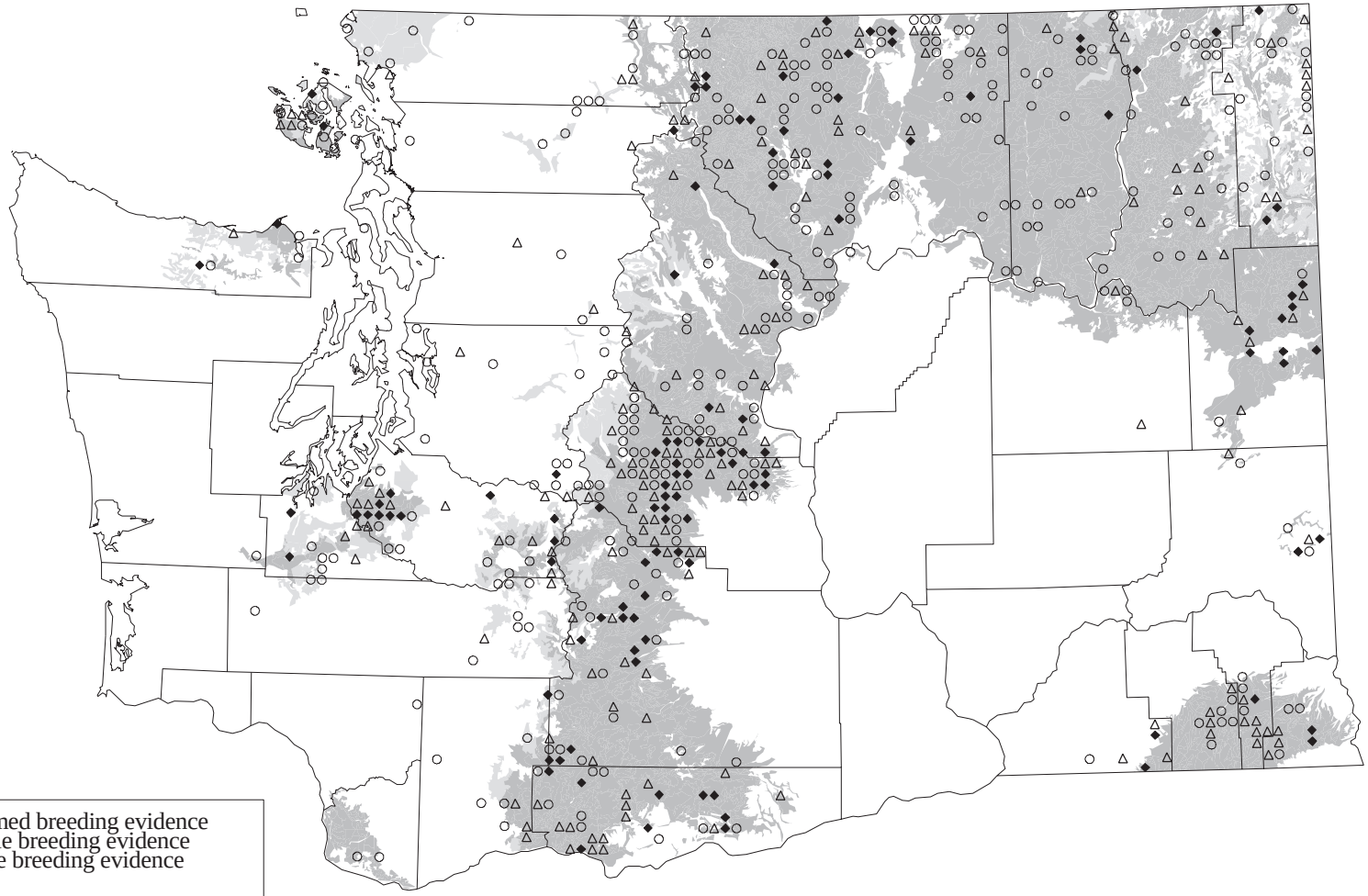
NOTE: Habitat quality differences within core and peripheral zones are not displayed.

(Scale 1:2,888,000)

Washington Gap Analysis Project 1997

Map 9. Sample bird map.

Chipping Sparrow - *Spizella passerina*



Legend

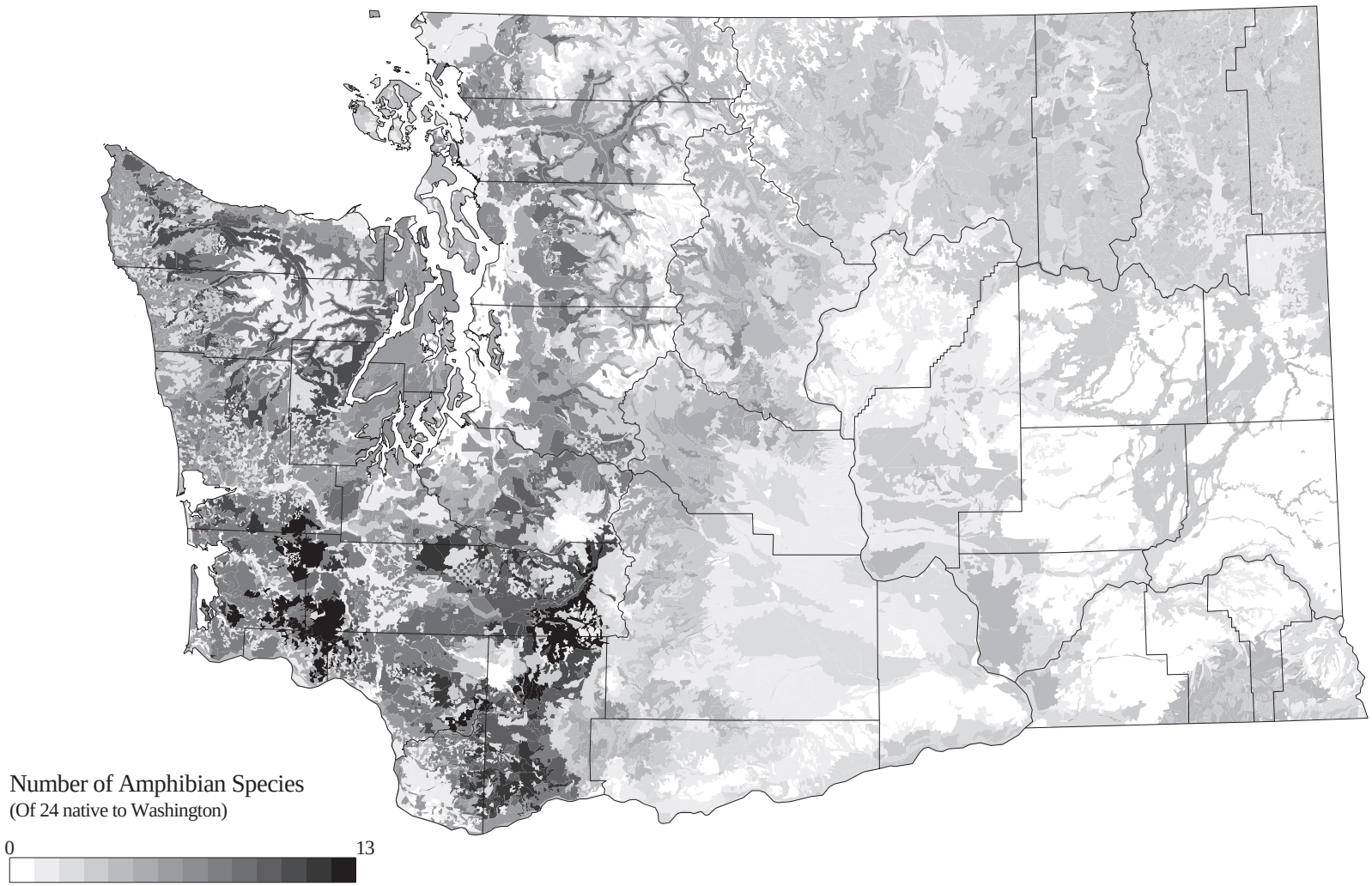
- ◆ Confirmed breeding evidence
- △ Probable breeding evidence
- ○ Possible breeding evidence

- Habitats in core zones
- Habitats in peripheral zones

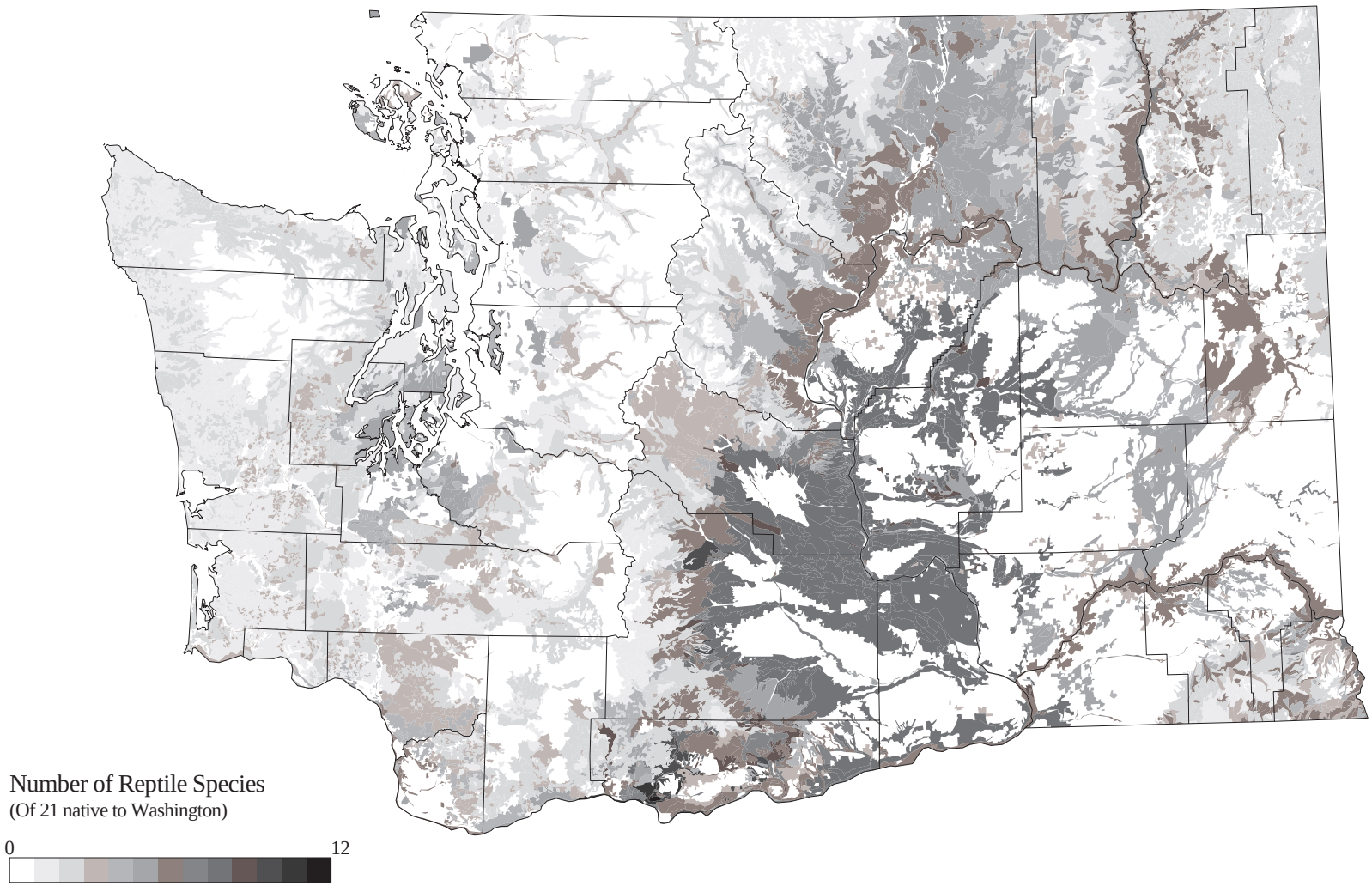
(Scale 1:2,888,000)

Washington Gap Analysis Project 1997

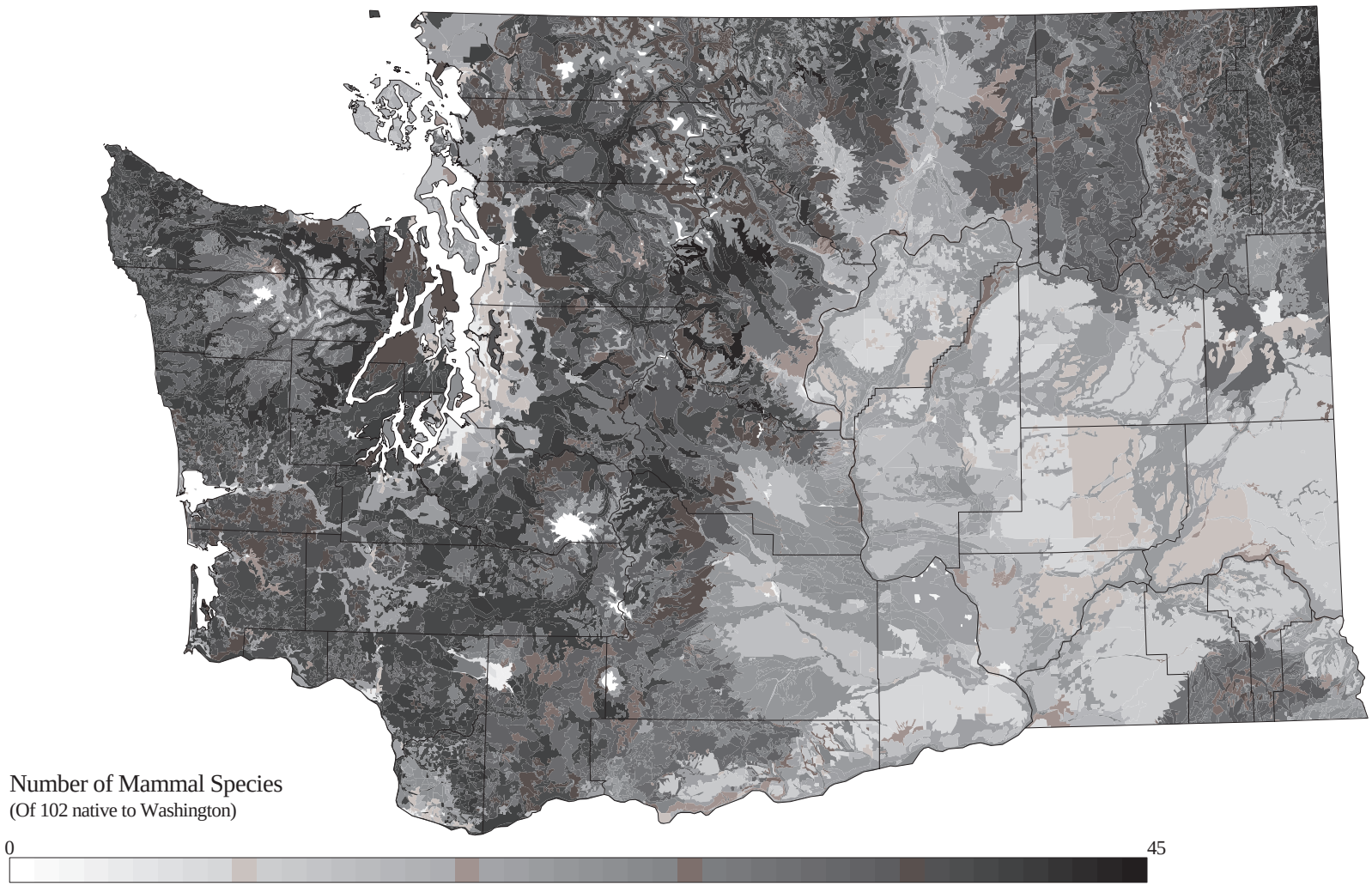
Map 10. Native amphibian species richness, derived from good and contingently suitable habitats in core zones, using primary cover only.



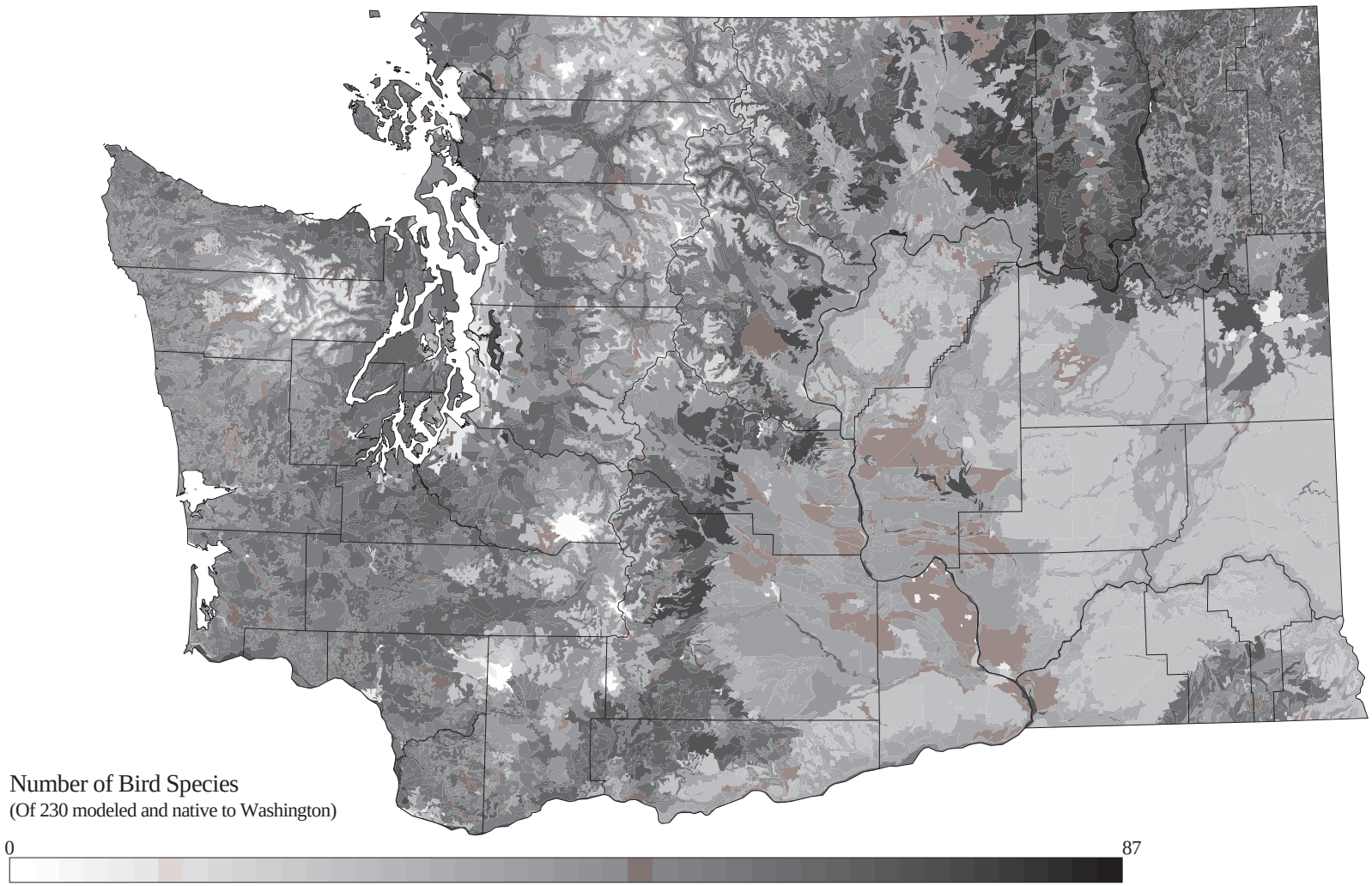
Map 11. Native reptile species richness, derived from good and contingently suitable habitats in core zones, using primary cover only.



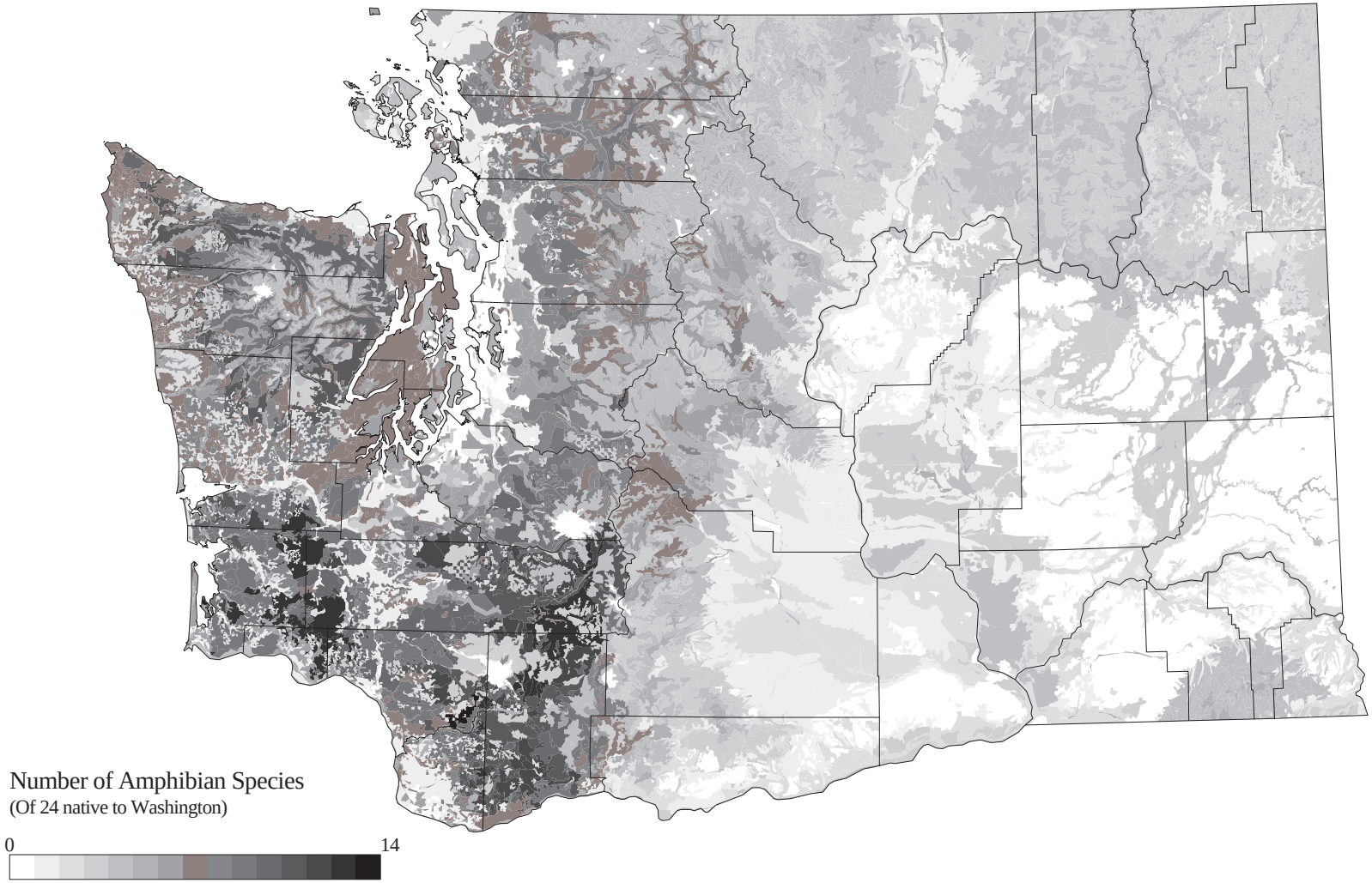
Map 12. Native mammal species richness, derived from good and contingently suitable habitats in core zones, using primary cover only.



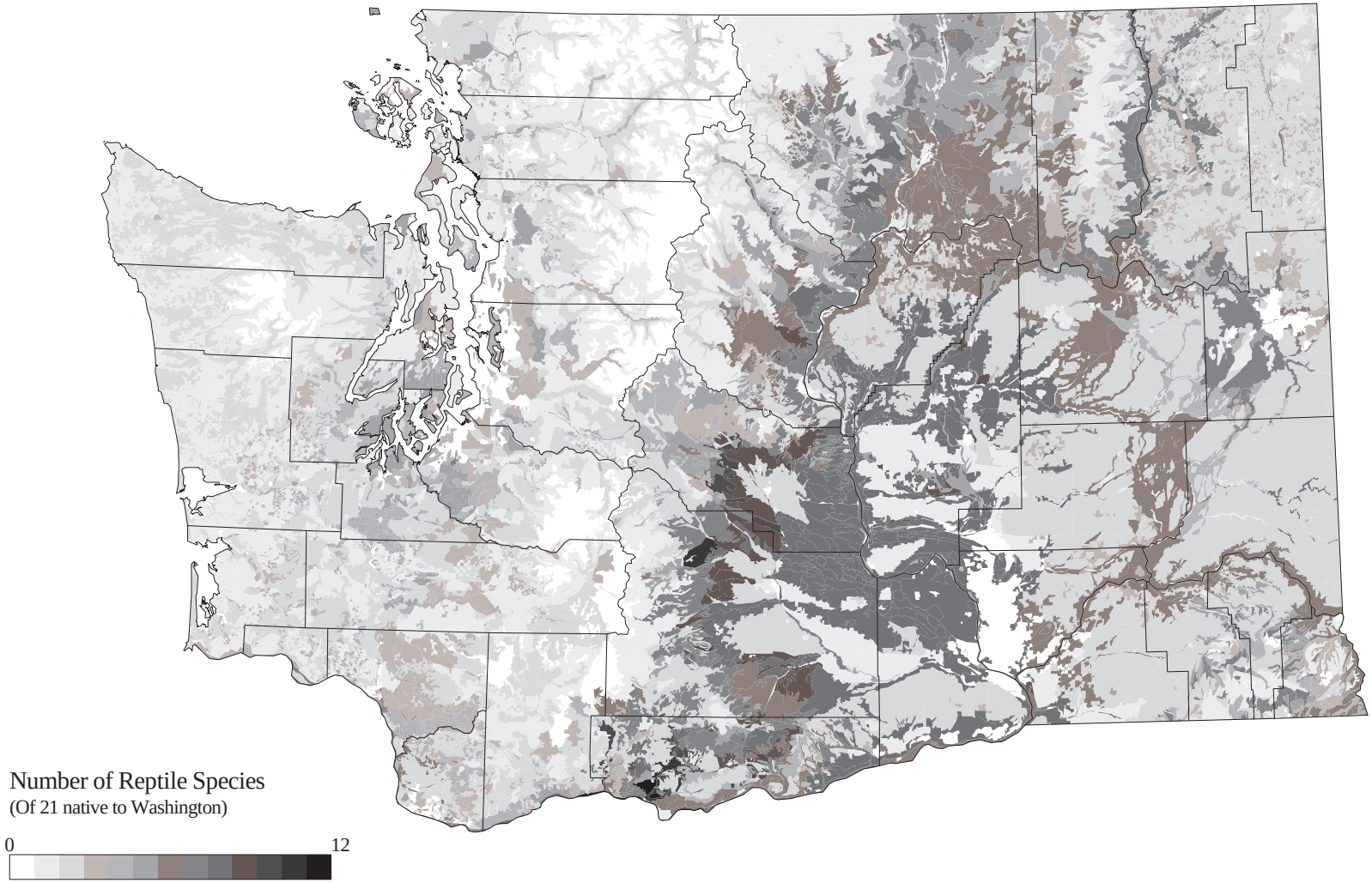
Map 13. Native bird species richness, derived from good and contingently suitable habitats in core zones, using primary cover only.



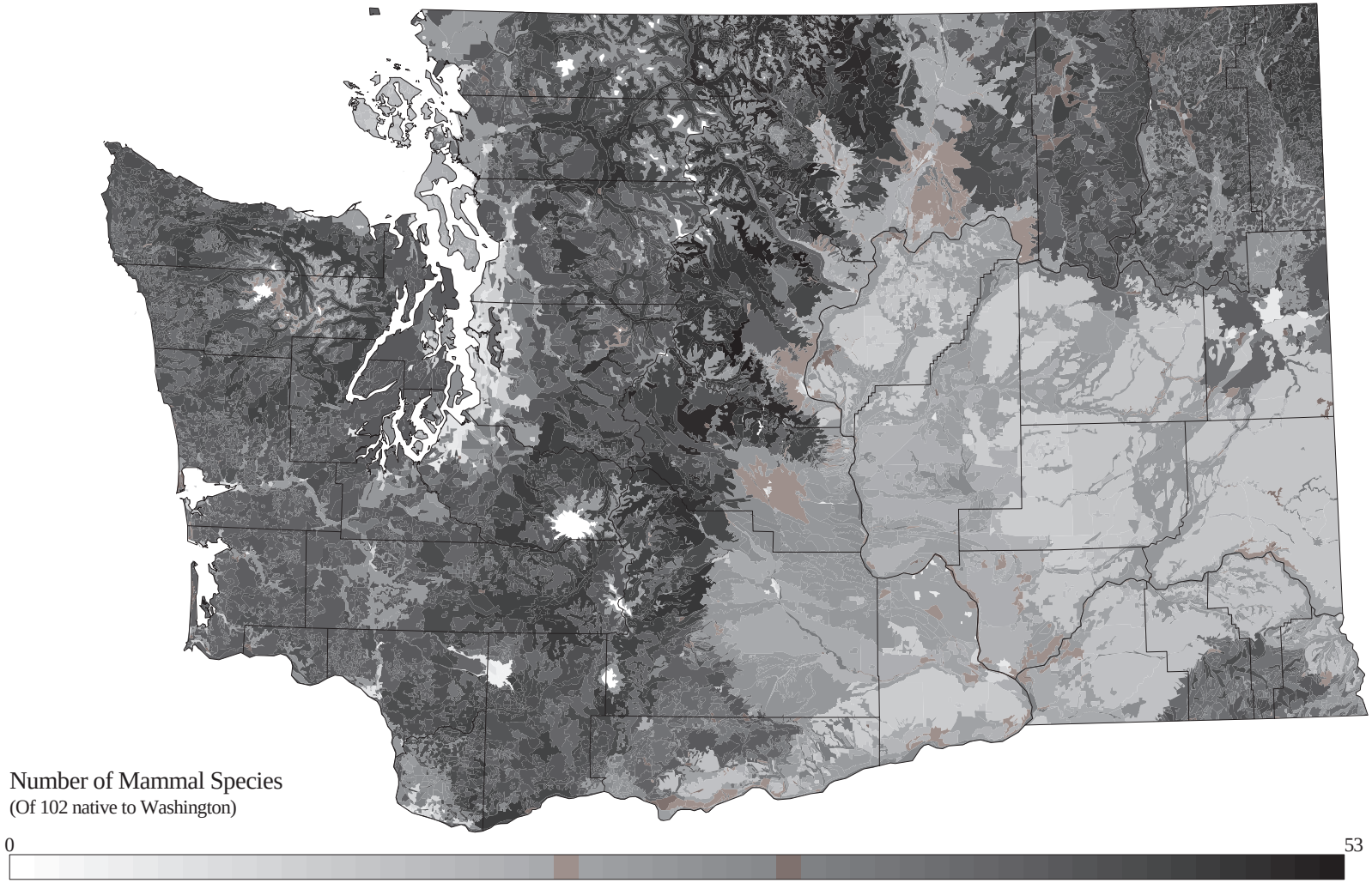
Map 14. Native amphibian species richness, derived from all suitable habitats in all zones, using primary cover only. Contrast this map with the richness map (Map 10) derived from only good and contingently suitable habitats in core zones.



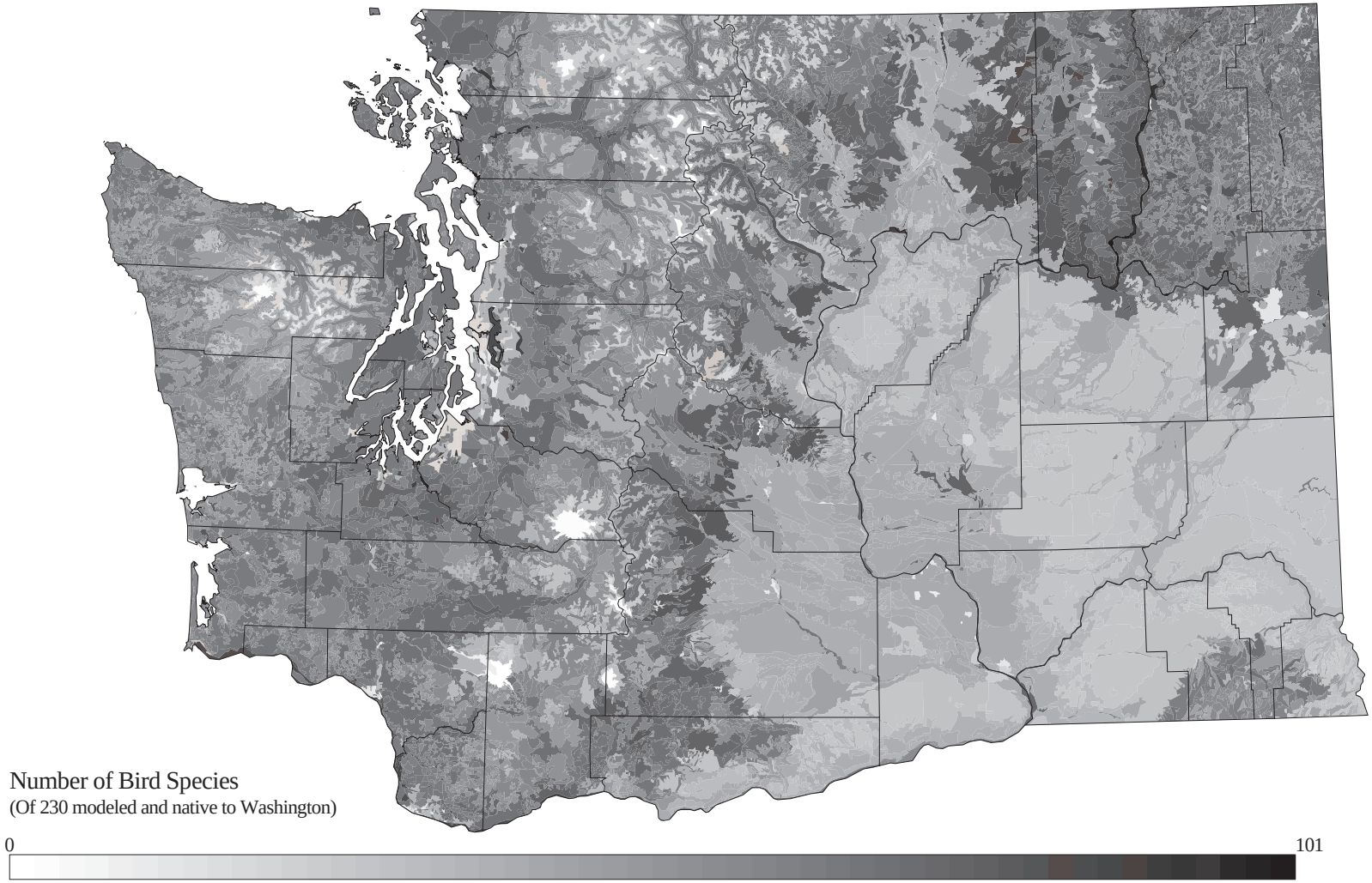
Map 15. Native reptile species richness, derived from all suitable habitats in all zones, using primary cover only. Contrast this map with the richness map (Map 11) derived from only good and contingently suitable habitats in core zones.



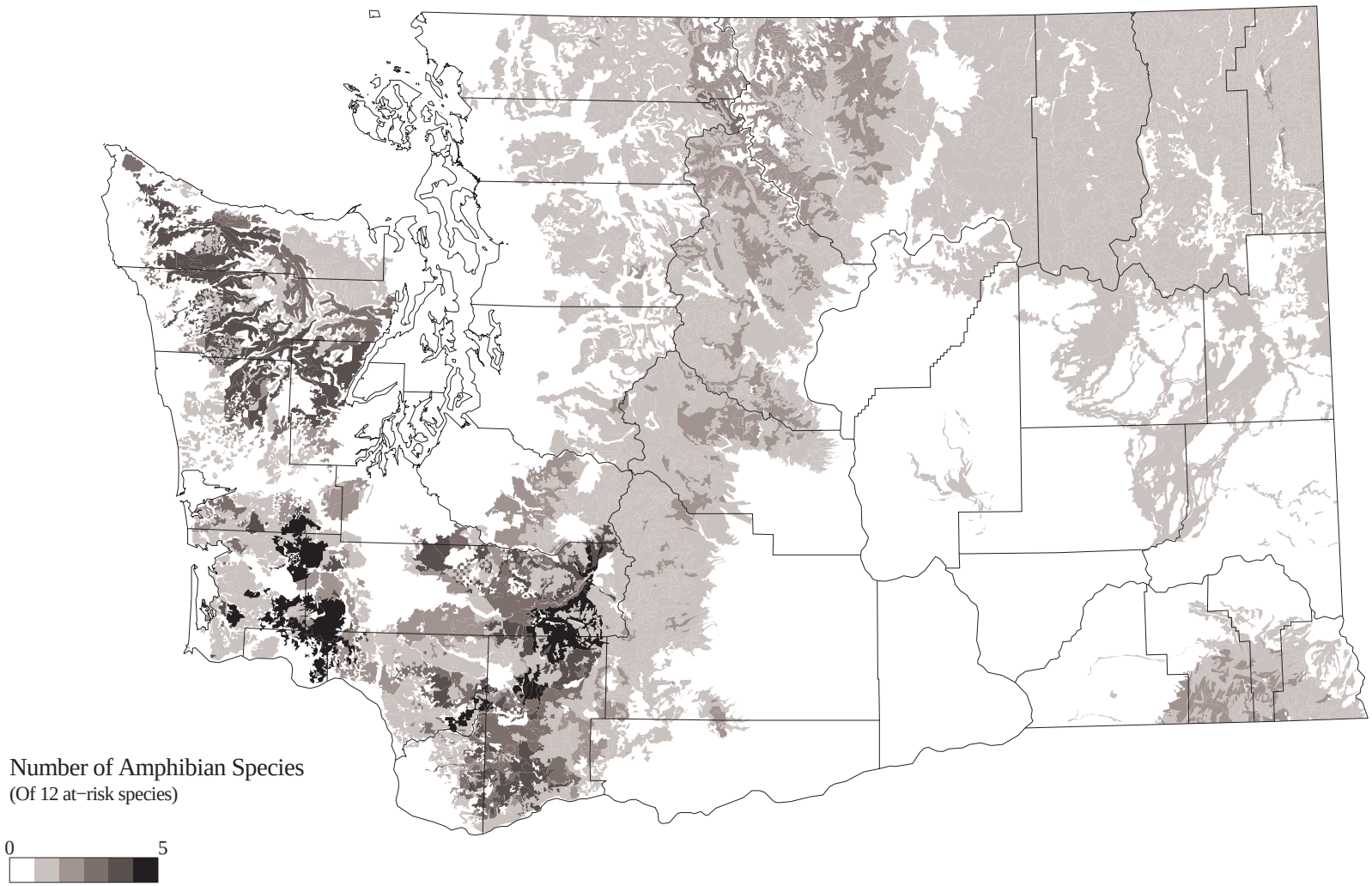
Map 16. Native mammal species richness, derived from all suitable habitats in all zones, using primary cover only. Contrast this map with the richness map (Map 12) derived from only good and contingently suitable habitats in core zones.



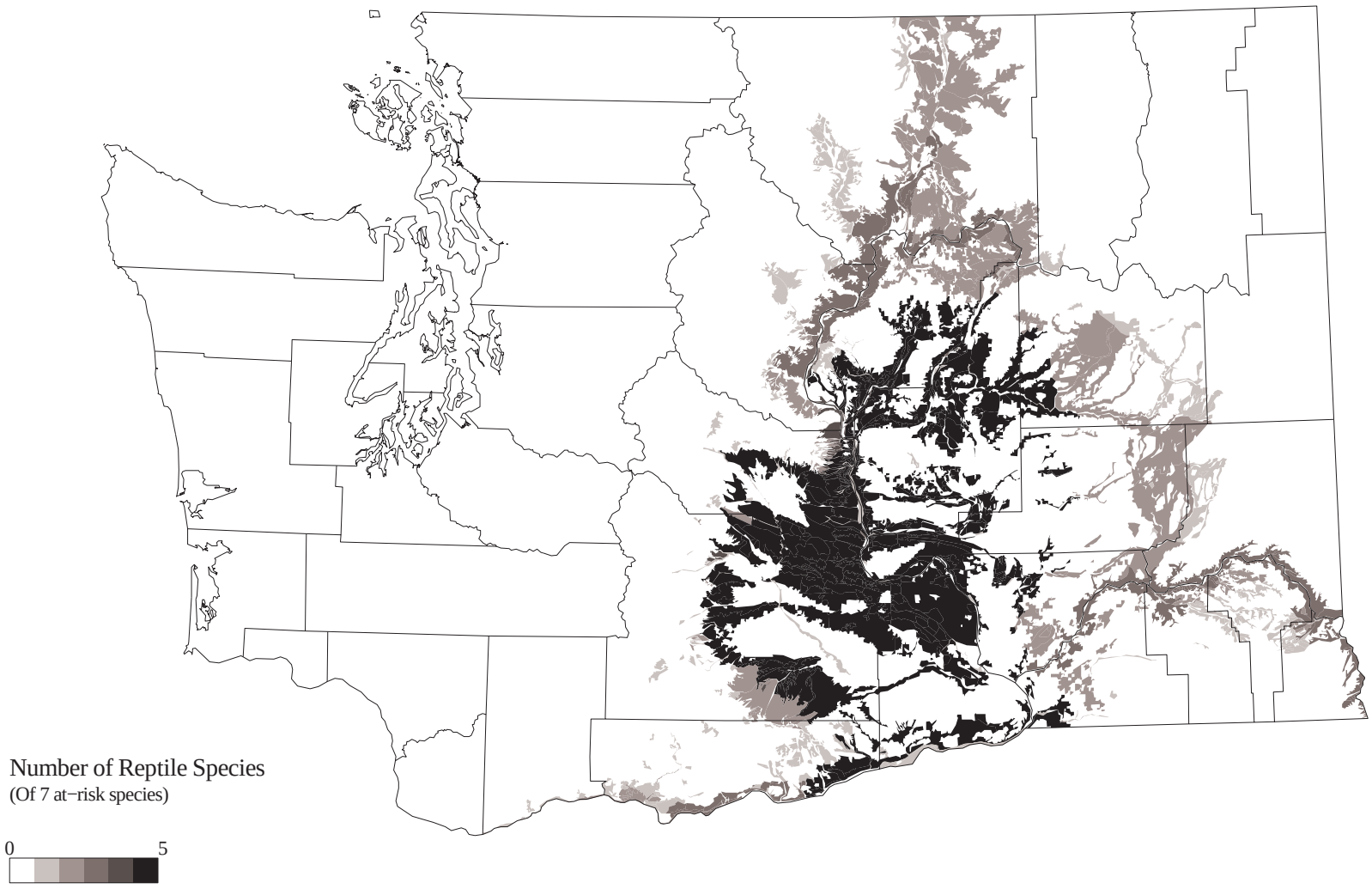
Map 17. Native bird species richness, derived from all suitable habitats in all zones, using primary cover only. Contrast this map with the richness map (Map13) derived from only good and contingently suitable habitats in core zones.



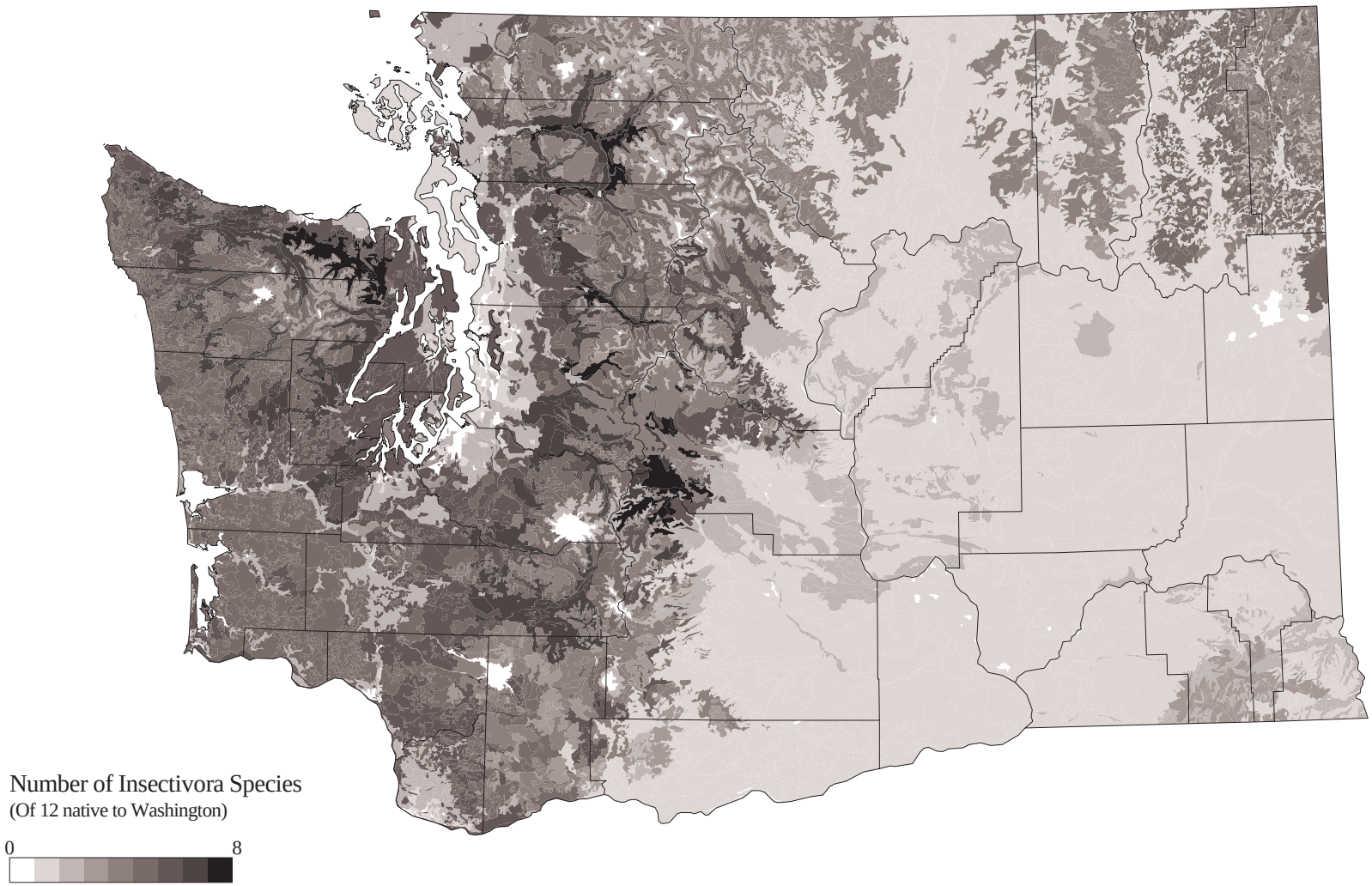
Map 18. Richness of native amphibians most at risk due to human activities. (Derived from good and contingently suitable habitats in core zones, using primary cover only.)



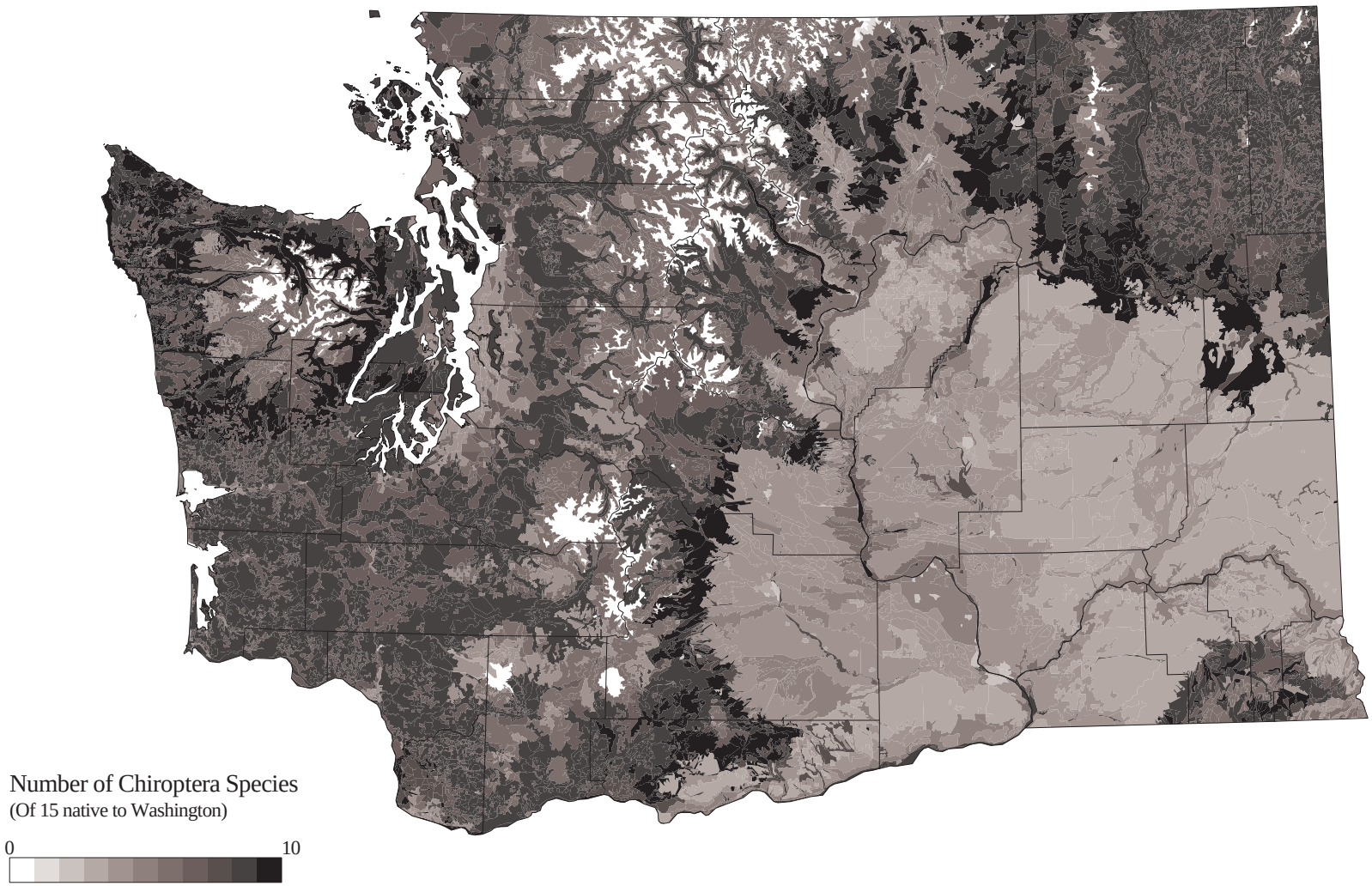
Map 19. Richness of native reptiles most at risk due to human activites. (Derived from good and contingently suitable habitats in core zones, using primary cover only.)



Map 20. Native Insectivora (shrew and mole) richness. (Derived from good and contingently suitable habitats in core zones, using primary cover only.)

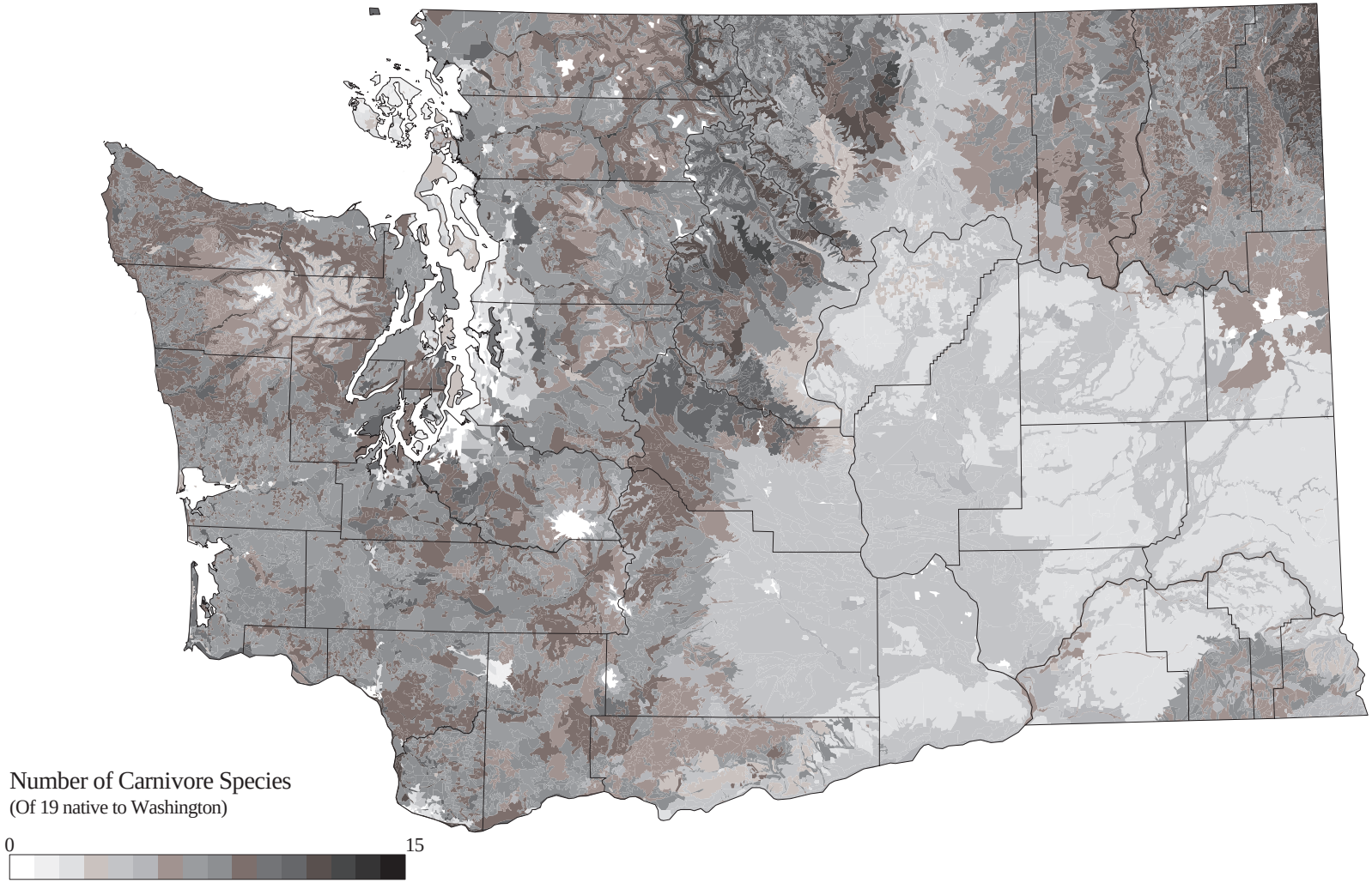


Map 21. Native Chiroptera (bat) richness. (Derived from good and contingently suitable habitats in core zones, using primary cover only.)

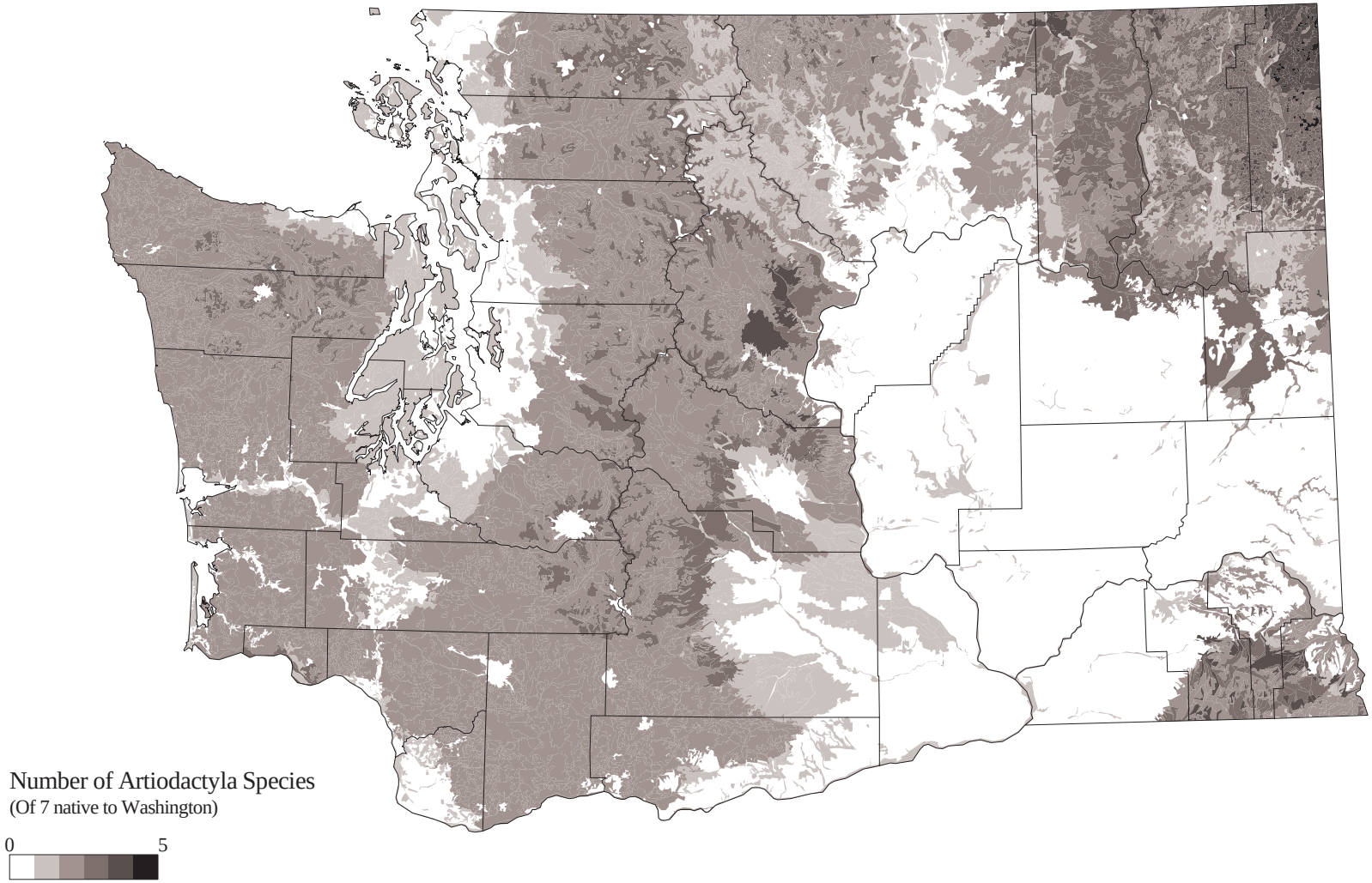


Map 22. Native Lagomorph (rabbit, hare, and Pika) richness. (Derived from good and contingently suitable habitats in core zones, using primary cover only.)

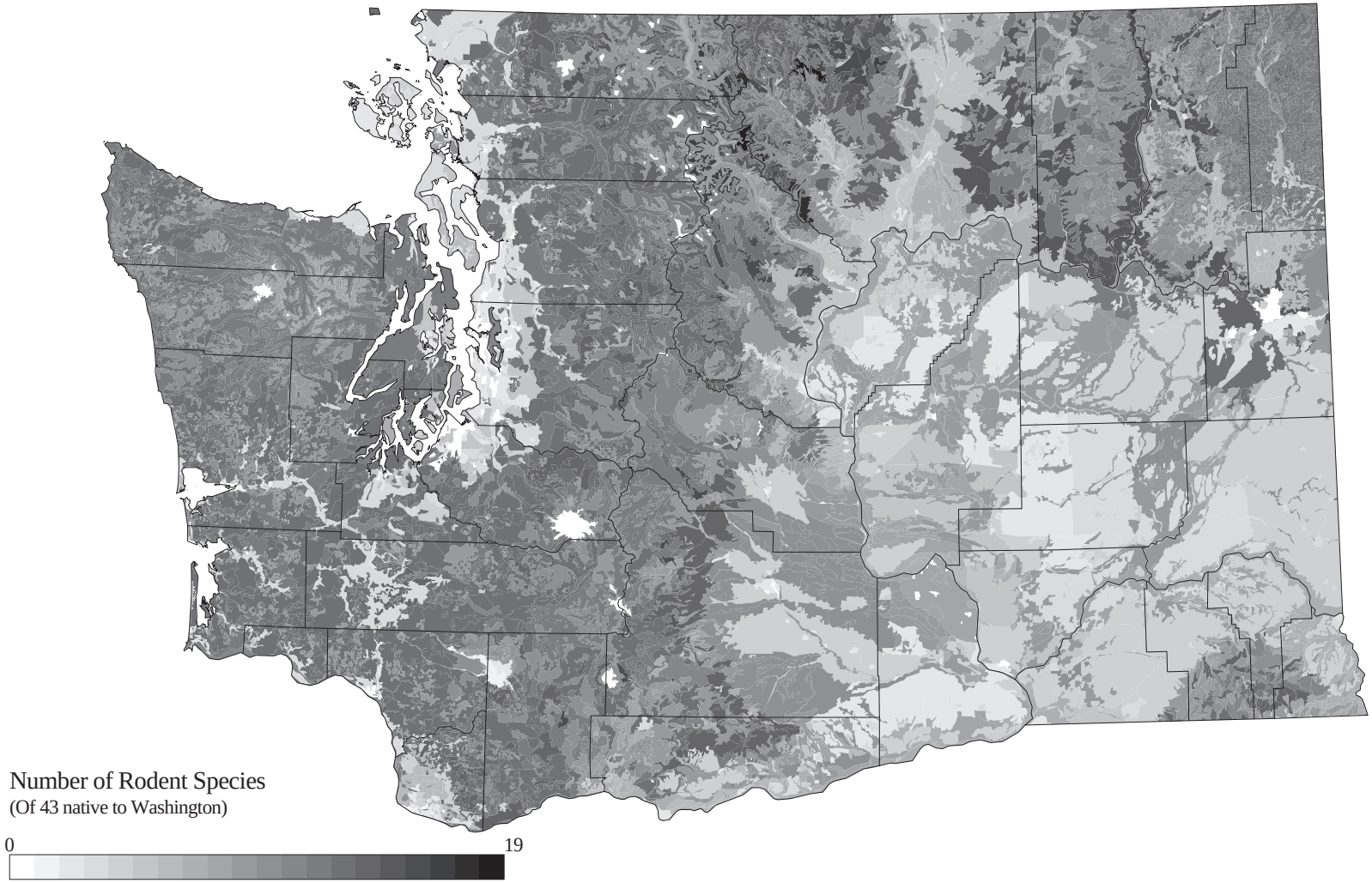
Map 23. Native Carnivora (mustelid, ursine, canine, feline, etc.) richness. (Derived from good and contingently suitable habitats in core zones, using primary cover only.)



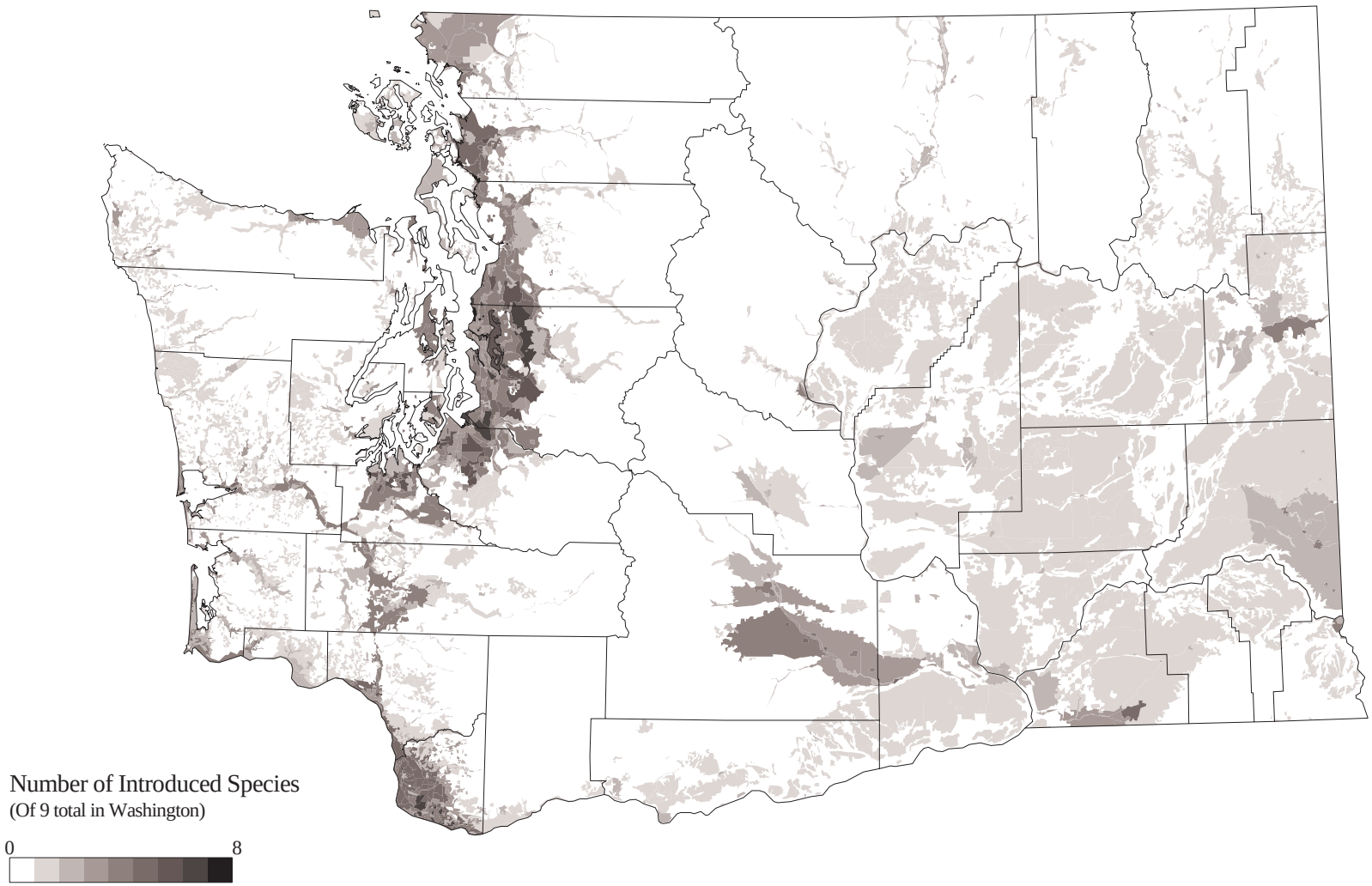
Map 24. Native Artiodactyla (deer, elk, goat, sheep, and caribou) richness. (Derived from good and contingently suitable habitats in core zones, using primary cover only.)



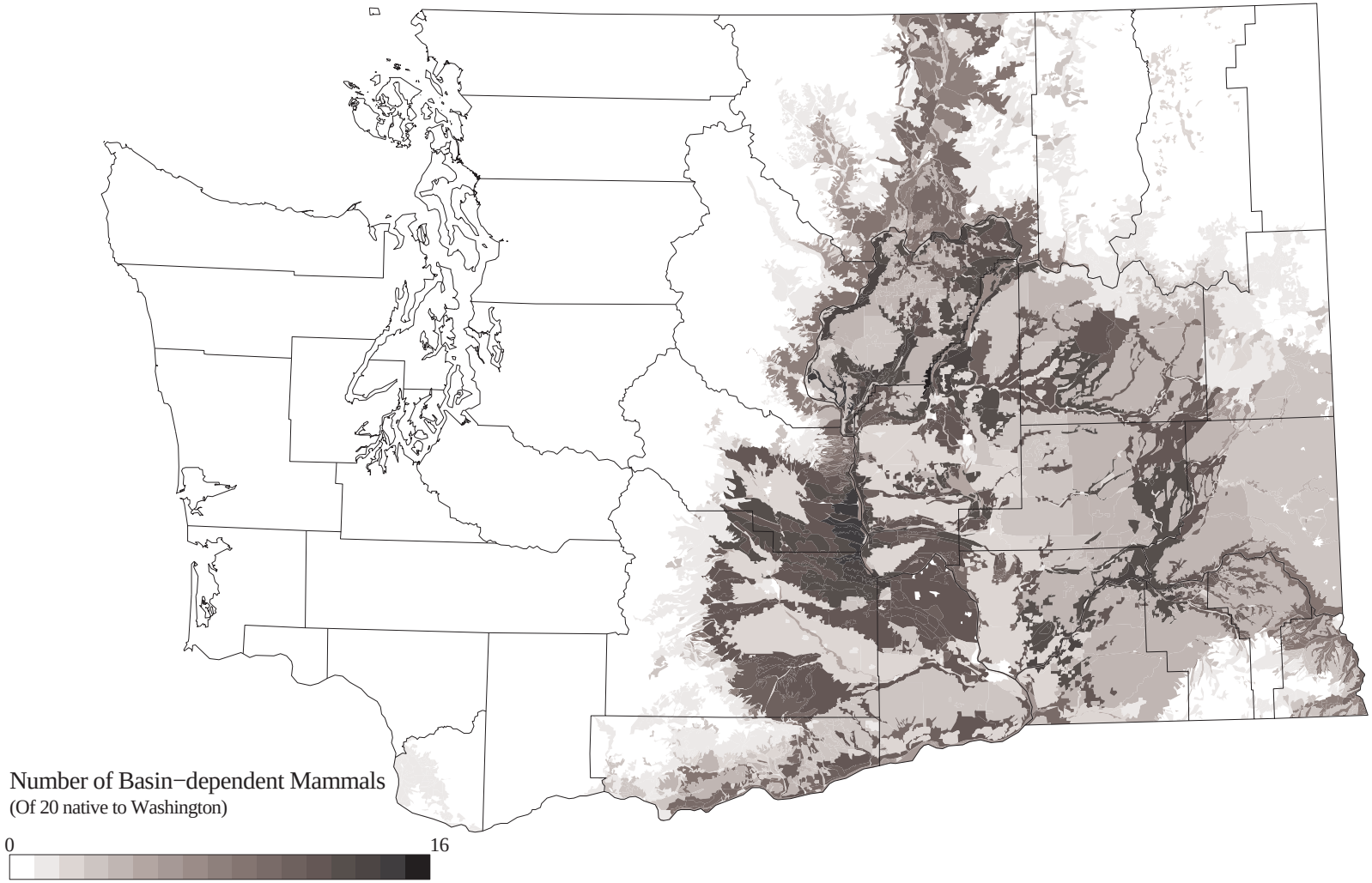
Map 25. Native Rodentia (mouse, rat, squirrel, beaver, vole, etc.) richness. (Derived from good and contingently suitable habitats in core zones, using primary cover only.)



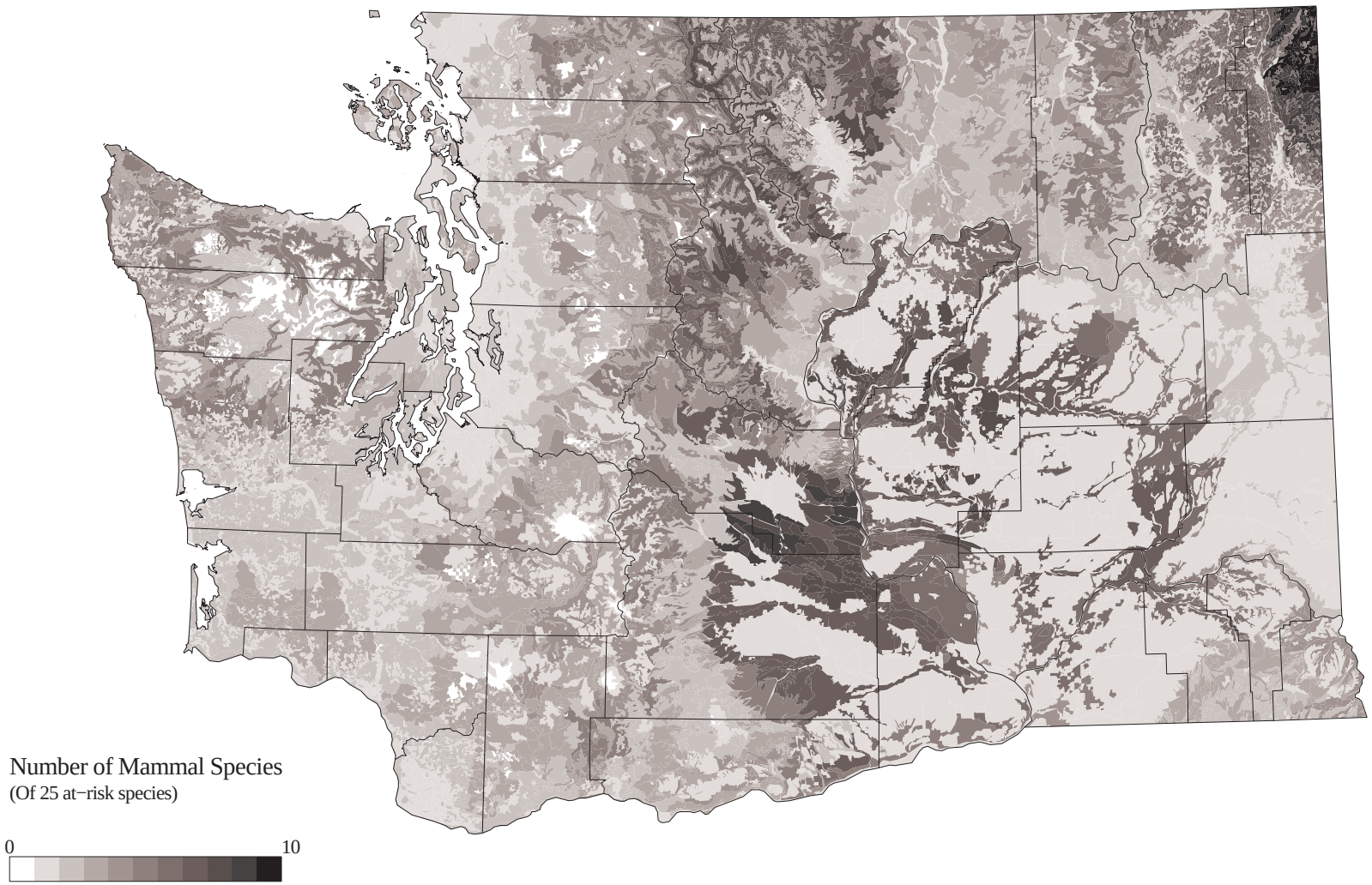
Map 26. Introduced mammal richness. (Derived from good and contingently suitable habitats in core zones, using primary cover only.)



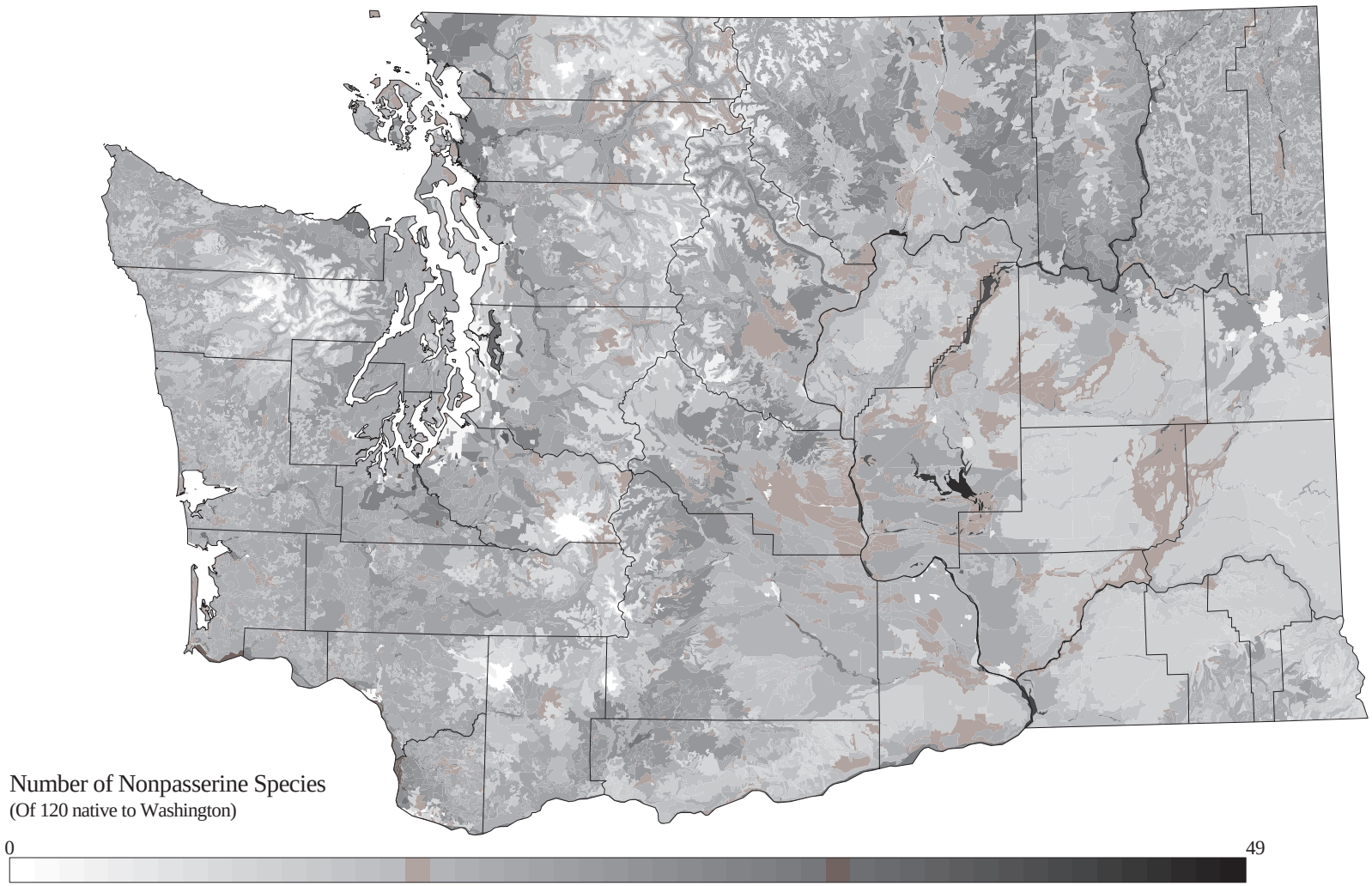
Map 27. Richness of Columbia Basin−dependent mammal species, i.e., species with most of their Washington ranges within the Basin. (Derived from good and contingently suitable habitats in core zones, using primary cover only.)



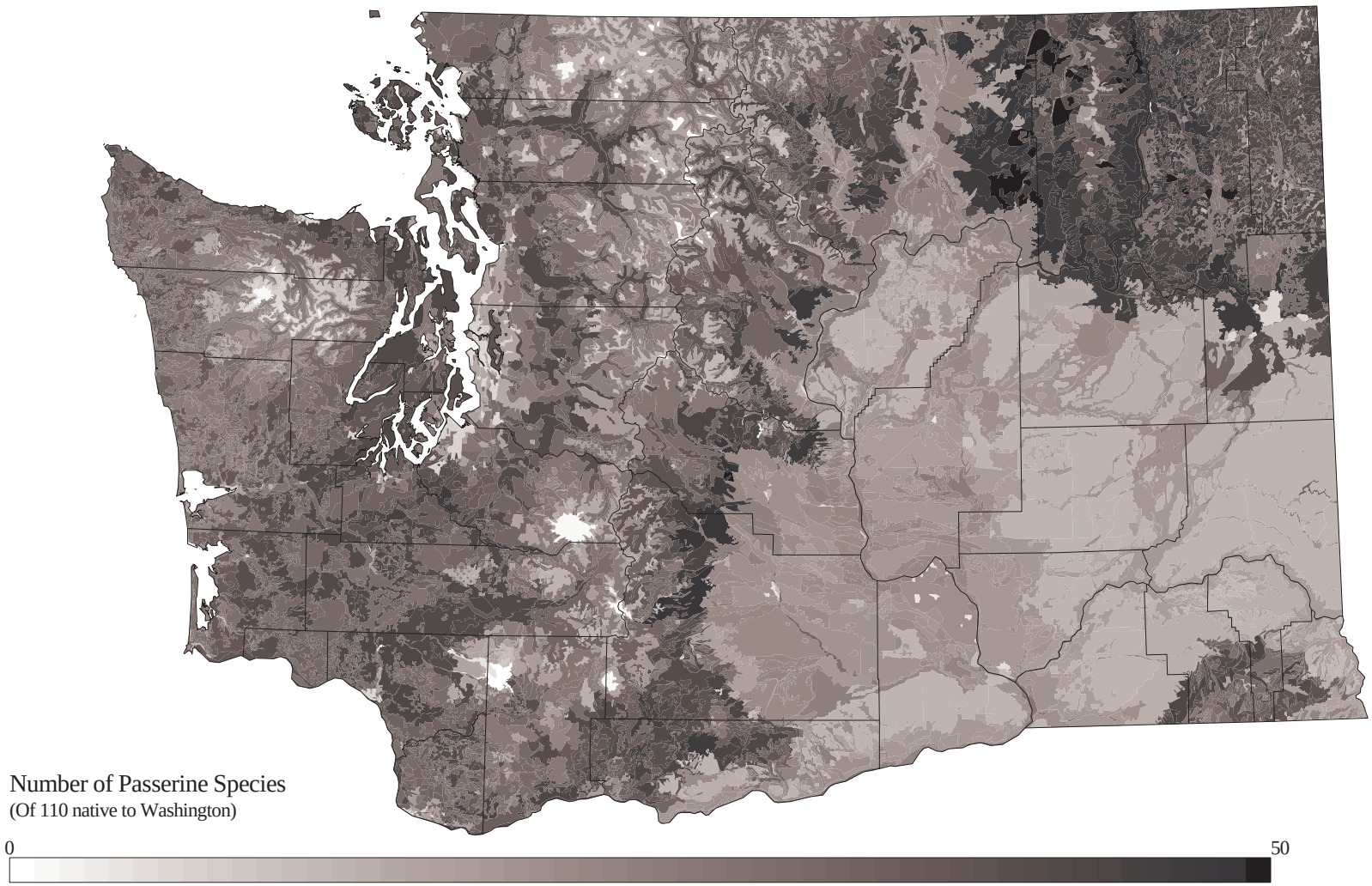
Map 28. Richness of native mammals most at risk due to human activities (Derived from good and contingently suitable habitats in core zones, using primary cover only.)



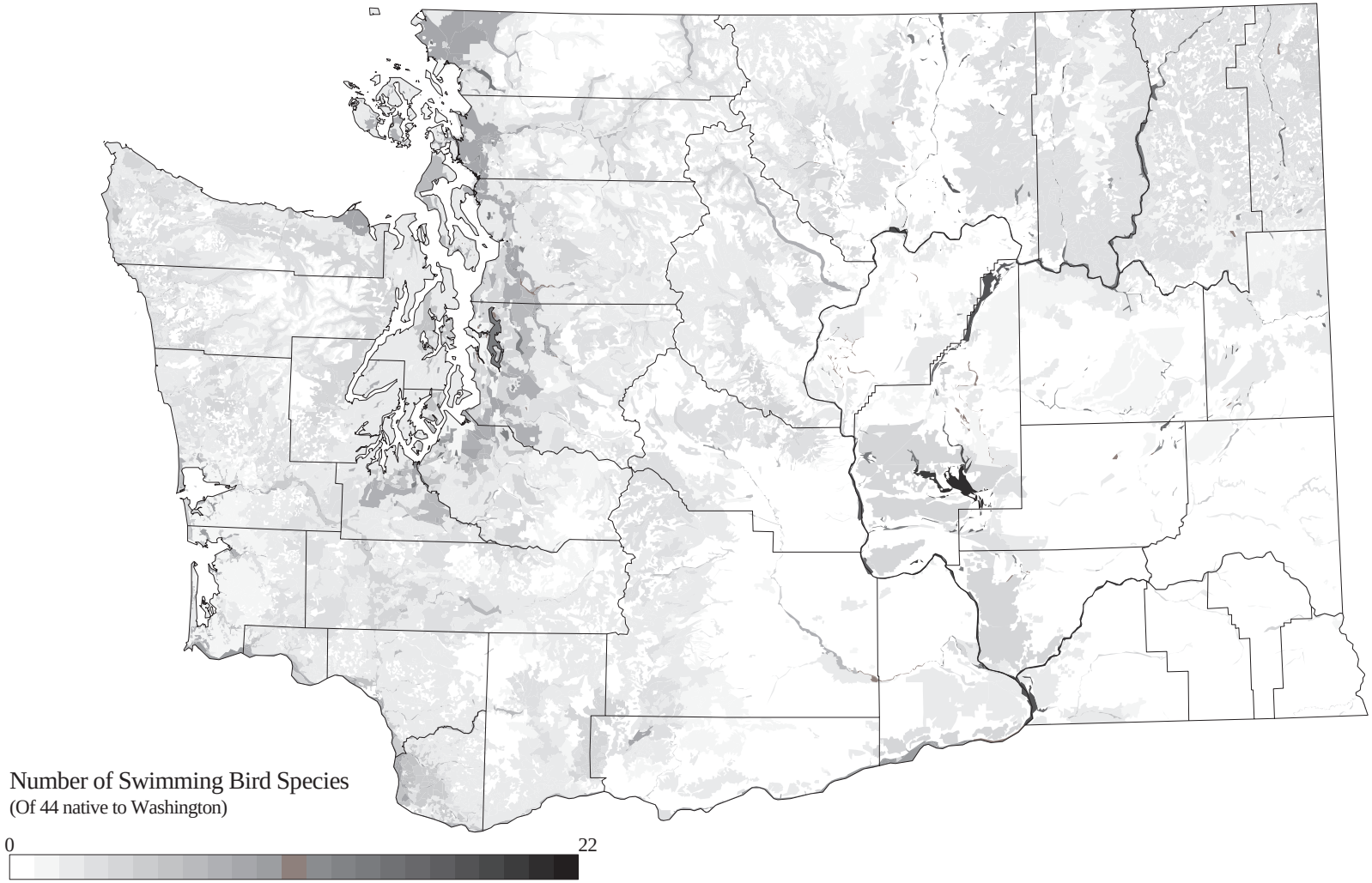
Map 29. Richness of native nonpasserine species. (Derived from good and contingently suitable habitats in core zones, using primary cover only.)



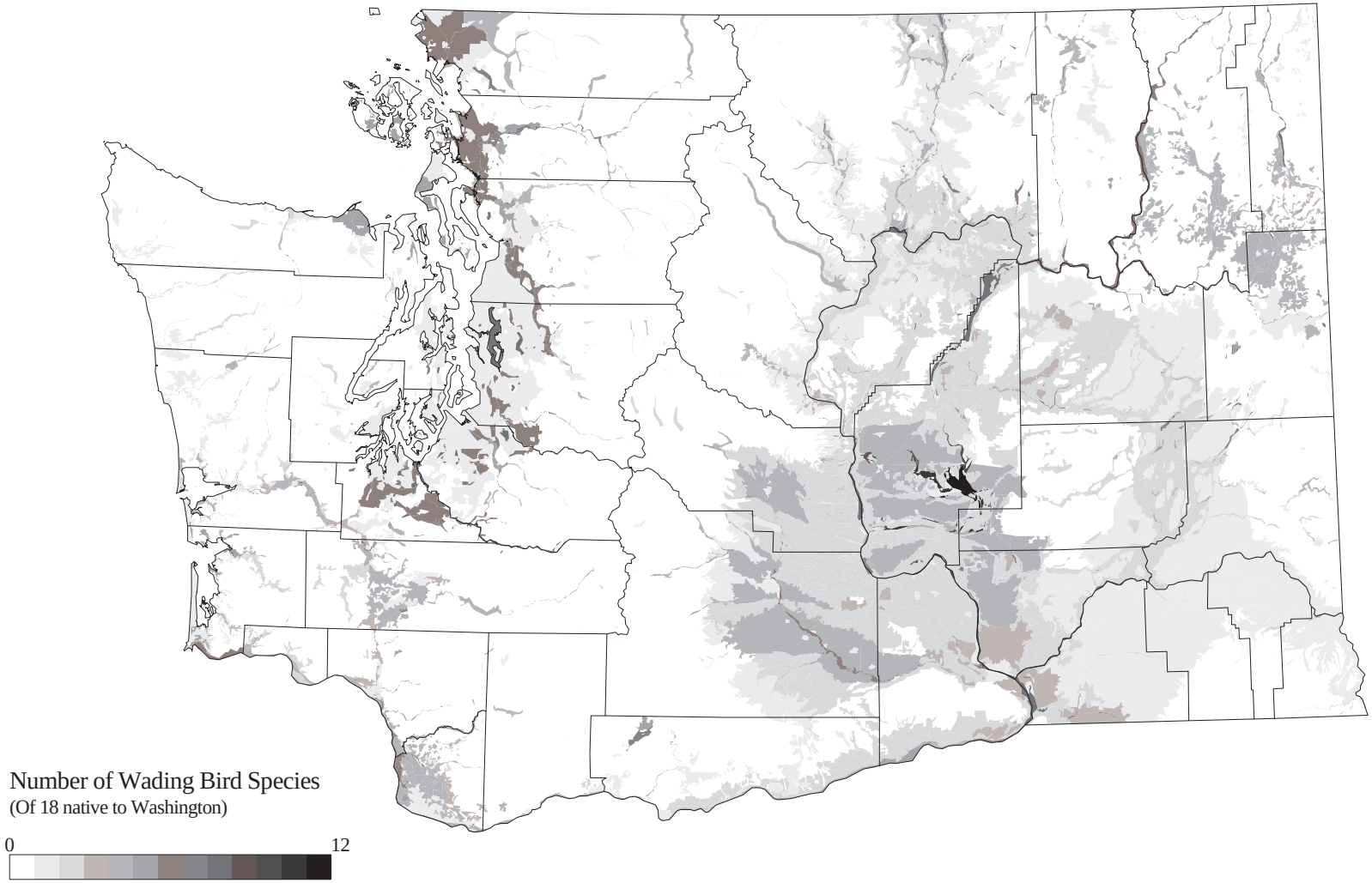
Map 30. Richness of native passerine species. (Derived from good and contingently suitable habitats in core zones, using primary cover only.)



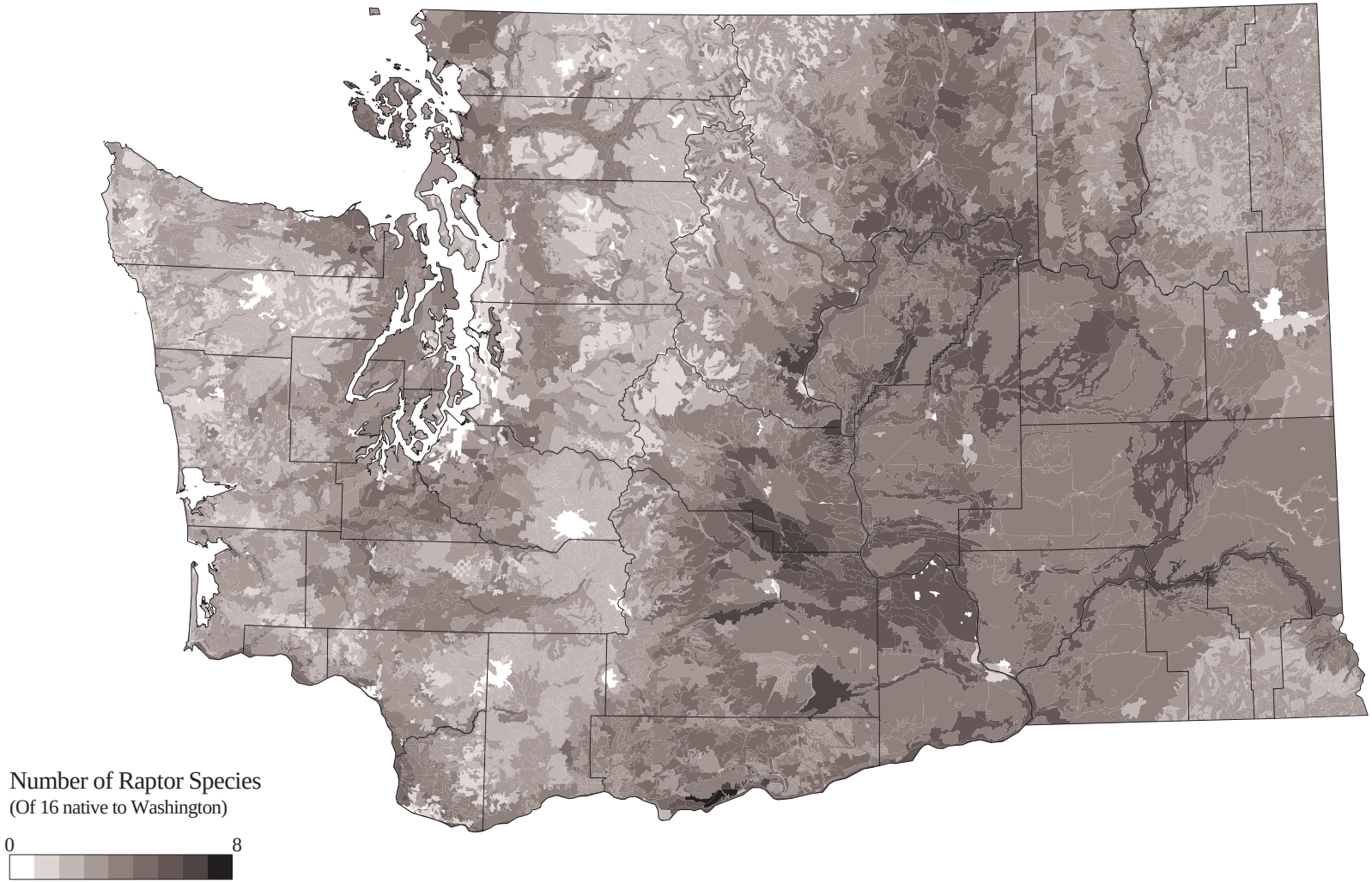
Map 31. Richness of swimming bird species: loons, grebes, petrels, cormorants, geese, ducks, coots, gulls, terns, murres, auks, and puffins. (Derived from good and contingently suitable habitats in core zones, using primary cover only.)



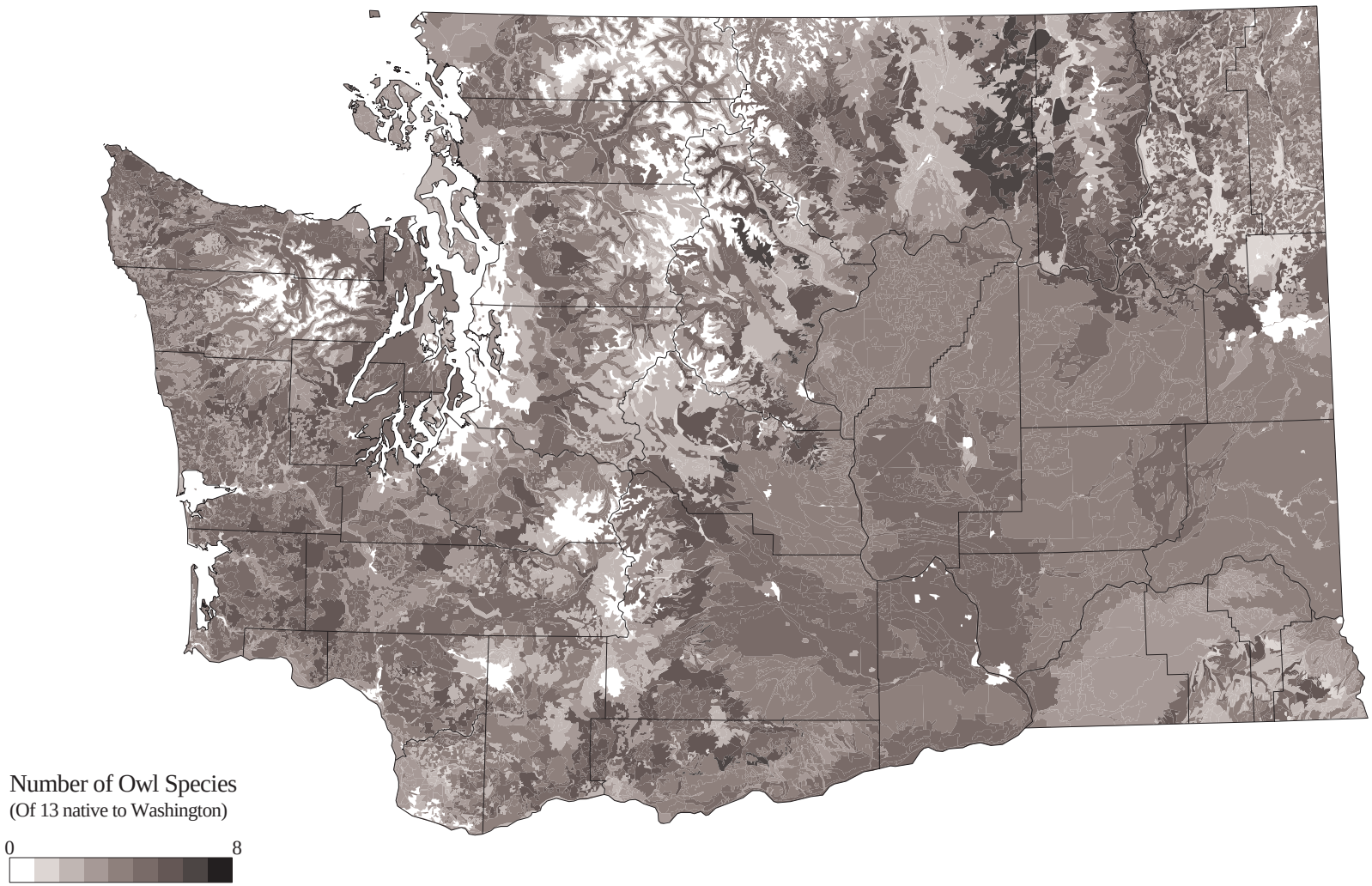
Map 32. Richness of wading bird species: bitterns, herons, egrets, cranes, rails, soras, plovers, sandpipers, avocets, stilts, oystercatchers. (Derived from good and contingently suitable habitats in core zones, using primary cover only.)



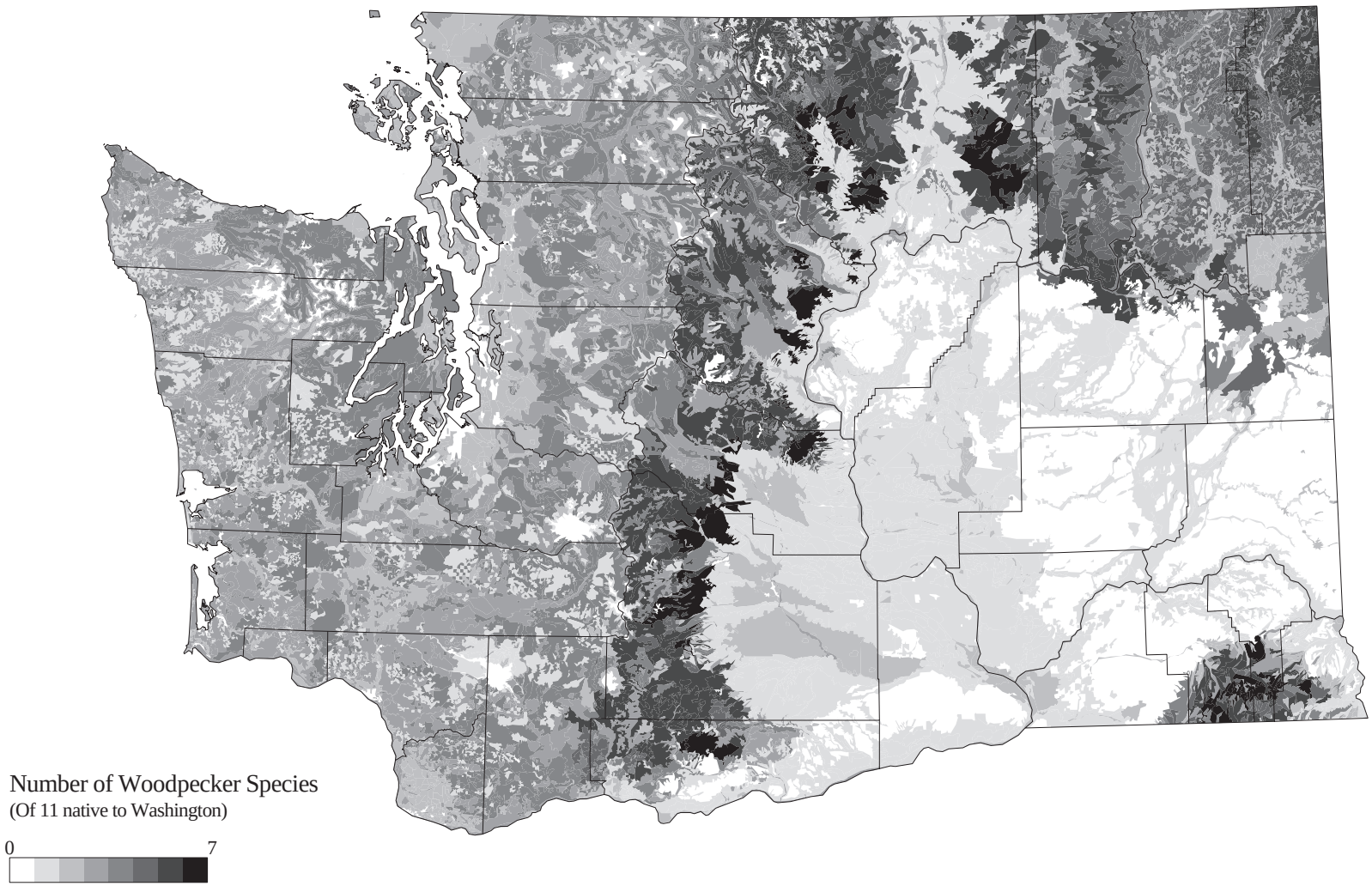
Map 33. Richness of diurnal raptors: Turkey Vulture, hawks, White-tailed Kite, eagles, and falcons. (Derived from good and contingently suitable habitats in core zones, using primary cover only.)



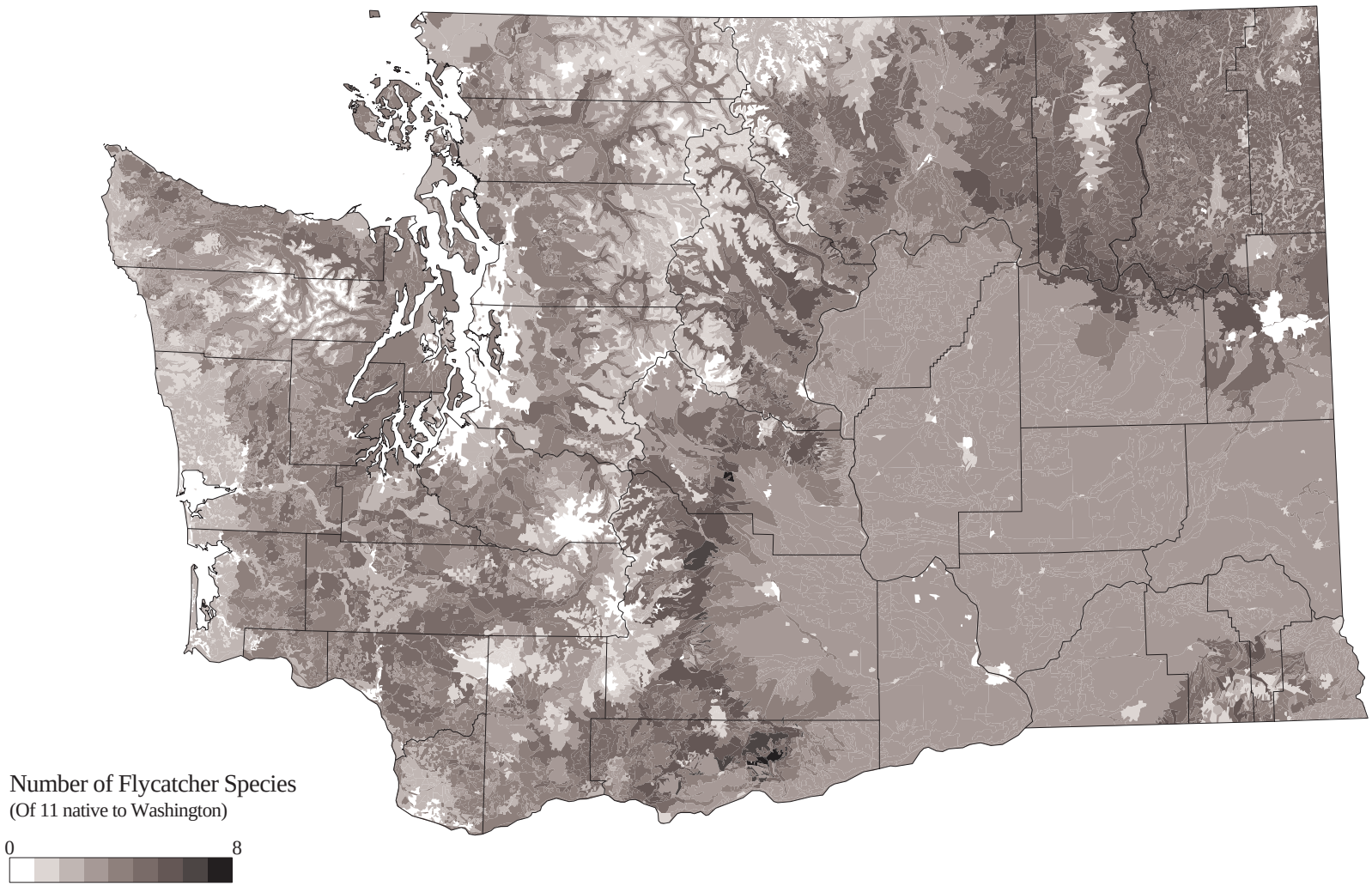
Map 34. Richness of owl species. (Derived from good and contingently suitable habitats in core zones, using primary cover only.)



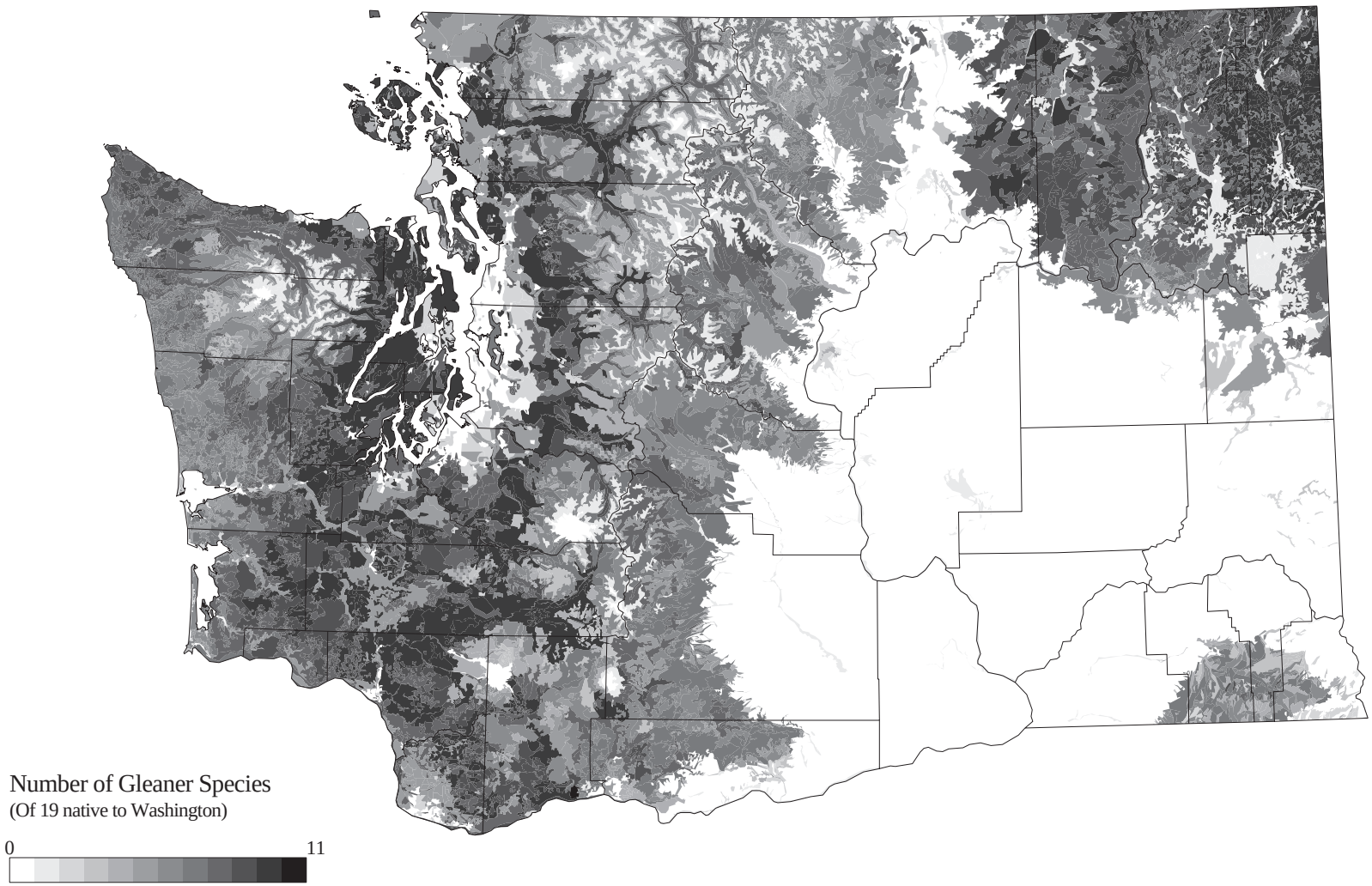
Map 35. Richness of woodpecker species. (Derived from good and contingently suitable habitats in core zones, using primary cover only.)



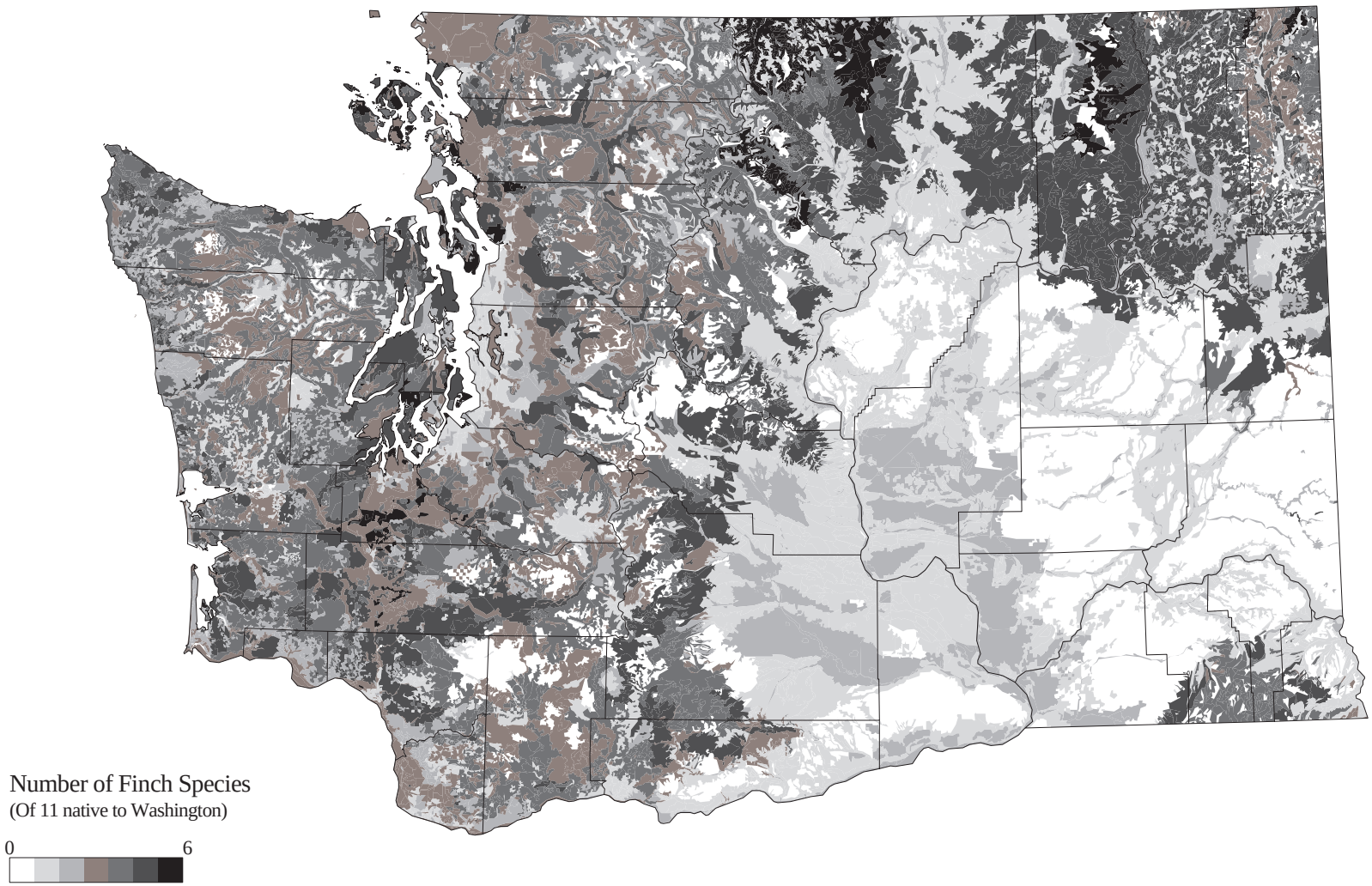
Map 36. Richness of flycatcher species. (Derived from good and contingently suitable habitats in core zones, using primary cover only.)



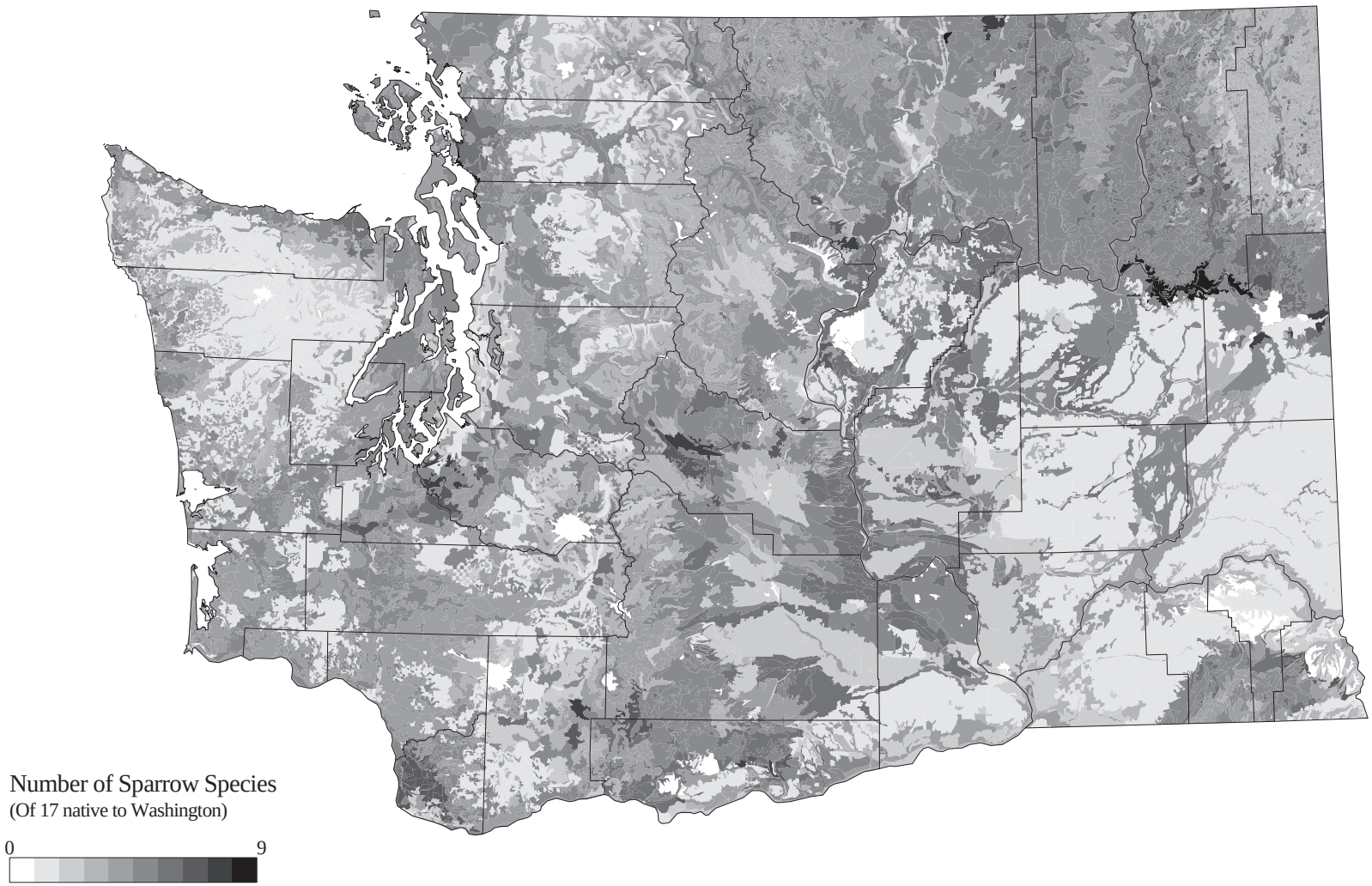
Map 37. Richness of gleaner (vireo, kinglet, and warbler) species. (Derived from good and contingently suitable habitats in core zones, using primary cover only.)



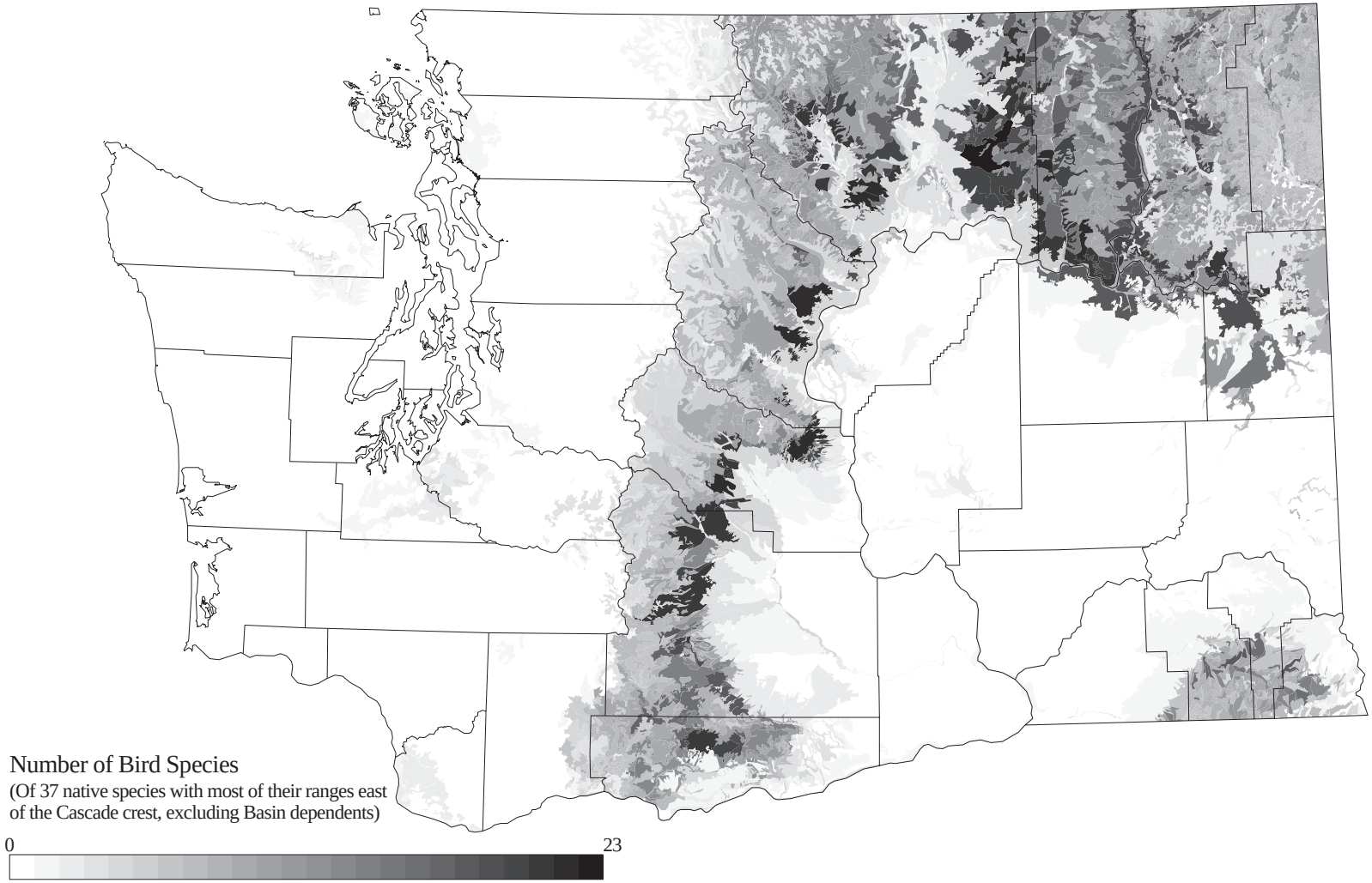
Map 38. Richness of finch species. (Derived from good and contingently suitable habitats in core zones, using primary cover only.)



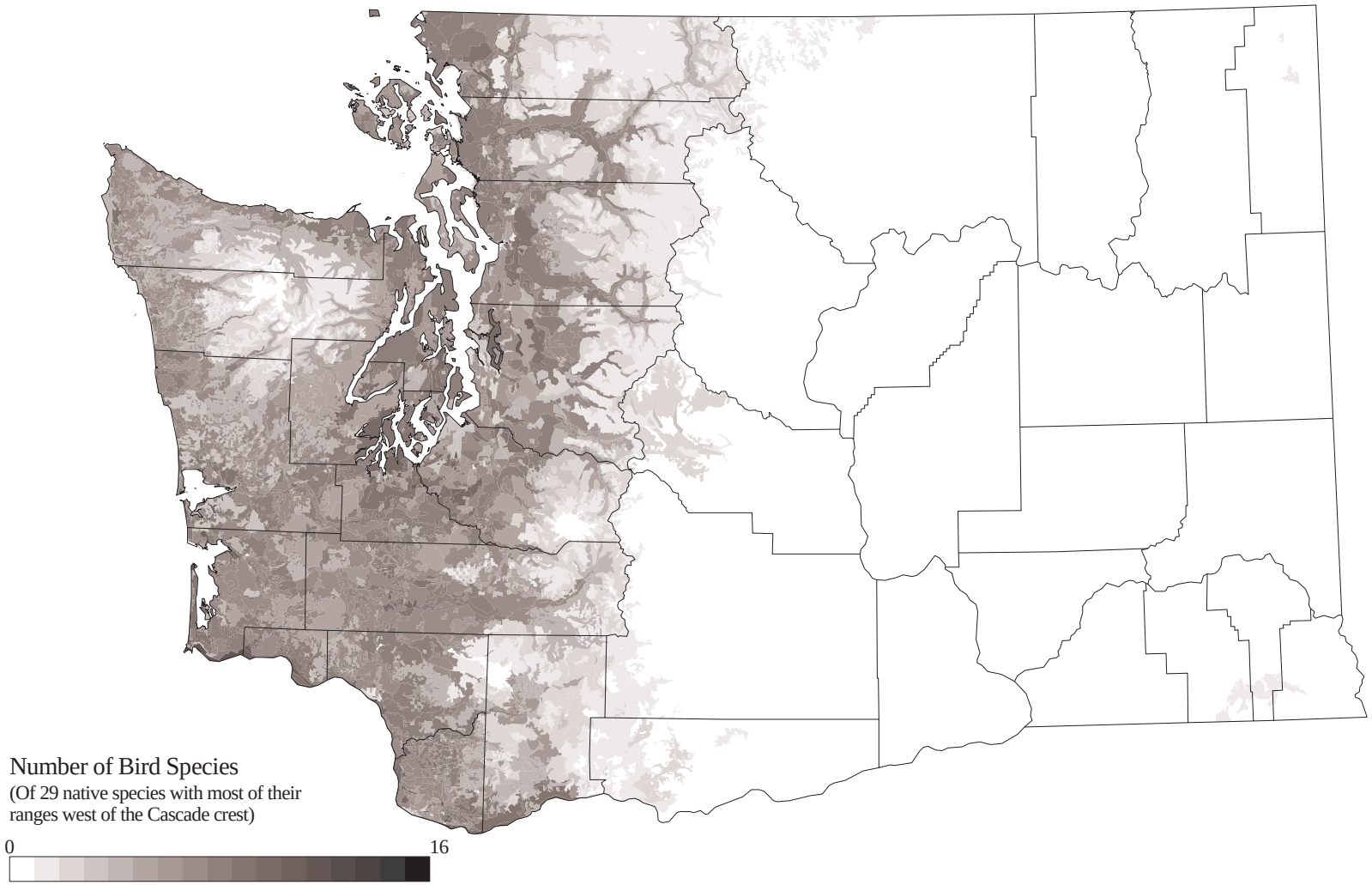
Map 39. Richness of sparrow species. (Derived from good and contingently suitable habitats in core zones, using primary cover only.)



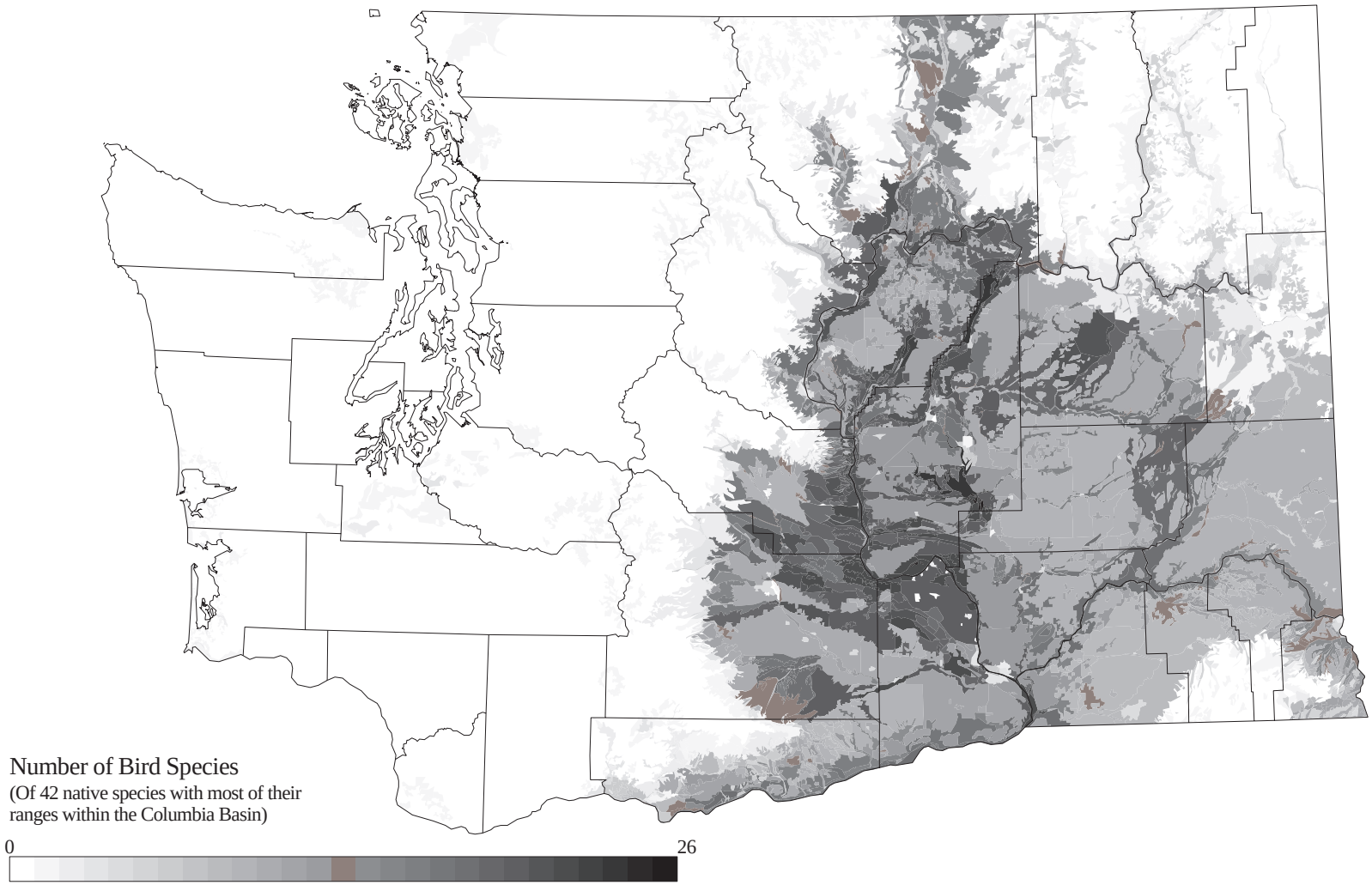
Map 40. Richness of bird species with most of their ranges east of the Cascade crest, excluding Columbia Basin dependents. (Derived from good and contingently suitable habitats in core zones, using primary cover only.)



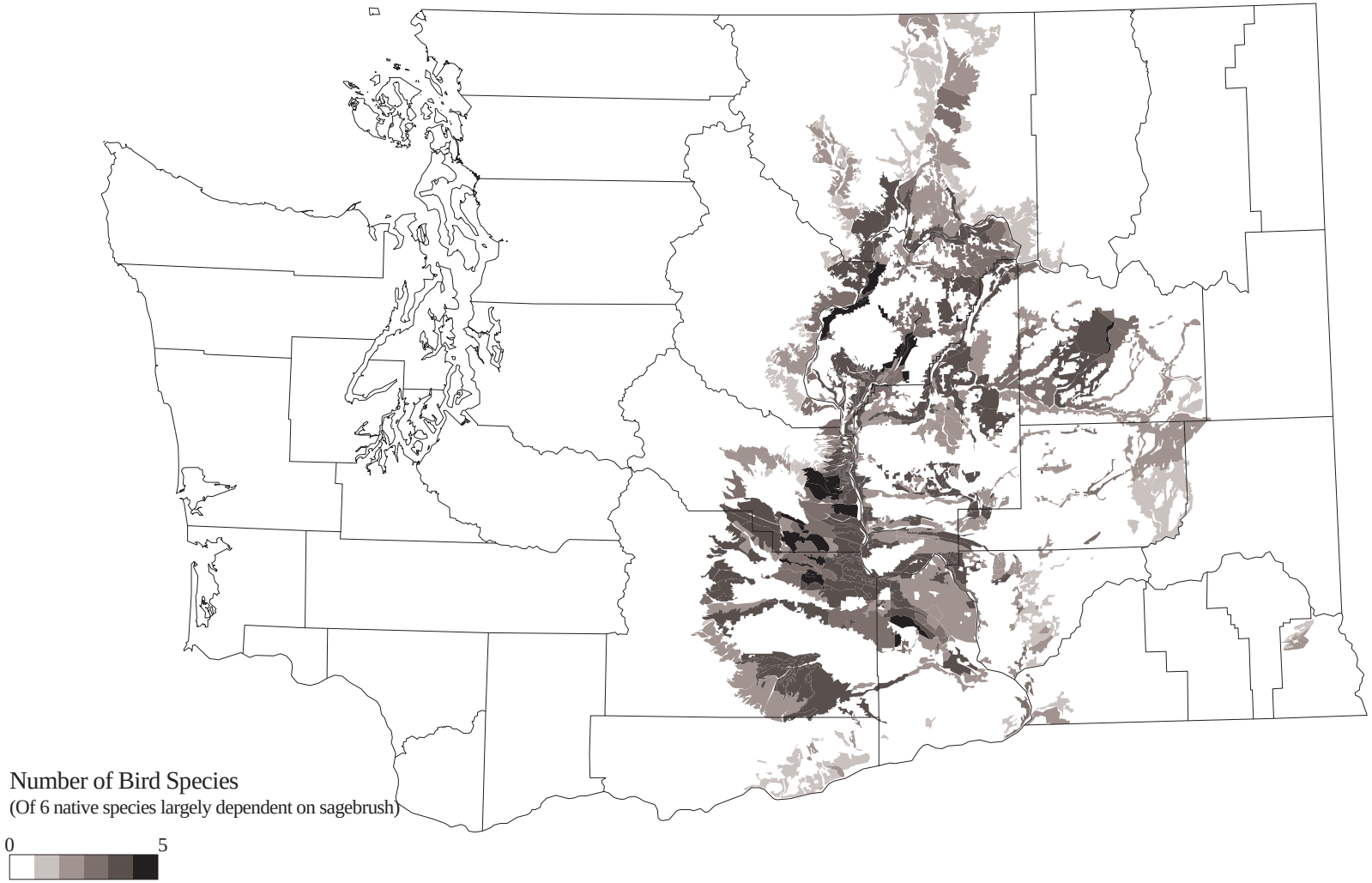
Map 41. Richness of bird species with most of their ranges west of the Cascade crest. (Derived from good and contingently suitable habitats in core zones, using primary cover only.)



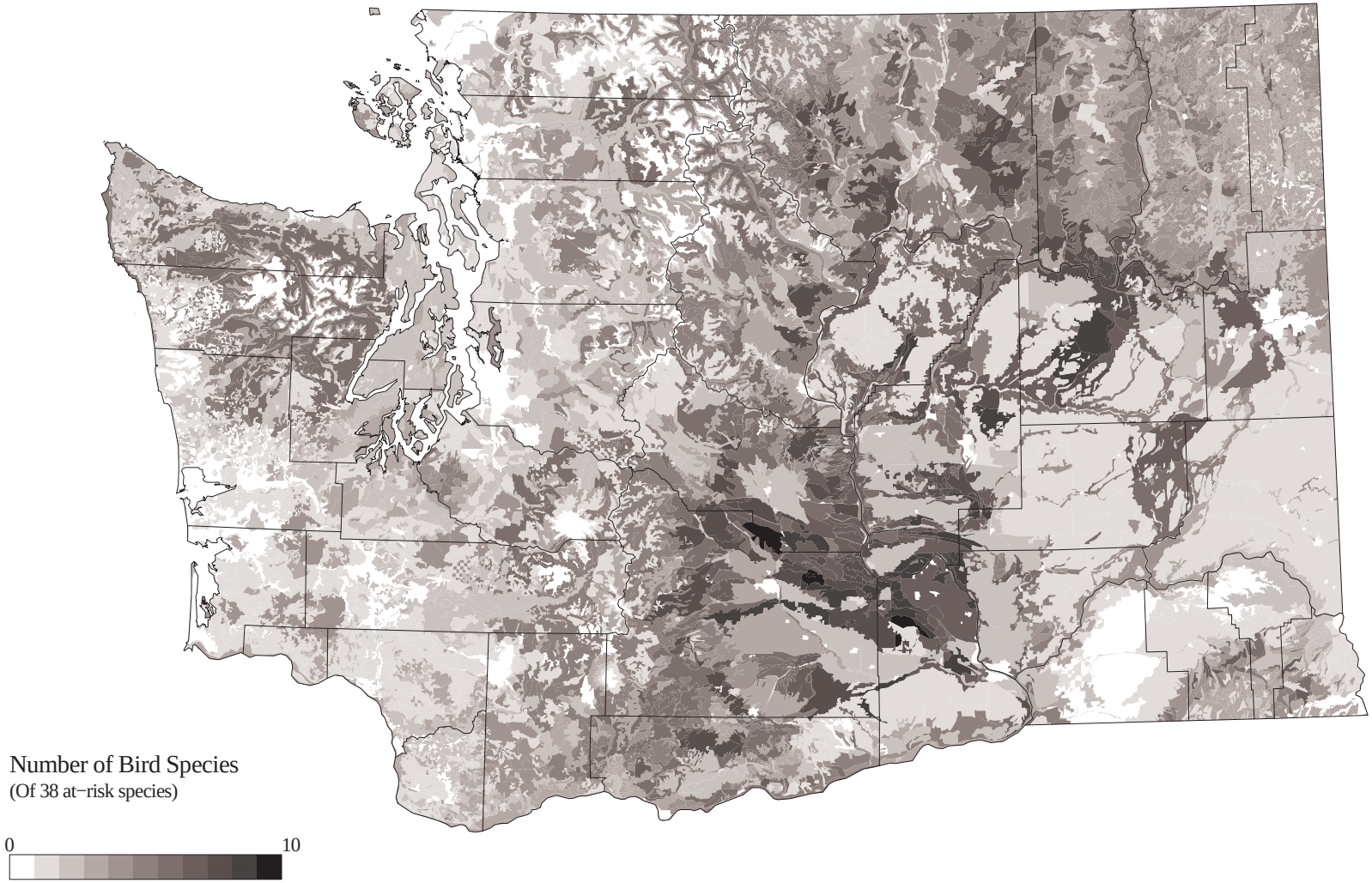
Map 42. Richness of bird species with most of their ranges within the Columbia Basin. (Derived from good and contingently suitable habitats in core zones, using primary cover only.)



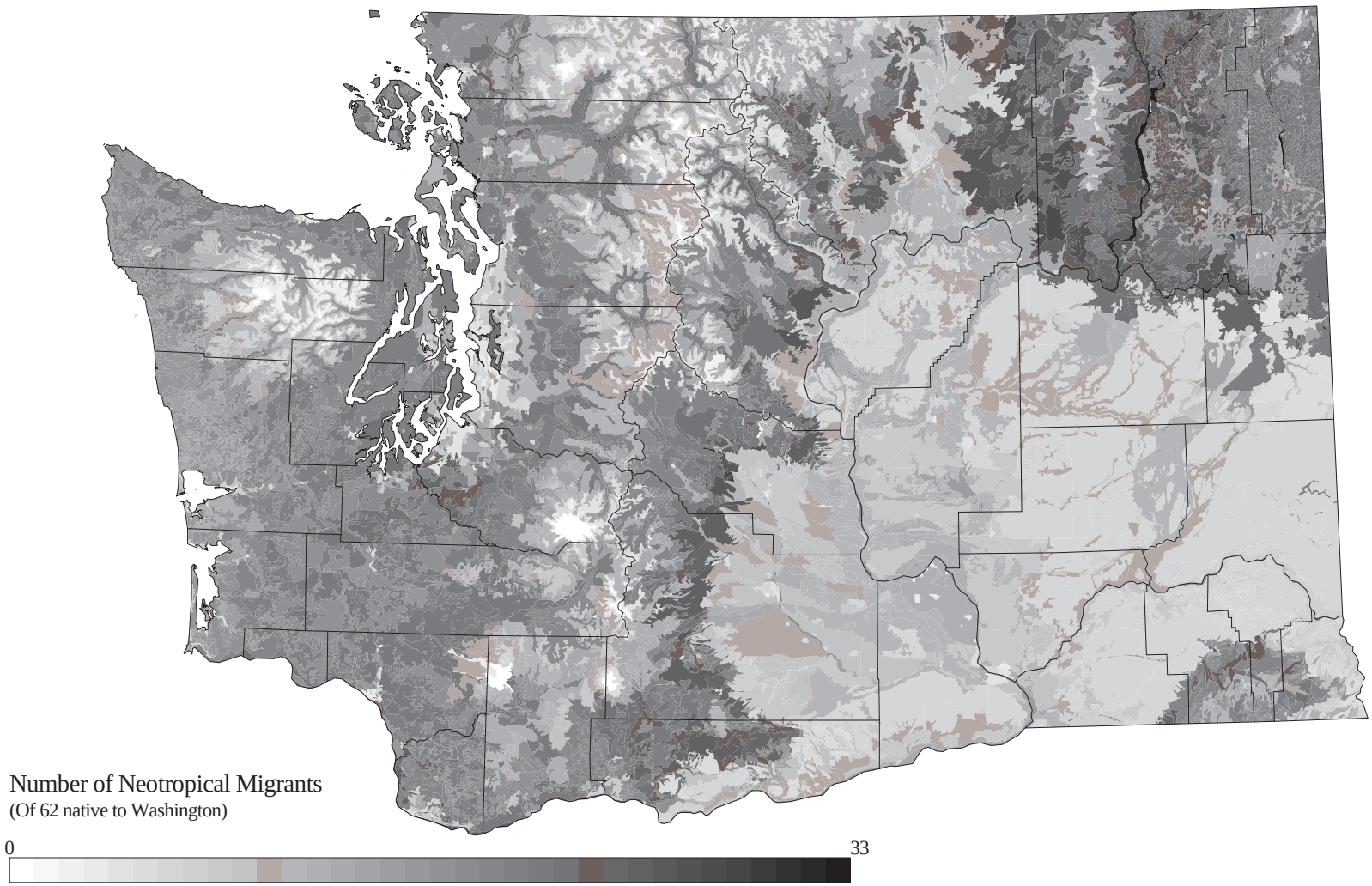
Map 43. Richness of bird species largely dependent on the presence of sagebrush: Sage Grouse, Loggerhead Shrike, Sage Thrasher, Black−throated Sparrow, Sage Sparrow, and Brewer‘s Sparrow. (Derived from good and contingently suitable habitats in core zones, using primary cover only.)



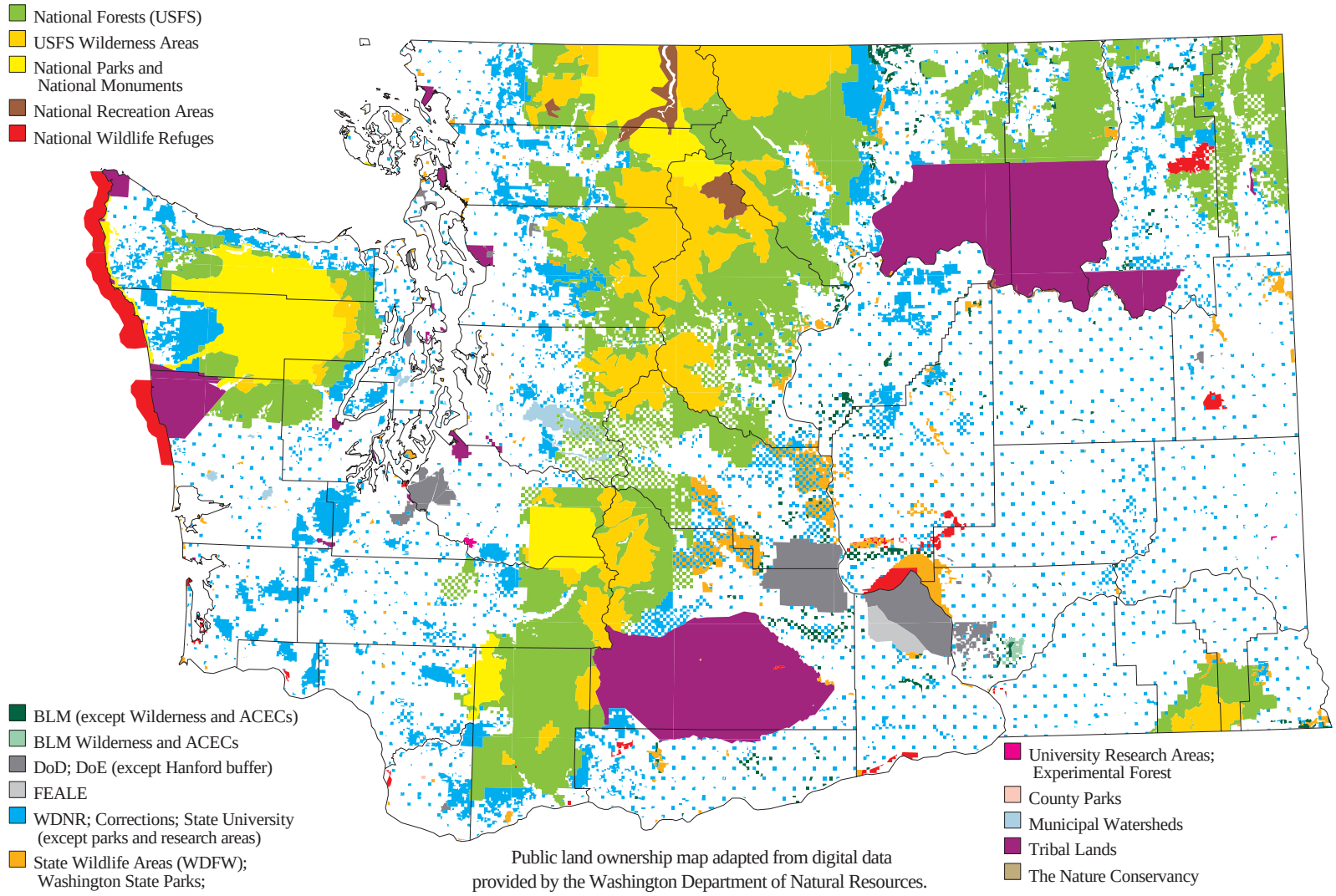
Map 44. Richness of native birds most at risk due to human activities. (Derived from good and contingently suitable habitats in core zones, using primary cover only.)



Map 45. Richness of native neotropical migrants. (Derived from good and contingently suitable habitats in core zones, using primary cover only.)

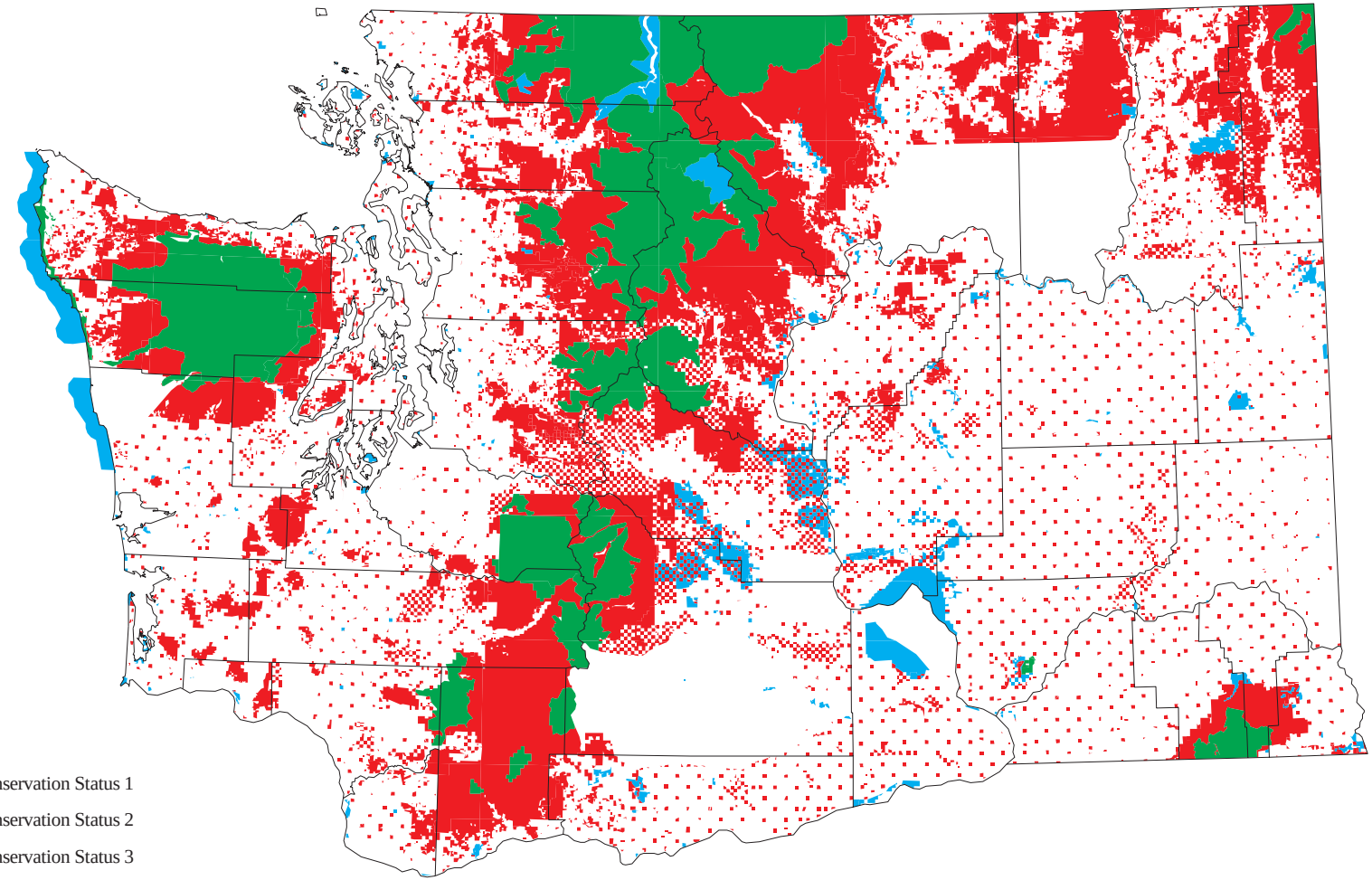


Map 46. Major public land ownership

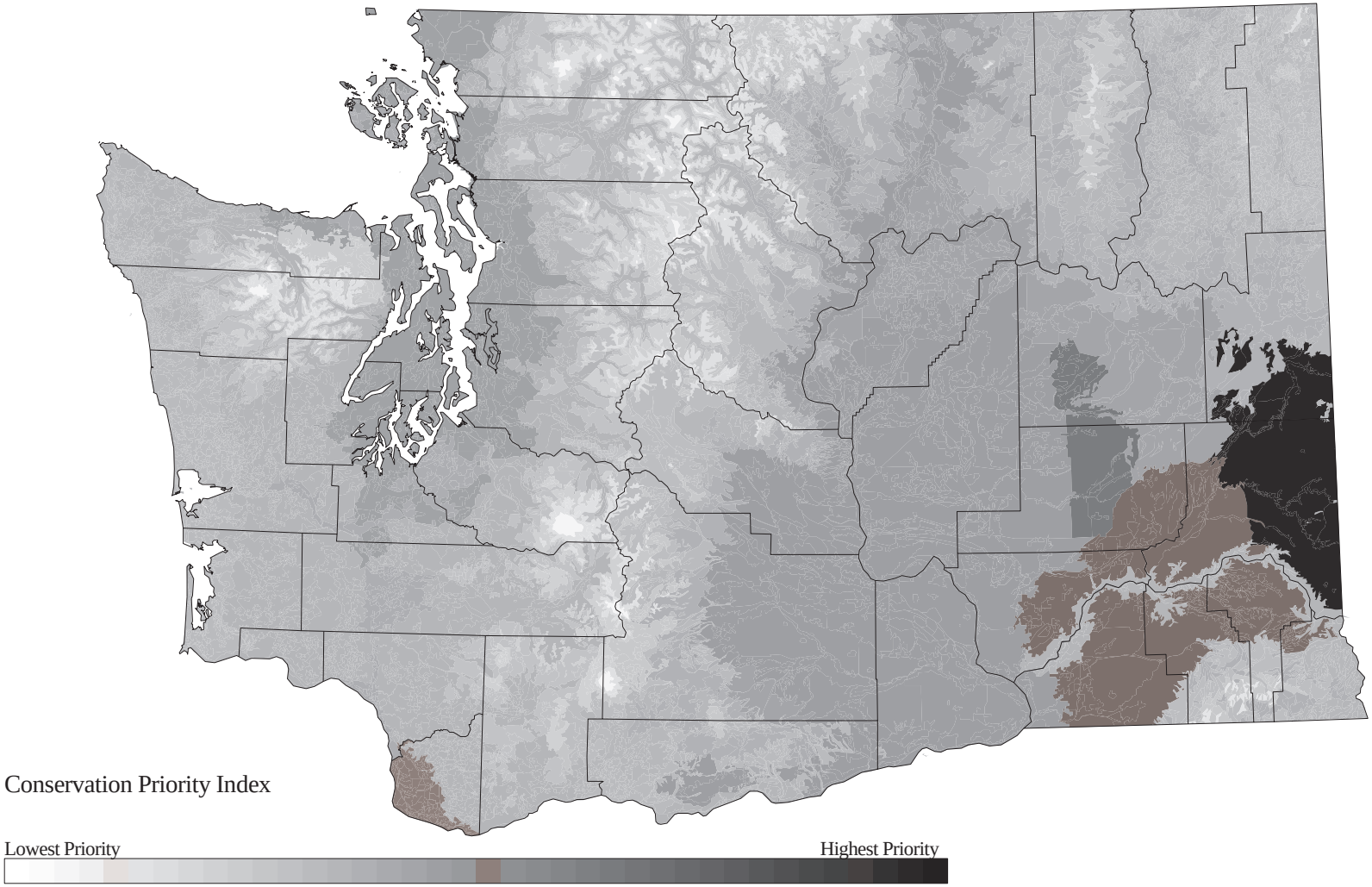


Public land ownership map adapted from digital data provided by the Washington Department of Natural Resources.

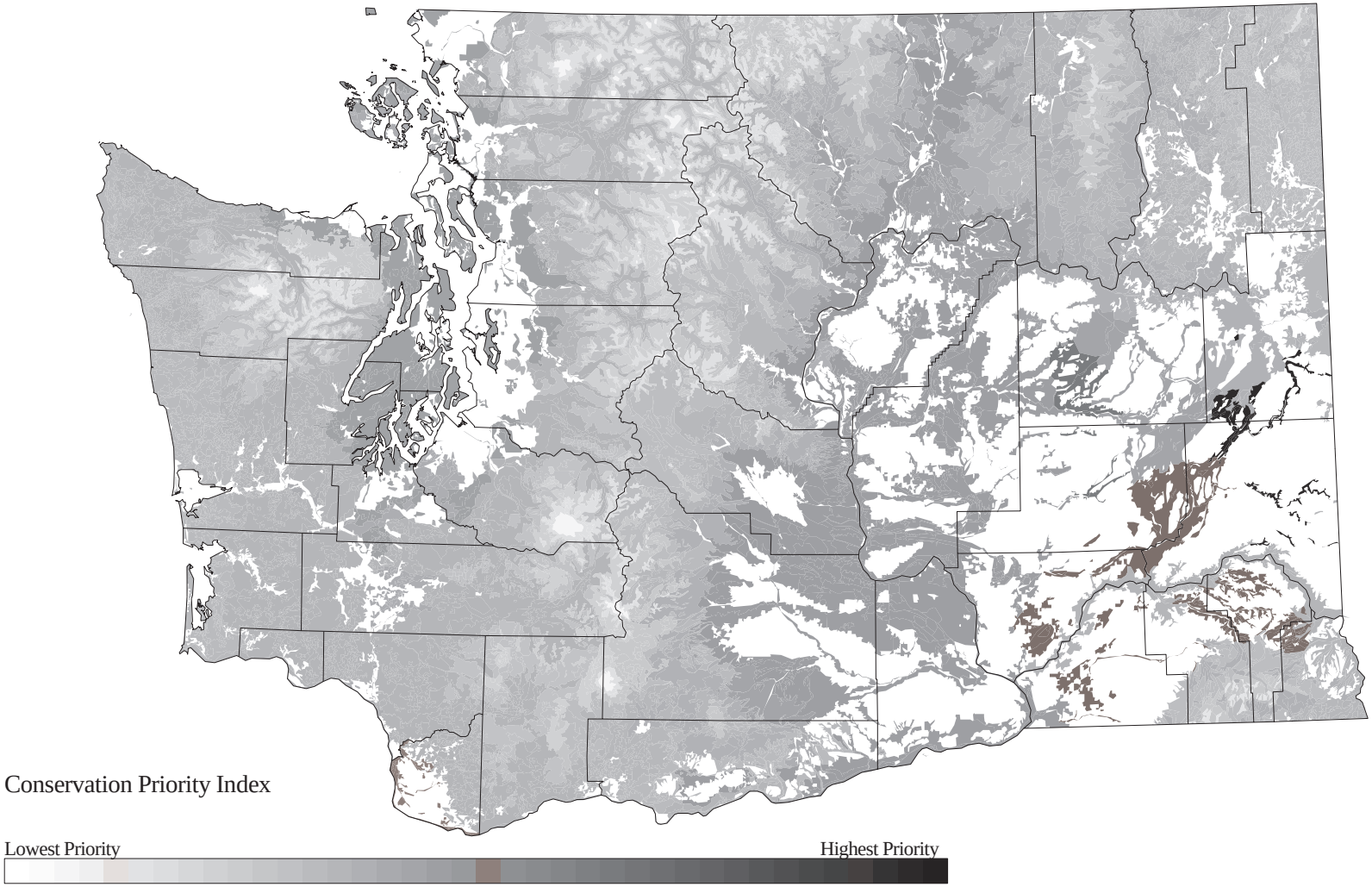
Map 47. Conservation Status categories



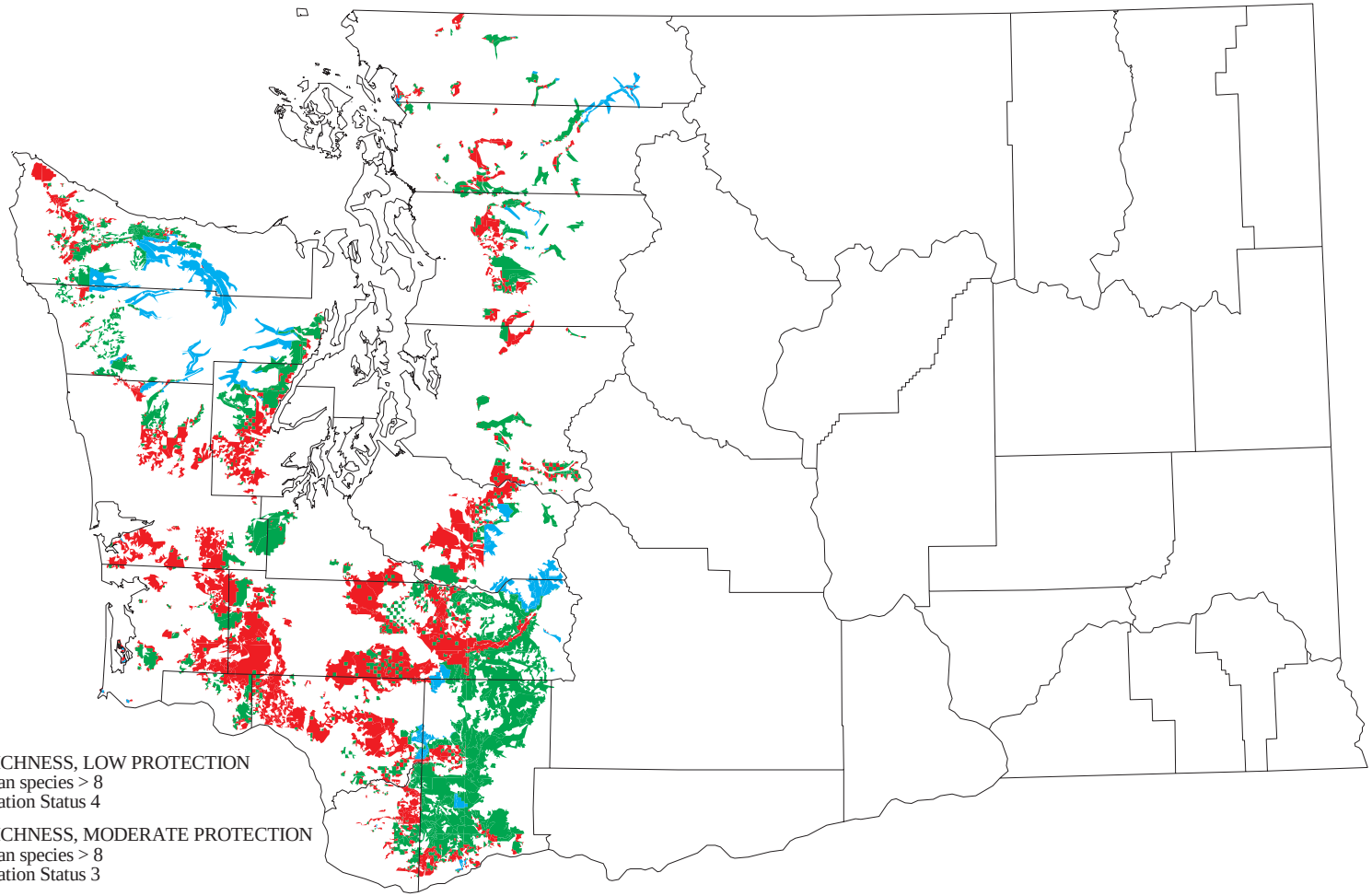
Map 48. Vegetation zones ranked by Conservation Priority Index



Map 49. Vegetation zones ranked by Conservation Priority Index, but excluding land cover polygons in which the primary cover is development or agriculture. Note that zones of high CPI have large percentages of their area converted to development or agriculture.



Map 50. Conservation Status of areas of highest native amphibian species richness. (Amphibian richness derived from good and contingently suitable habitats in core zones, using primary cover only.)

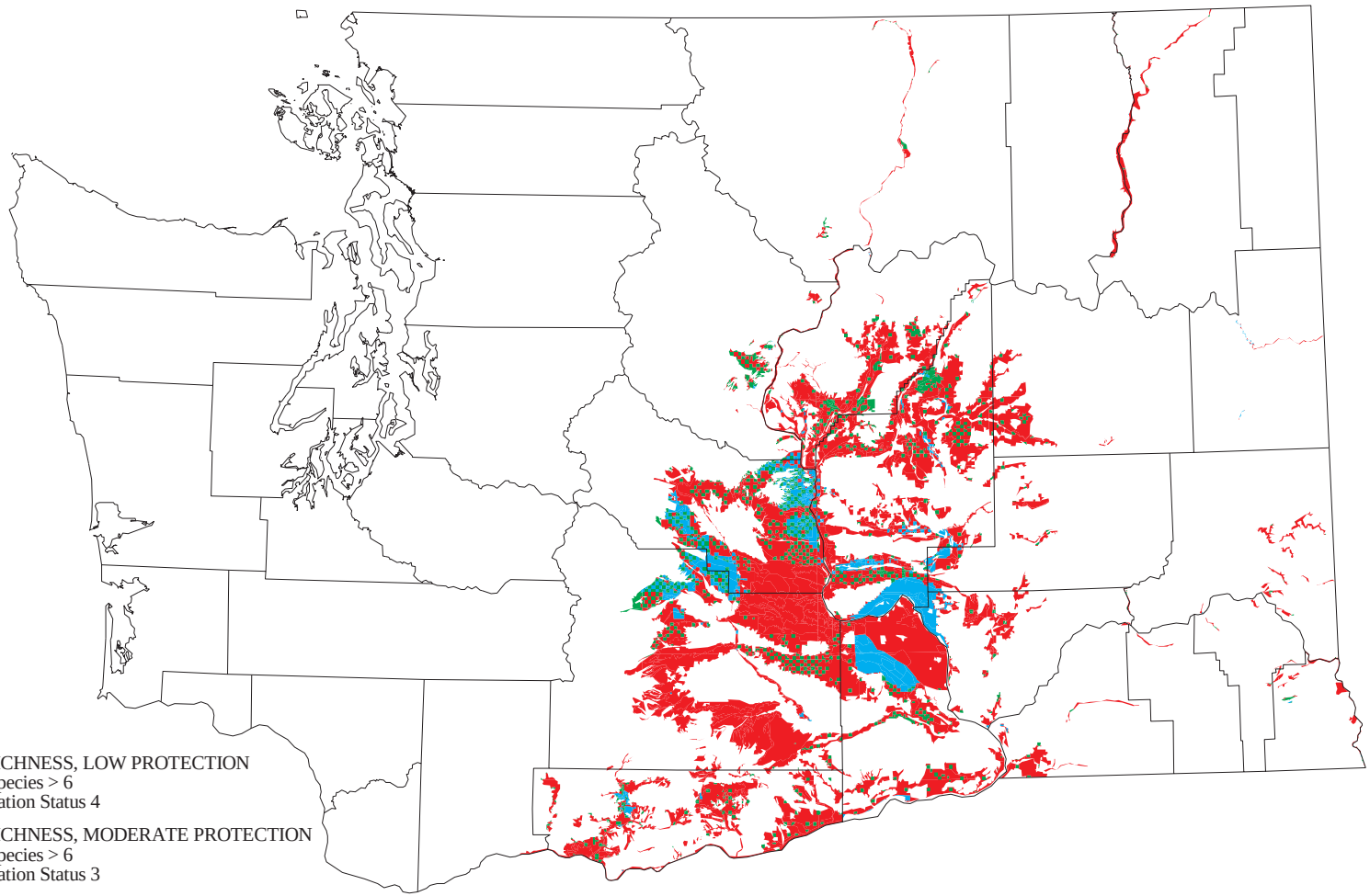


HIGH RICHNESS, LOW PROTECTION
Amphibian species > 8
Conservation Status 4

HIGH RICHNESS, MODERATE PROTECTION
Amphibian species > 8
Conservation Status 3

HIGH RICHNESS, HIGH PROTECTION
Amphibian species > 8
Conservation Status 1 or 2

Map 51. Conservation Status of areas of highest native reptile species richness. (Reptile richness derived from good and contingently suitable habitats in core zones, using primary cover only.)

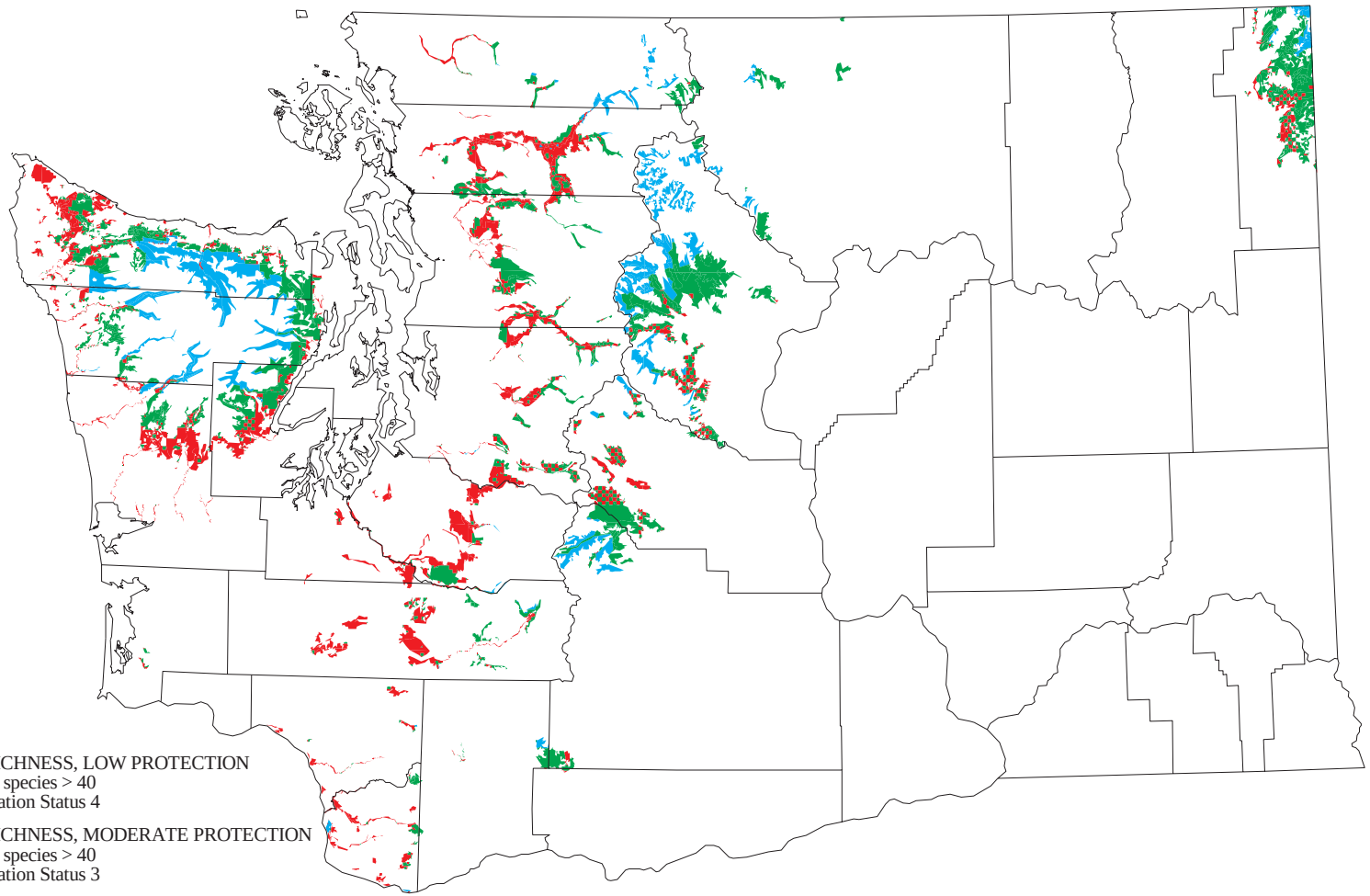


HIGH RICHNESS, LOW PROTECTION
Reptile species > 6
Conservation Status 4

HIGH RICHNESS, MODERATE PROTECTION
Reptile species > 6
Conservation Status 3

HIGH RICHNESS, HIGH PROTECTION
Reptile species > 6
Conservation Status 1 or 2

Map 52. Conservation Status of areas of highest native mammal species richness. (Mammal richness derived from good and contingently suitable habitats in core zones, using primary cover only.)

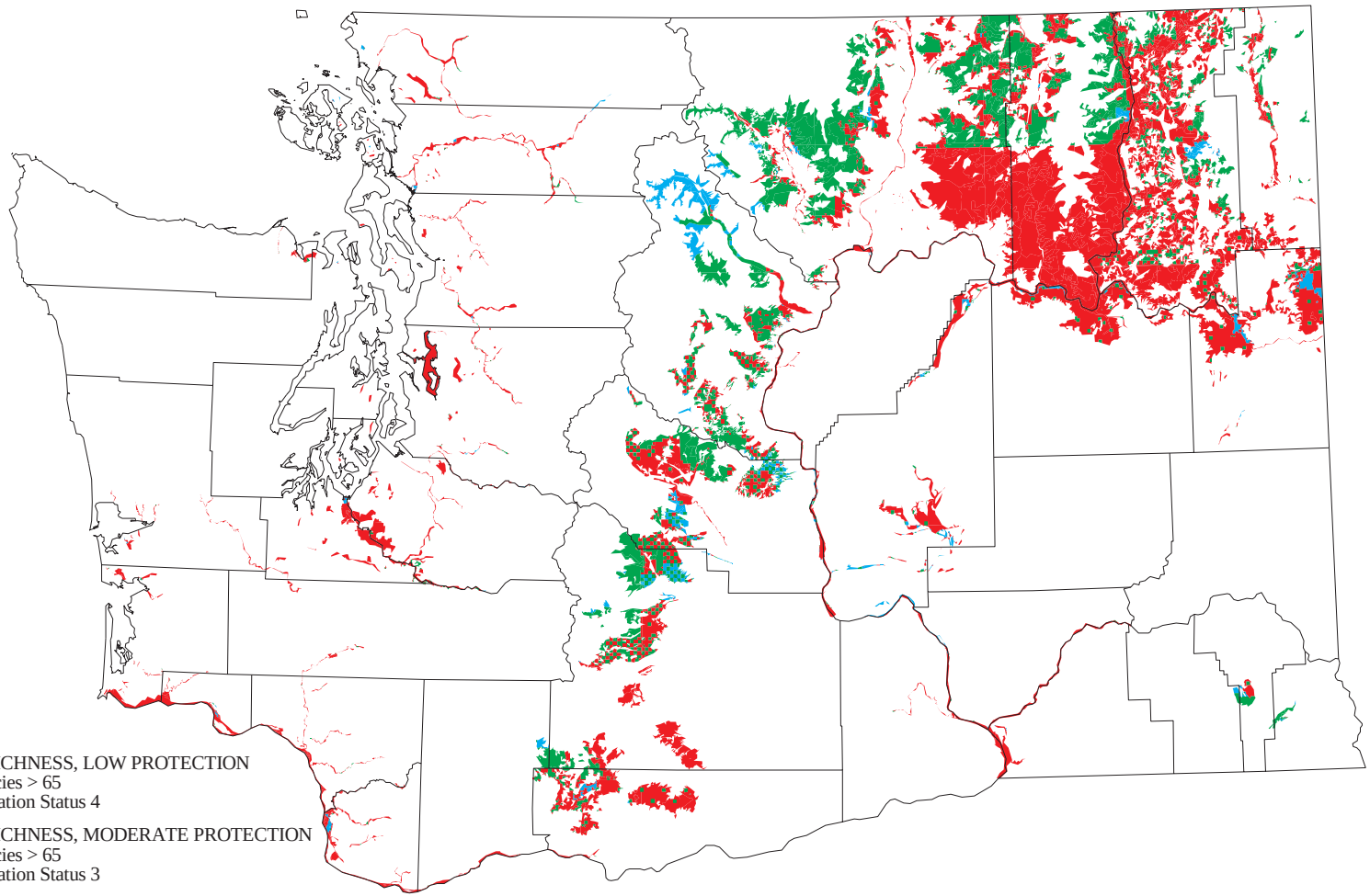


HIGH RICHNESS, LOW PROTECTION
Mammal species > 40
Conservation Status 4

HIGH RICHNESS, MODERATE PROTECTION
Mammal species > 40
Conservation Status 3

HIGH RICHNESS, HIGH PROTECTION
Mammal species > 40
Conservation Status 1 or 2

Map 53. Conservation Status of areas of highest native bird species richness. (Bird richness derived from good and contingently suitable habitats in core zones, using primary cover only.)

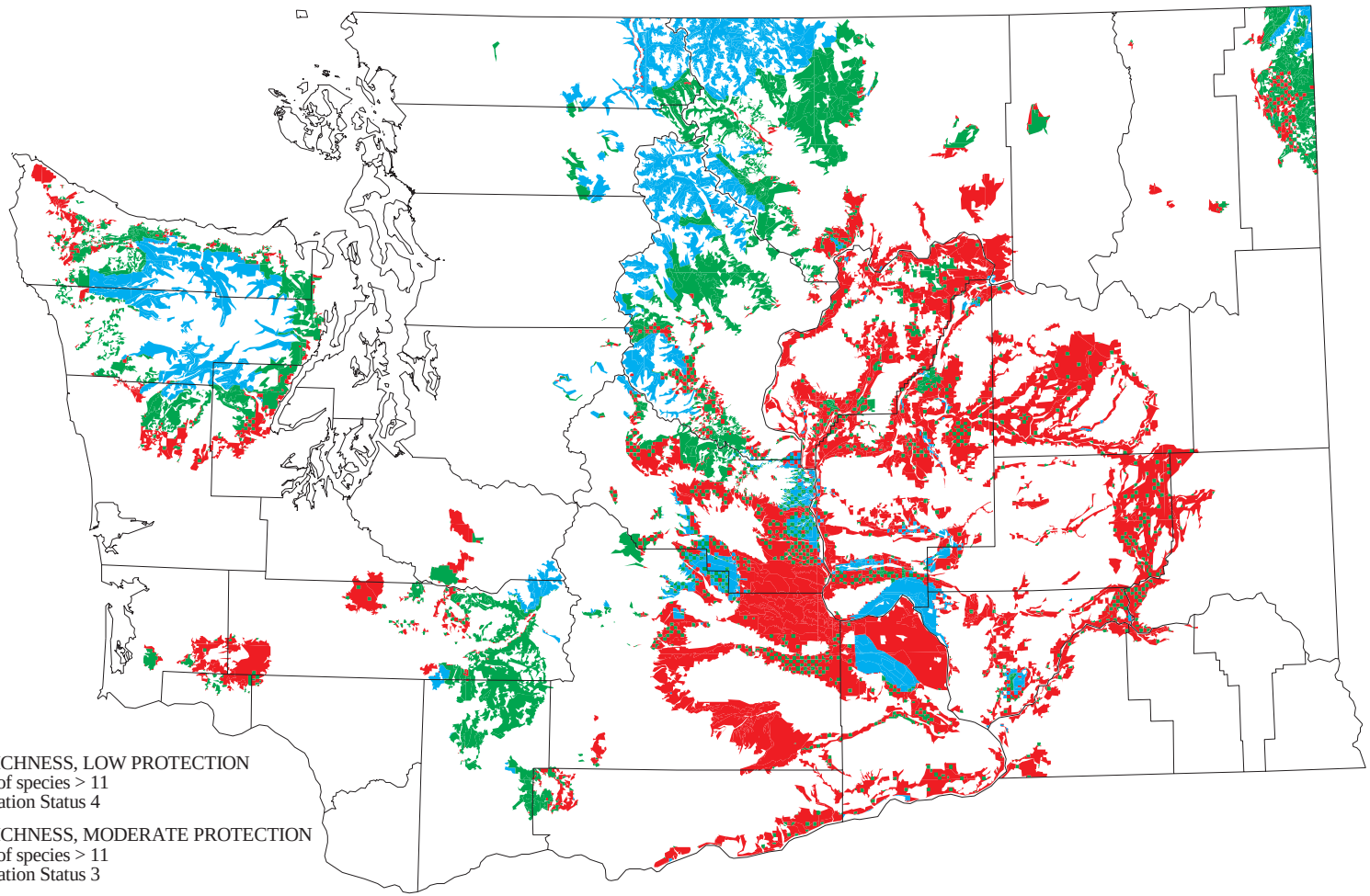


HIGH RICHNESS, LOW PROTECTION
Bird species > 65
Conservation Status 4

HIGH RICHNESS, MODERATE PROTECTION
Bird species > 65
Conservation Status 3

HIGH RICHNESS, HIGH PROTECTION
Bird species > 65
Conservation Status 1 or 2

Map 54. Conservation Status of areas with highest richness of at−risk species. (Species richness derived from good and contingently suitable habitats in core zones, using primary cover only.)

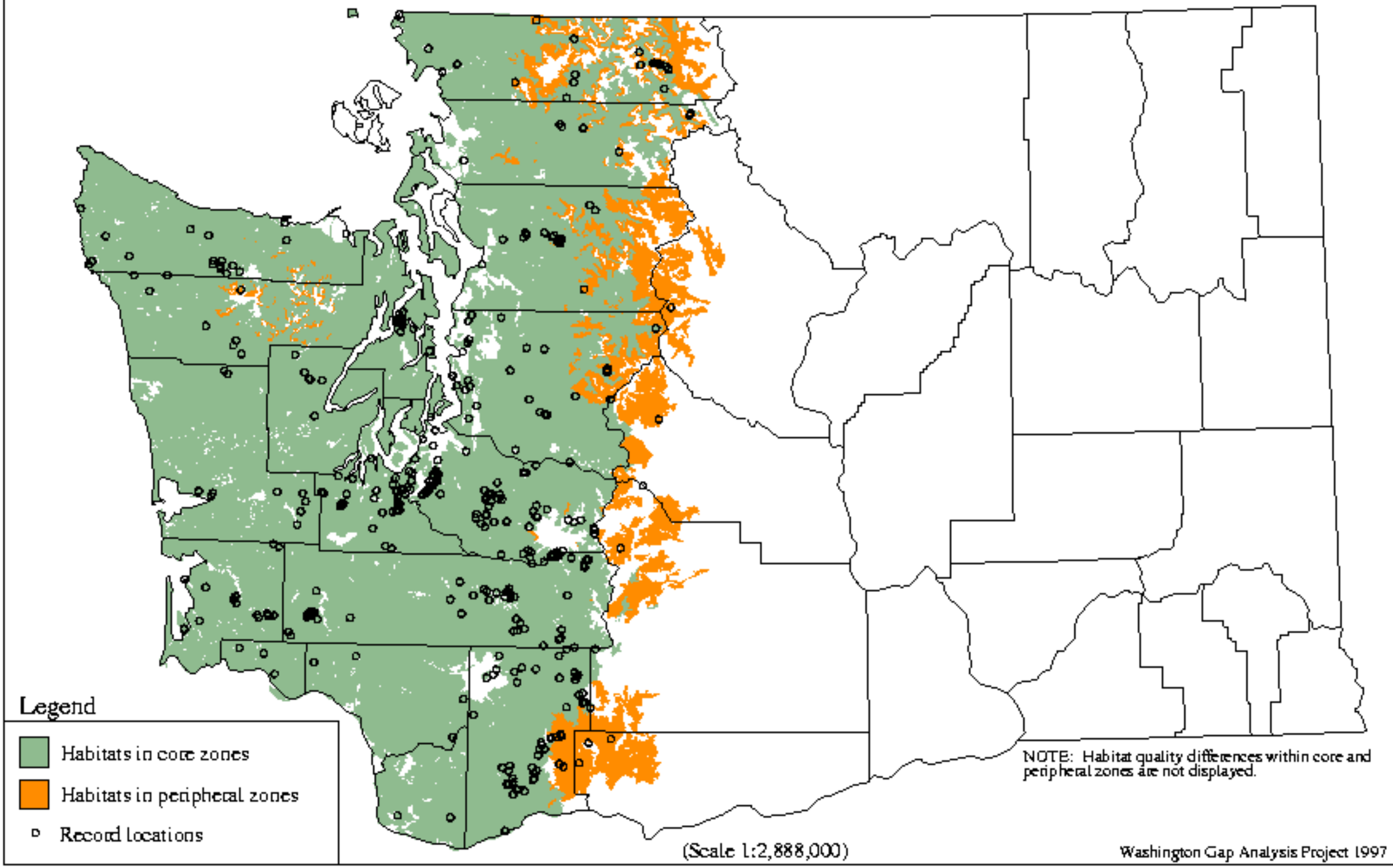


HIGH RICHNESS, LOW PROTECTION
Number of species > 11
Conservation Status 4

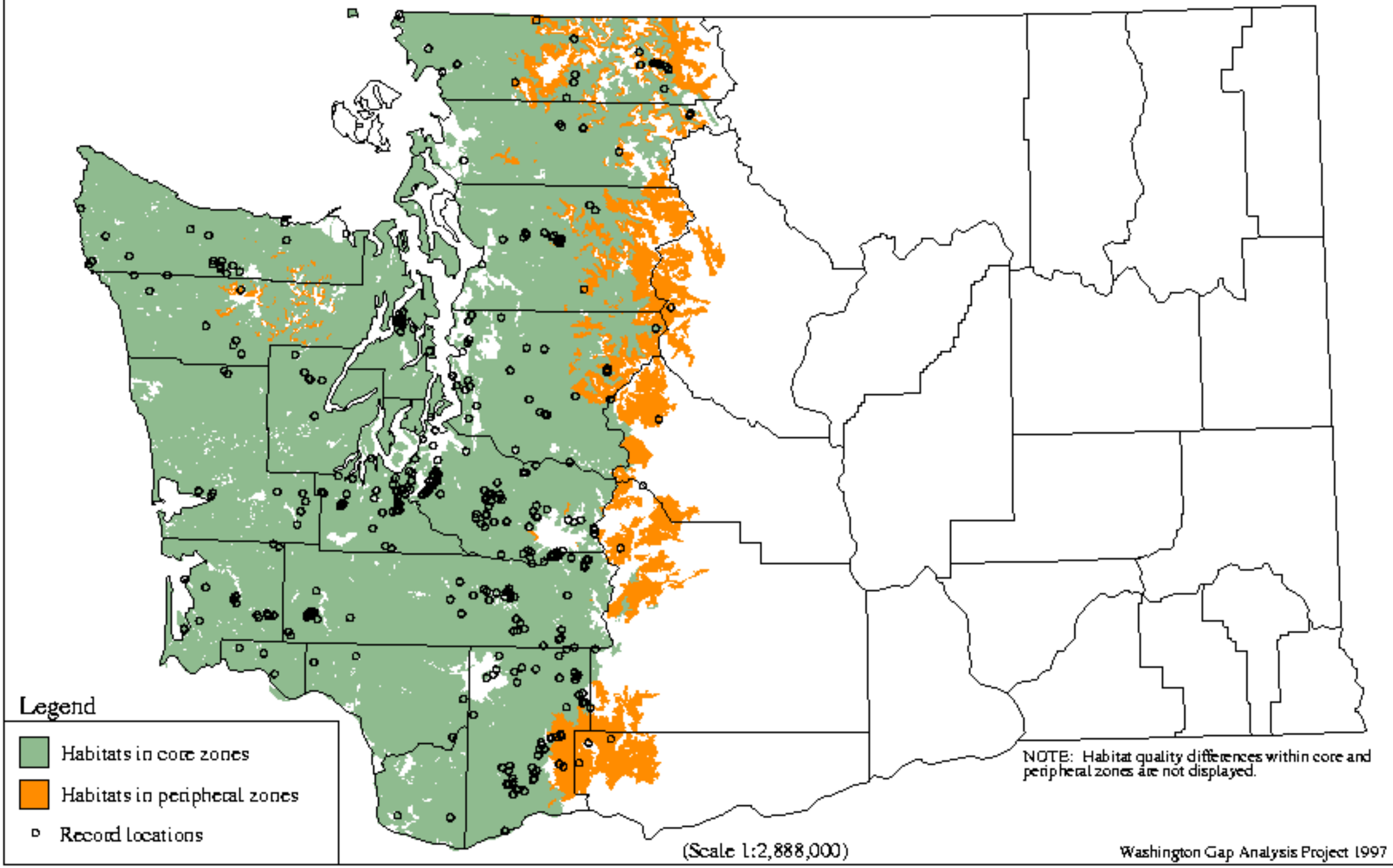
HIGH RICHNESS, MODERATE PROTECTION
Number of species > 11
Conservation Status 3

HIGH RICHNESS, HIGH PROTECTION
Number of species > 11
Conservation Status 1 or 2

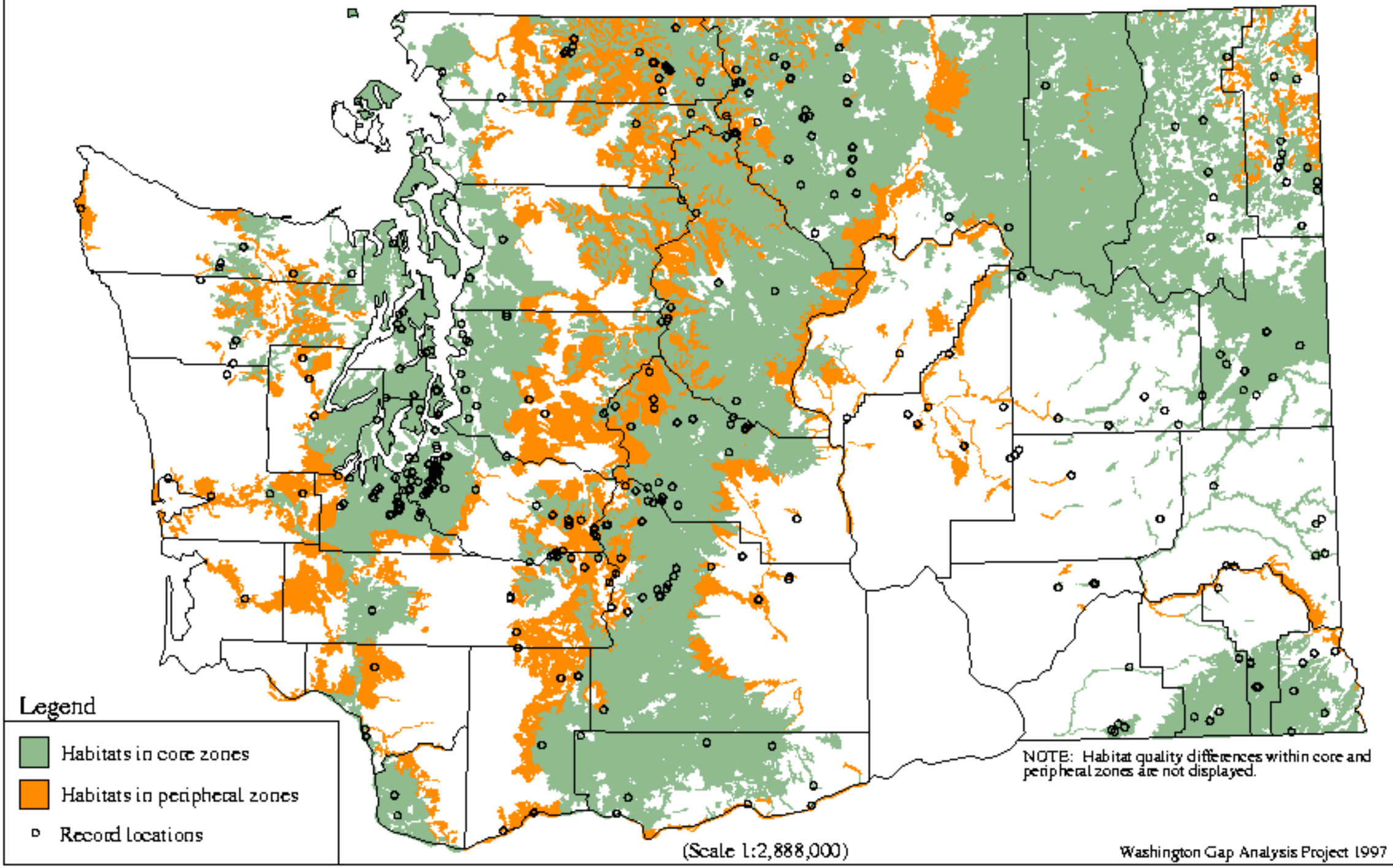
Ambystoma gracile - Northwestern Salamander



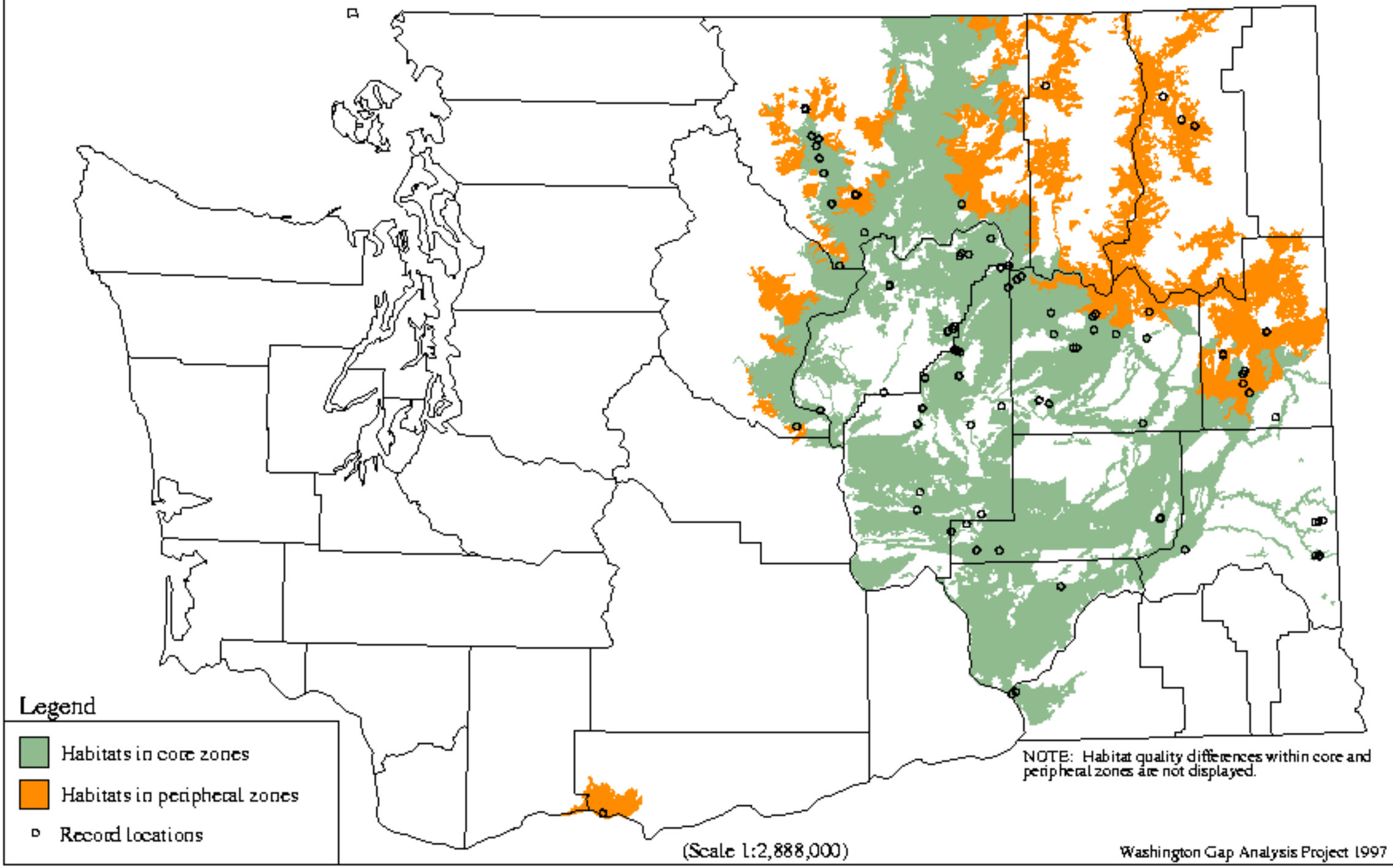
Ambystoma gracile - Northwestern Salamander



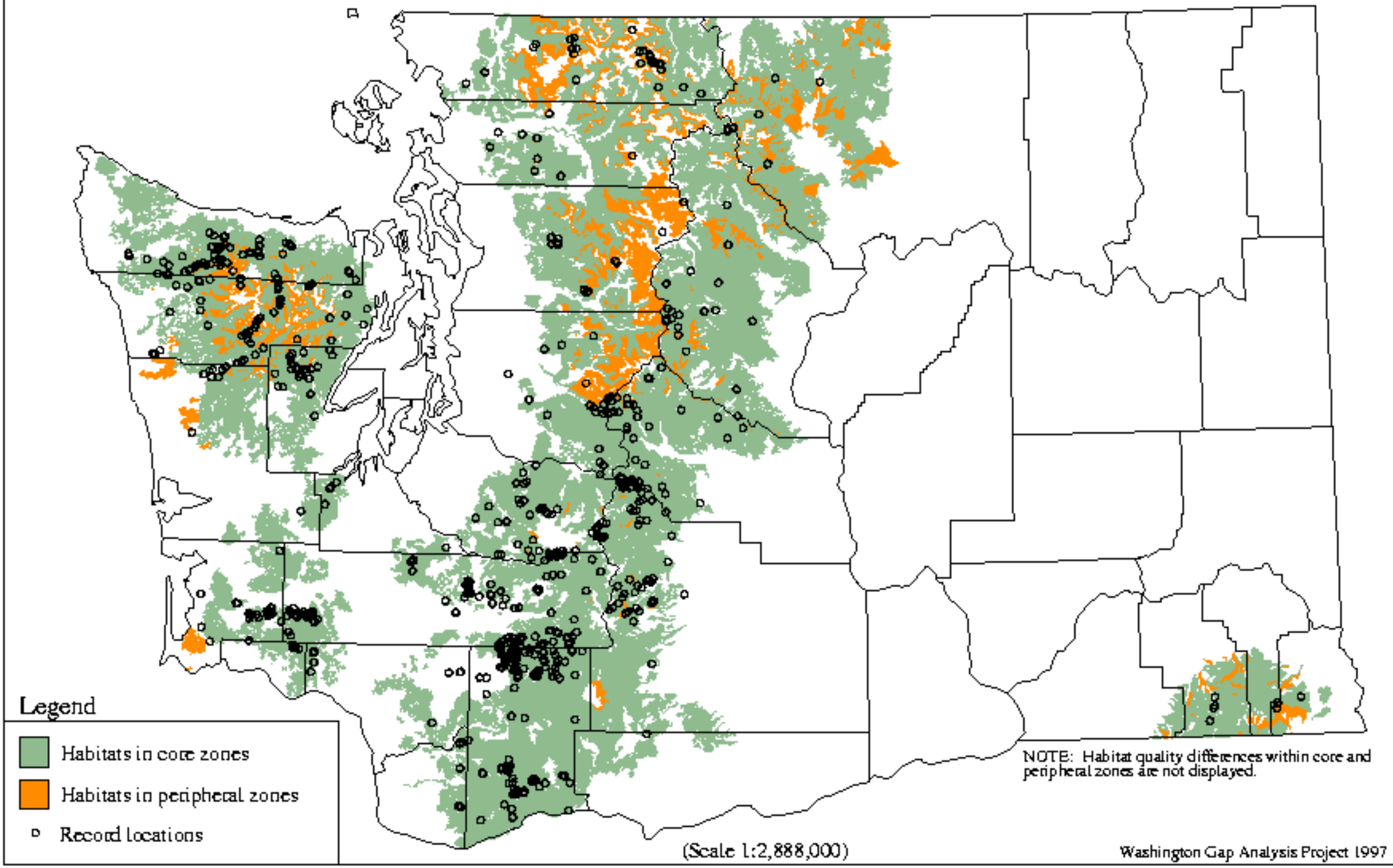
Ambystoma macrodactylum - Long-toed Salamander



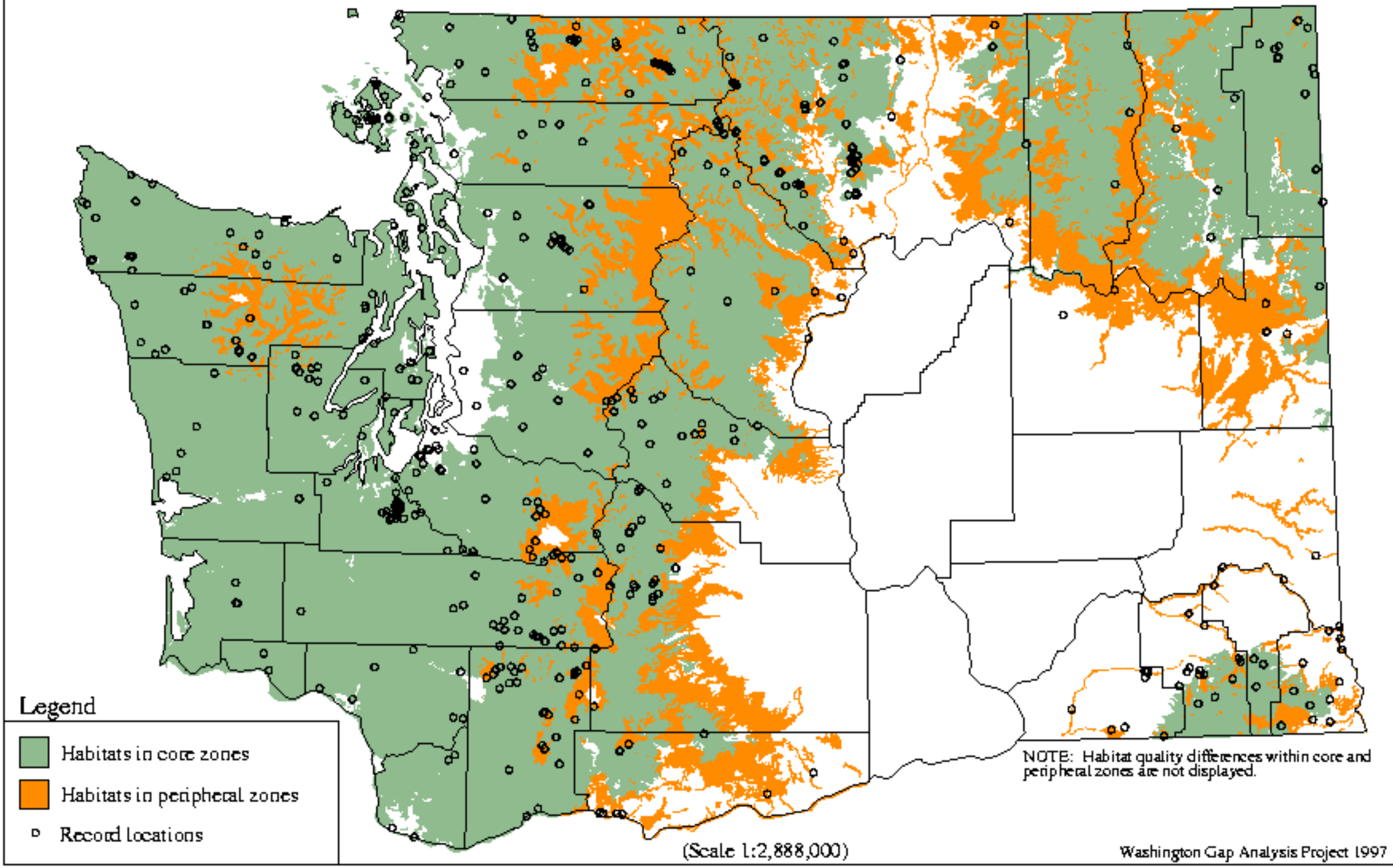
Ambystoma tigrinum - Tiger Salamander



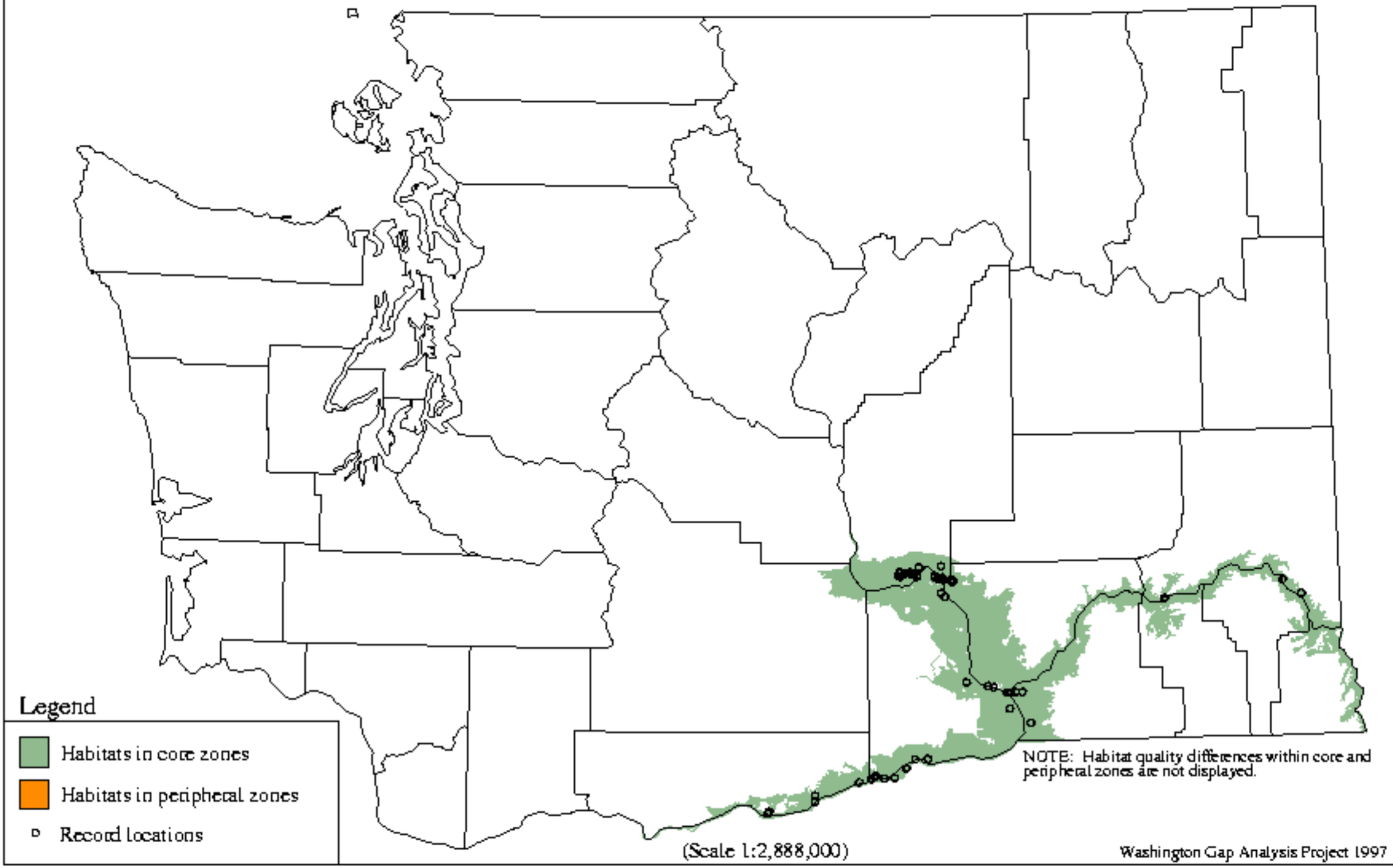
Ascaphus truei - Tailed Frog



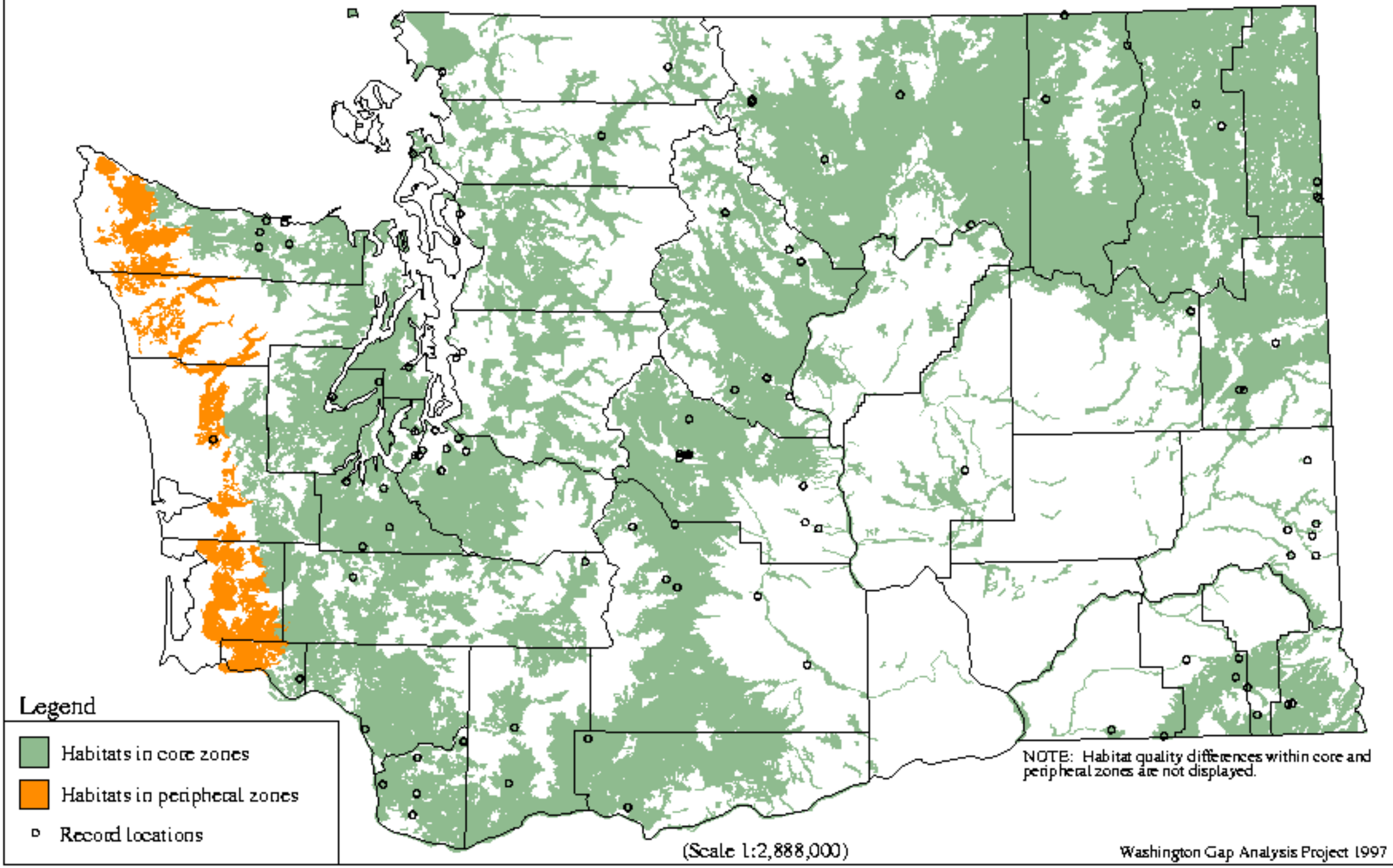
Bufo boreas - Western Toad



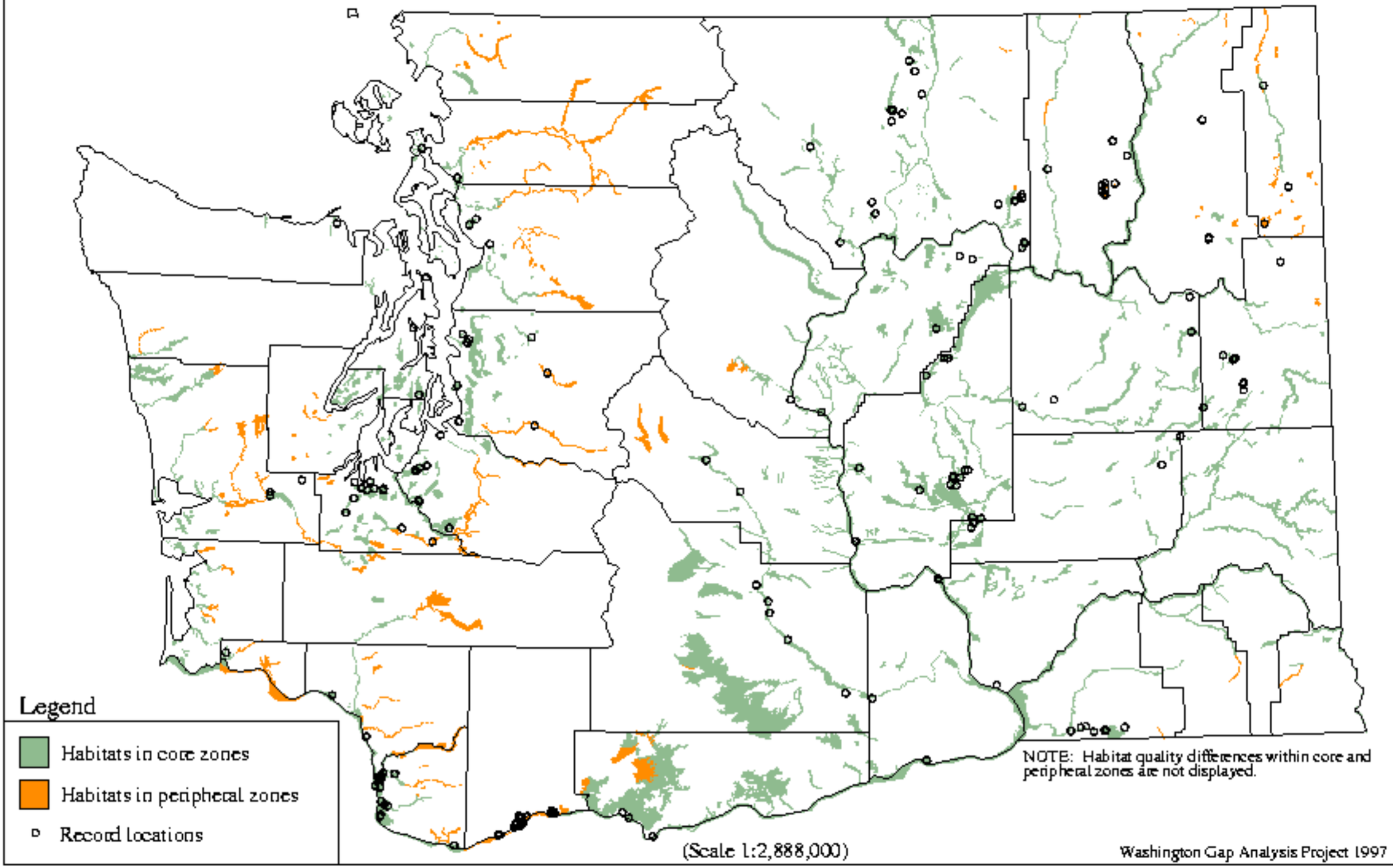
Bufo woodhousei - Woodhouse`s Toad



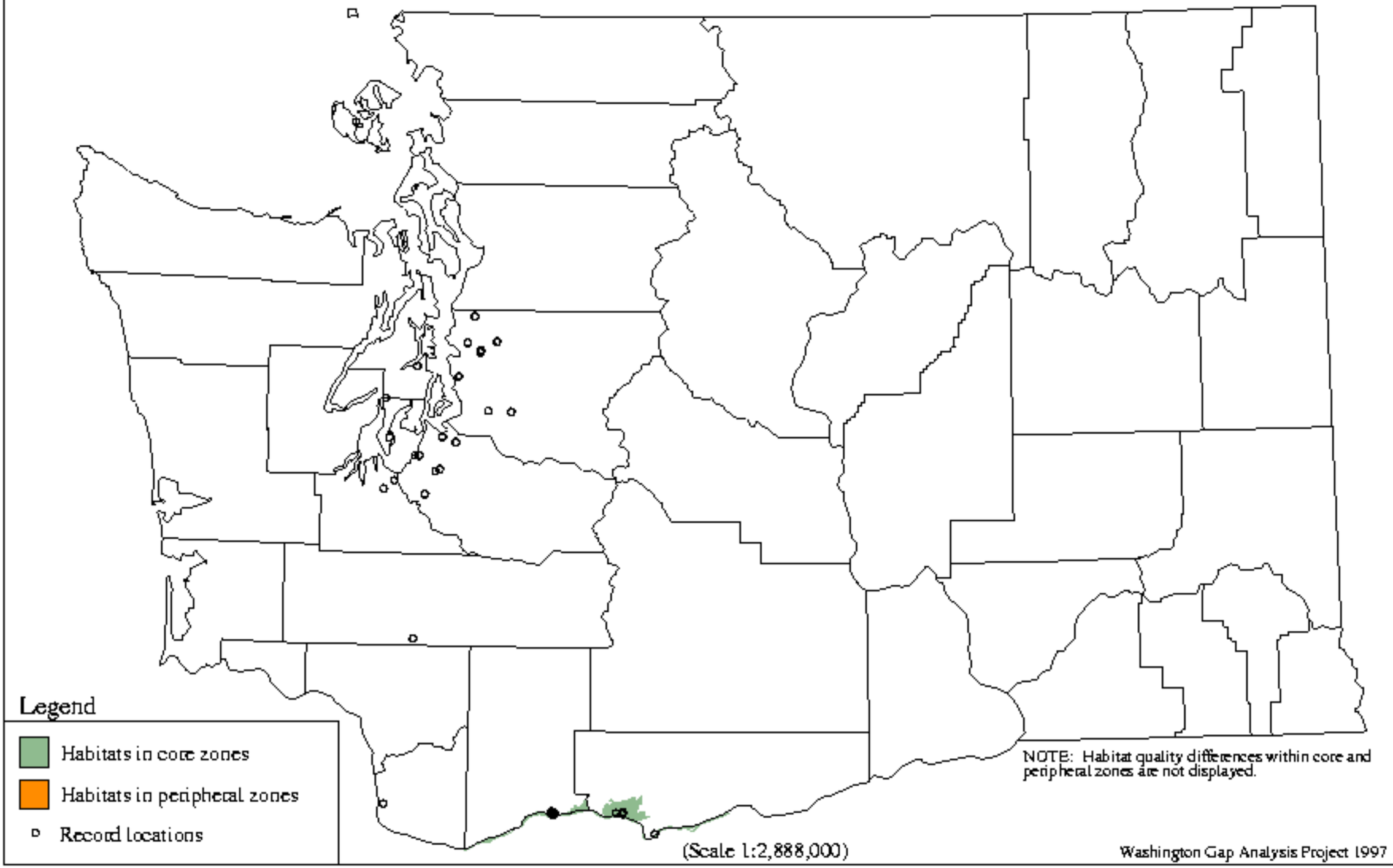
Charina bottae - Rubber Boa



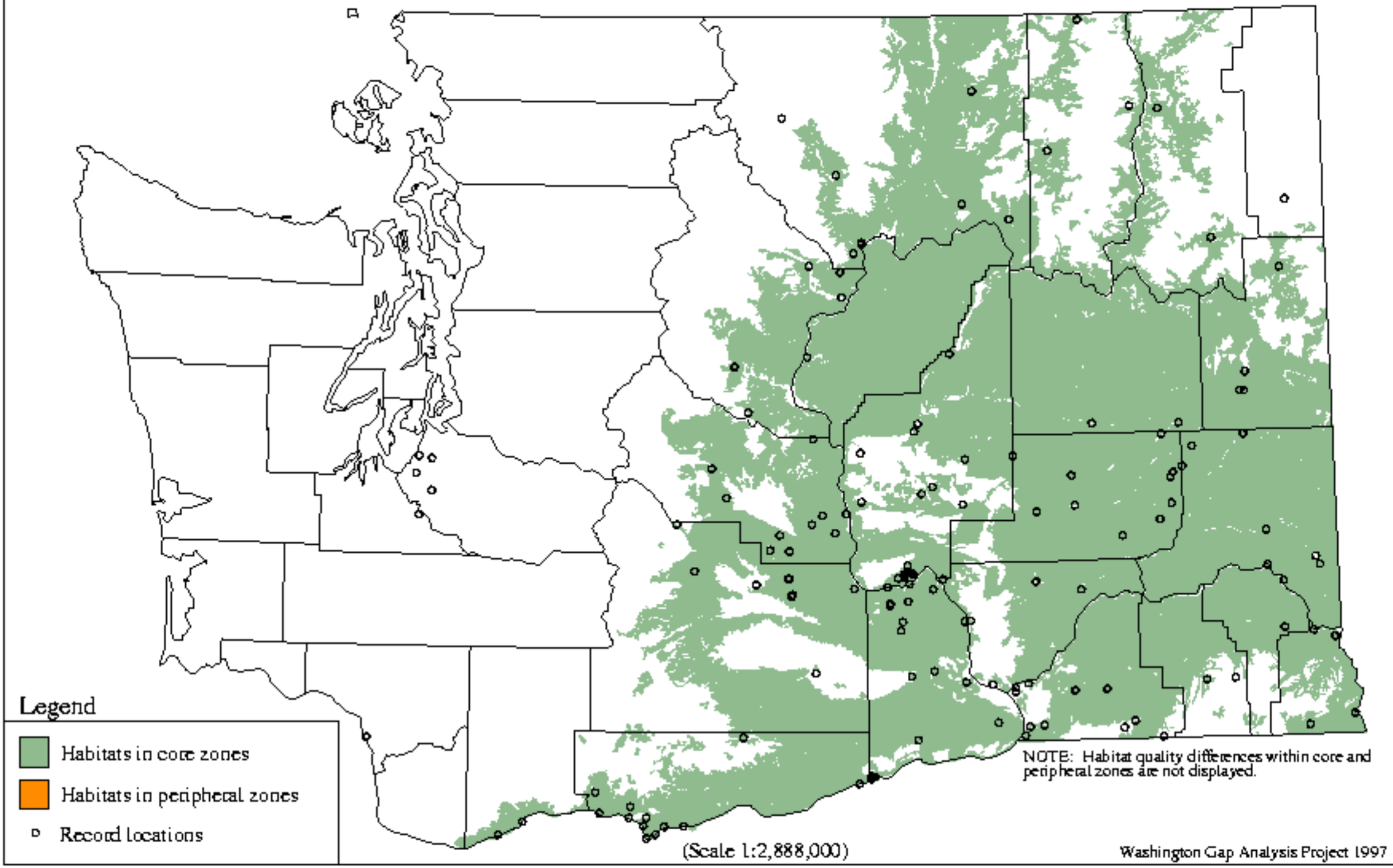
Chrysemys picta - Painted Turtle



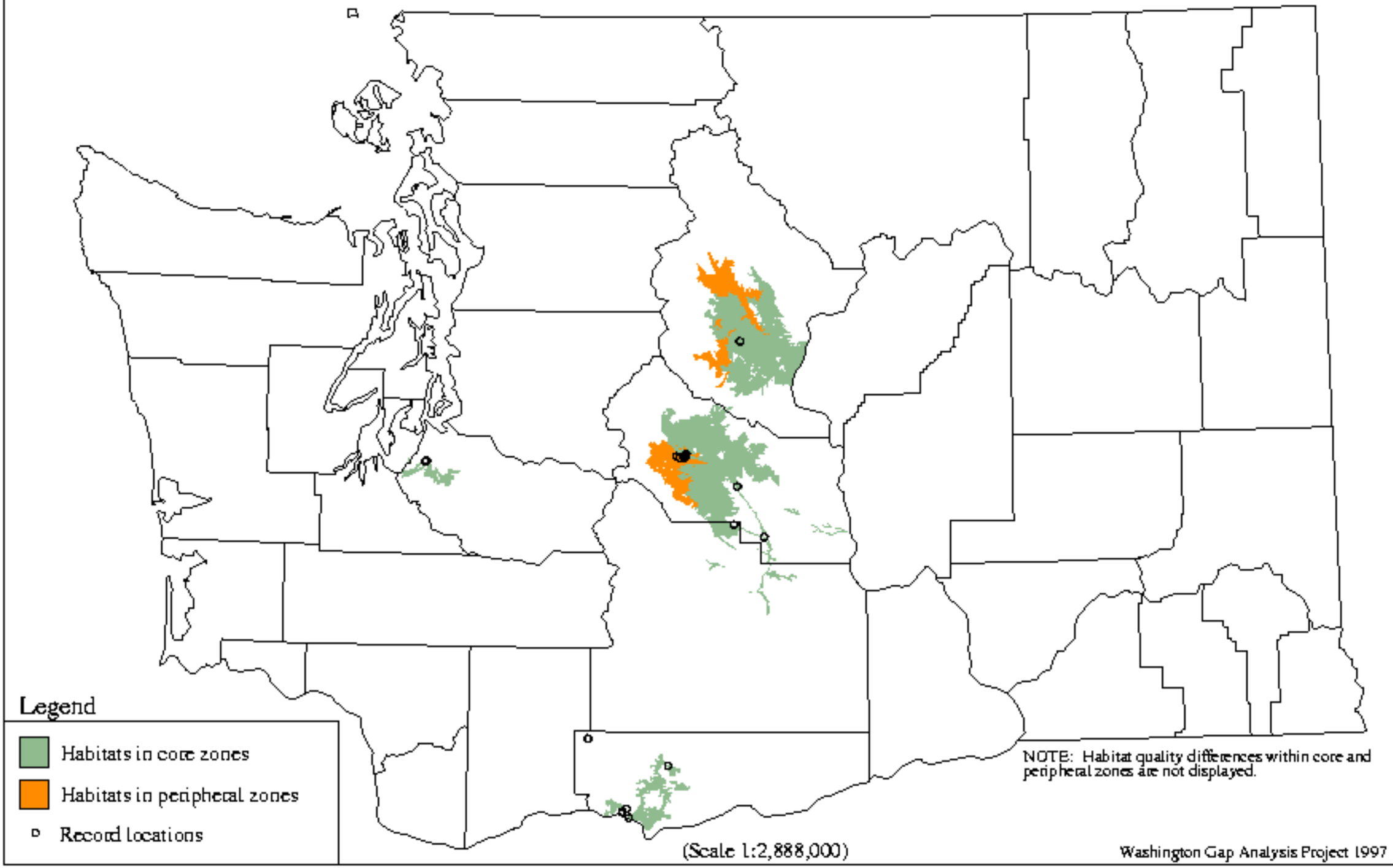
Clemmys marmorata - Western Pond Turtle



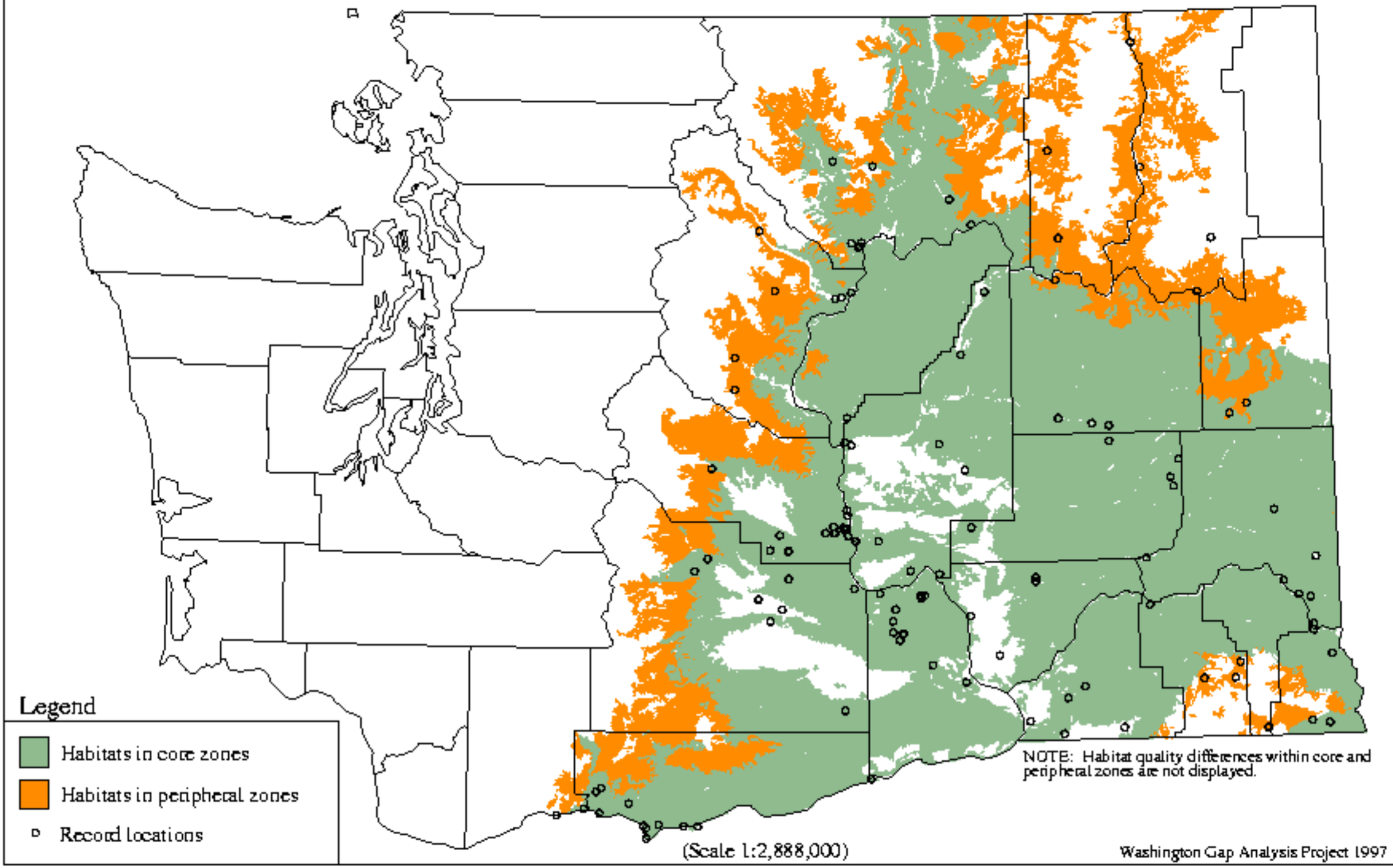
Coluber constrictor - **Racer**



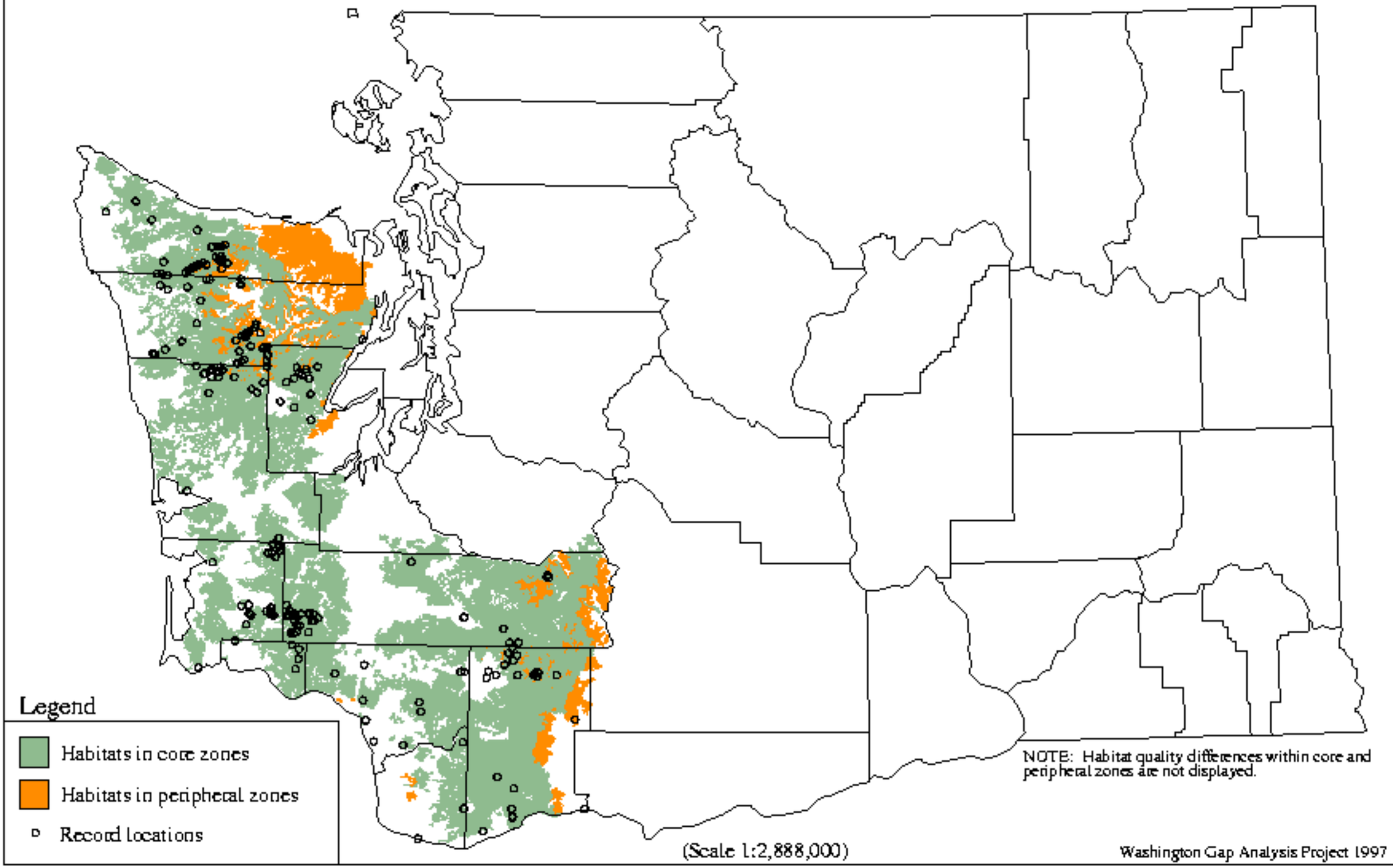
Contia tenuis - Sharptail Snake



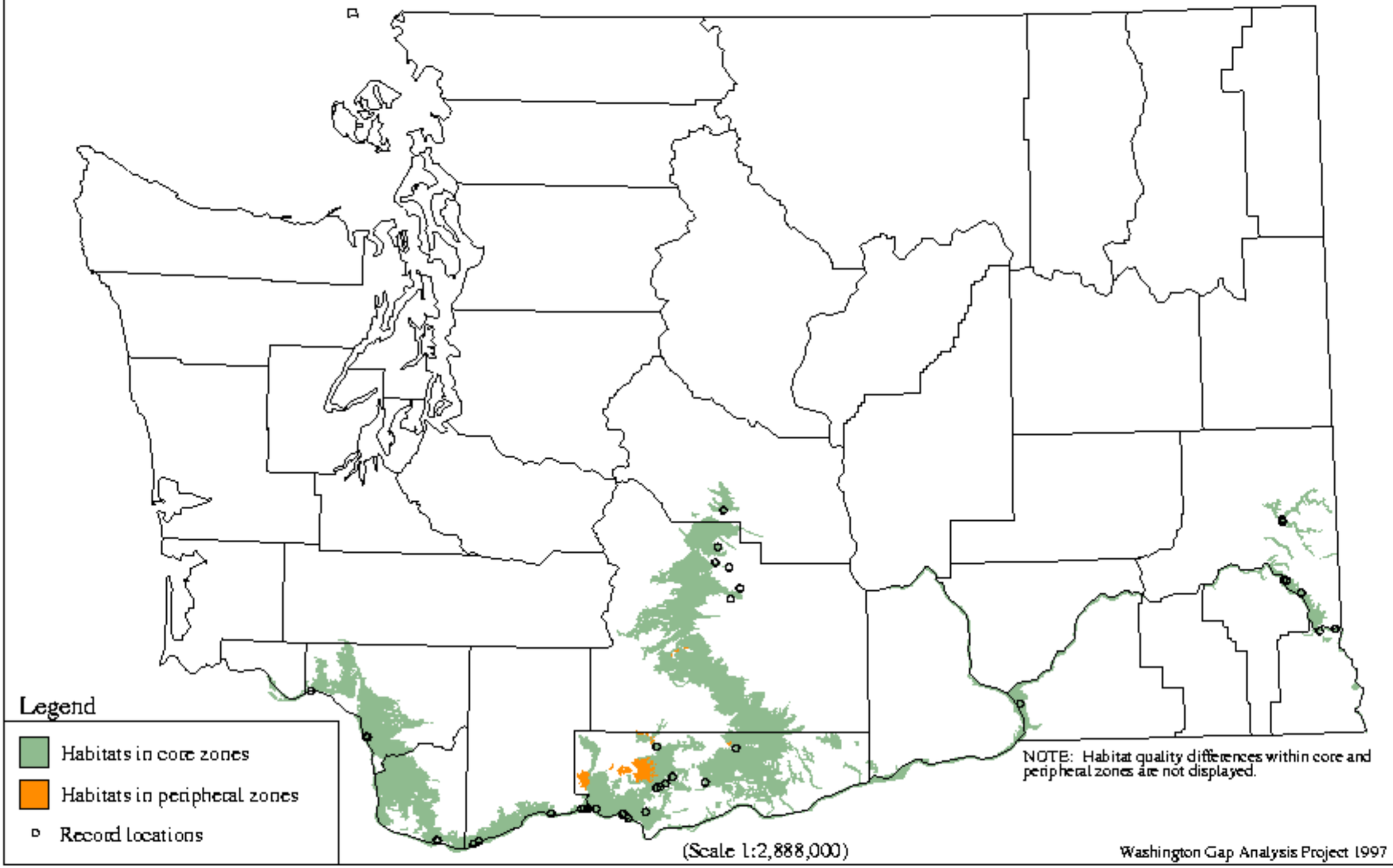
Crotalus viridis - Western Rattlesnake



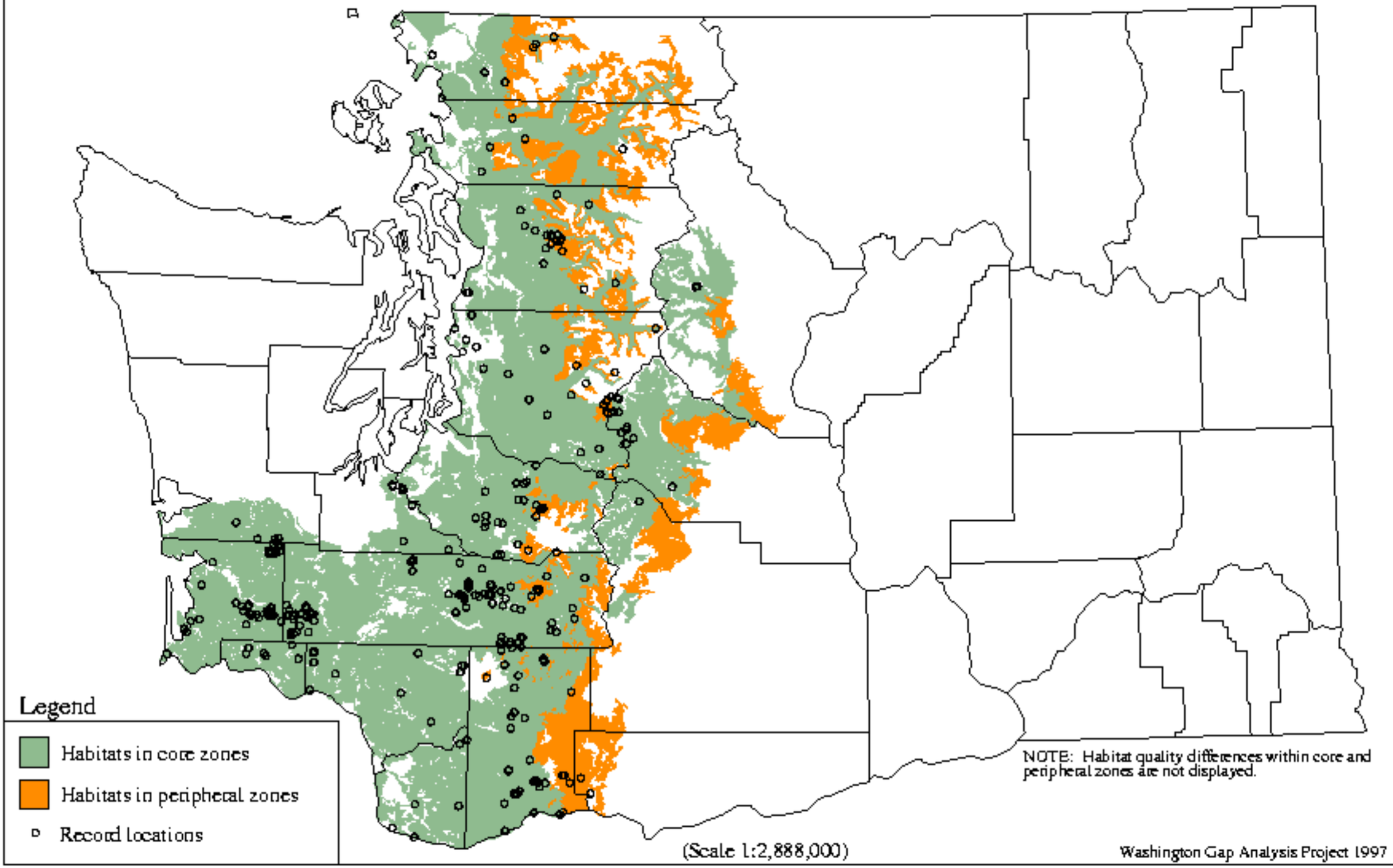
Dicamptodon copei - Cope`s Giant Salamander



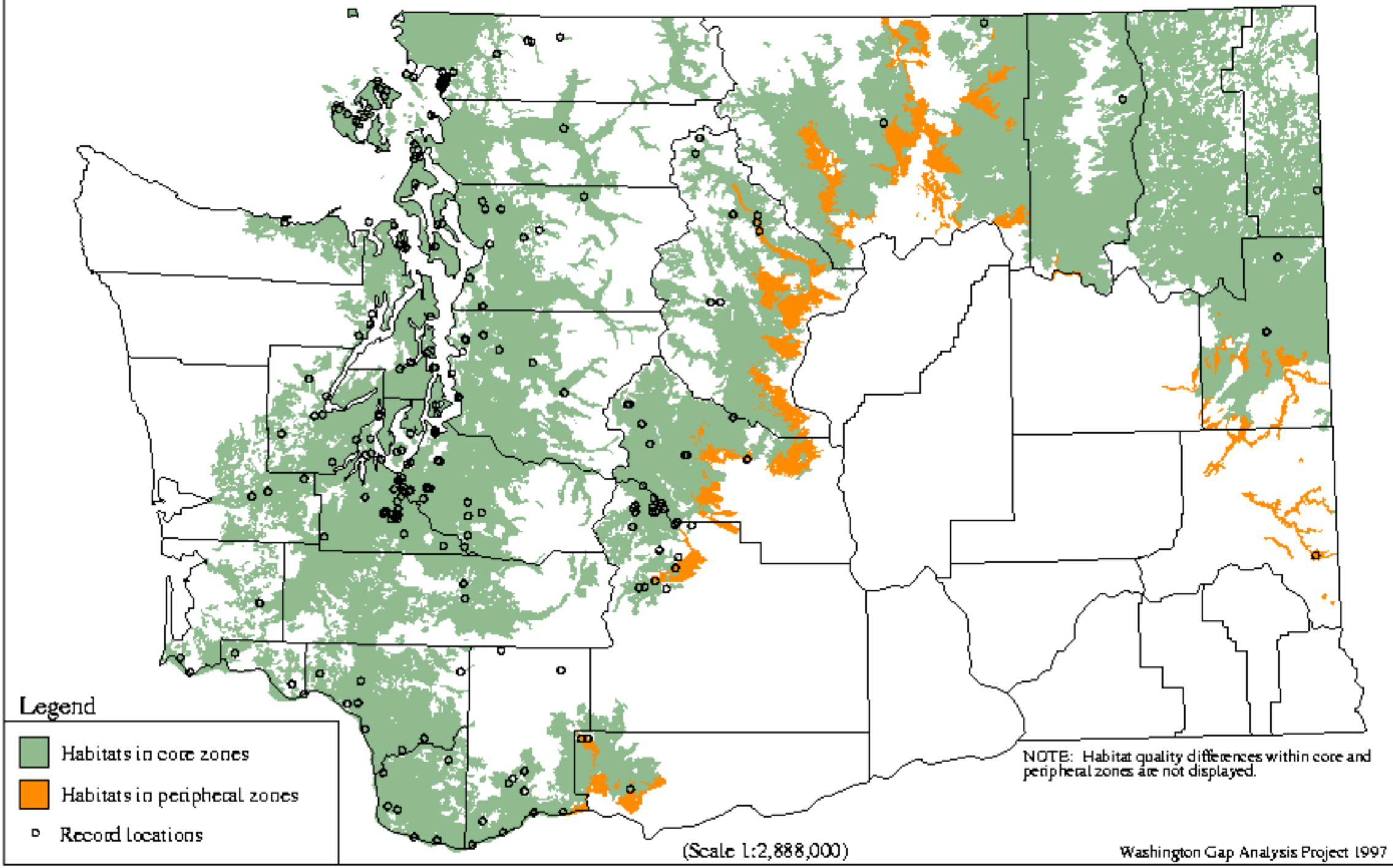
Diadophis punctatus - Ringneck Snake



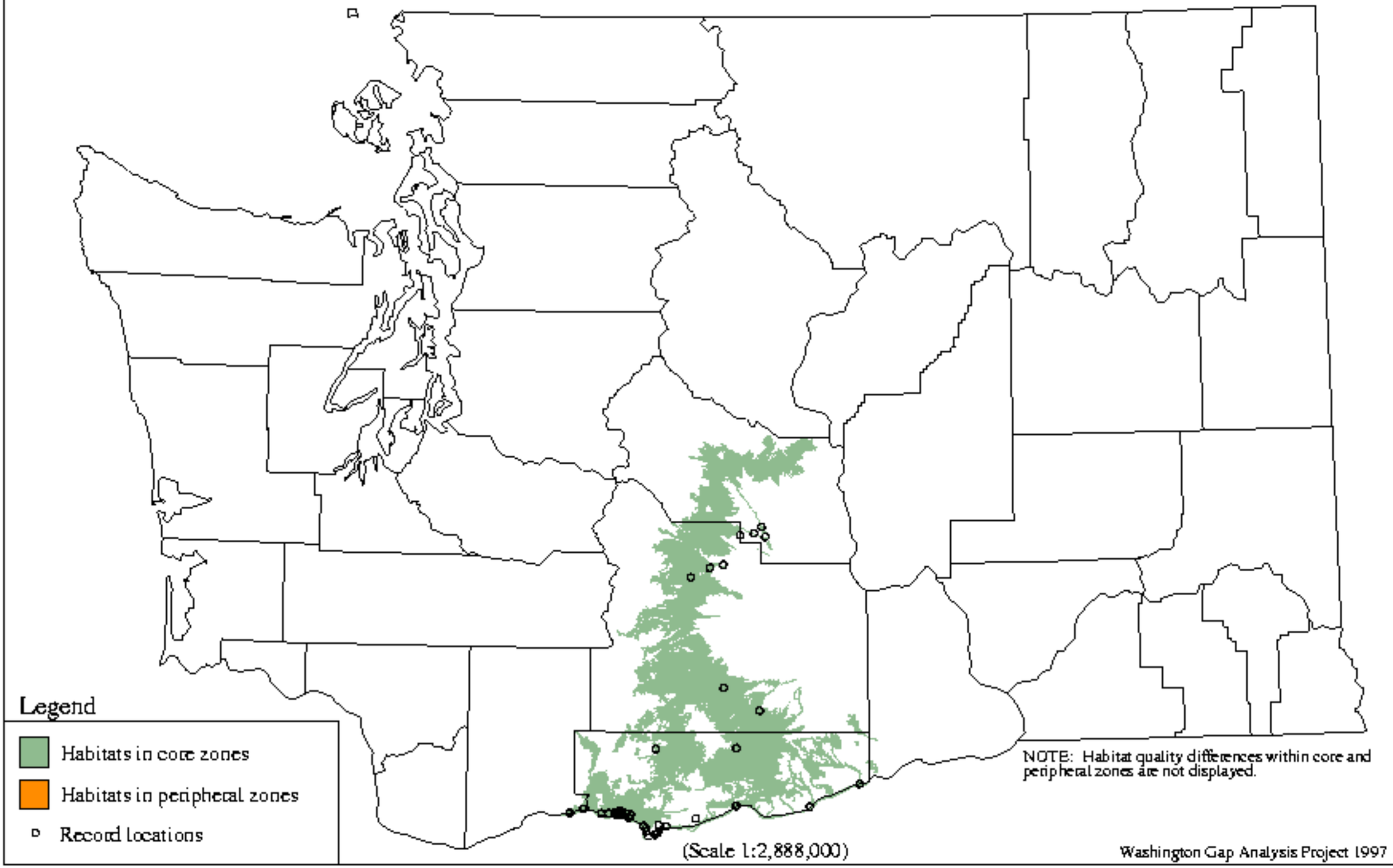
Dicamptodon tenebrosus - Pacific Giant Salamander



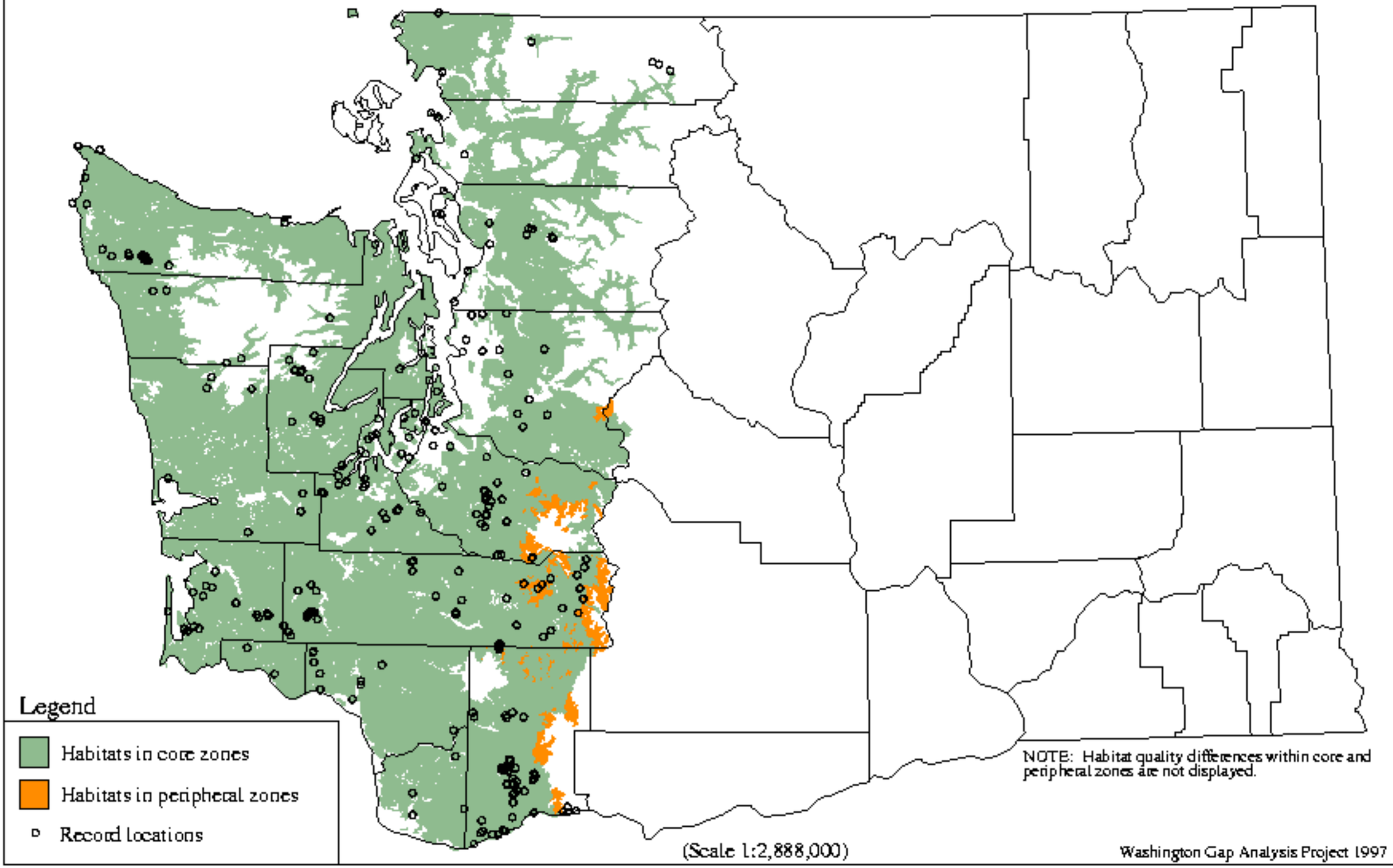
Elgaria coerulea - Northern Alligator Lizard



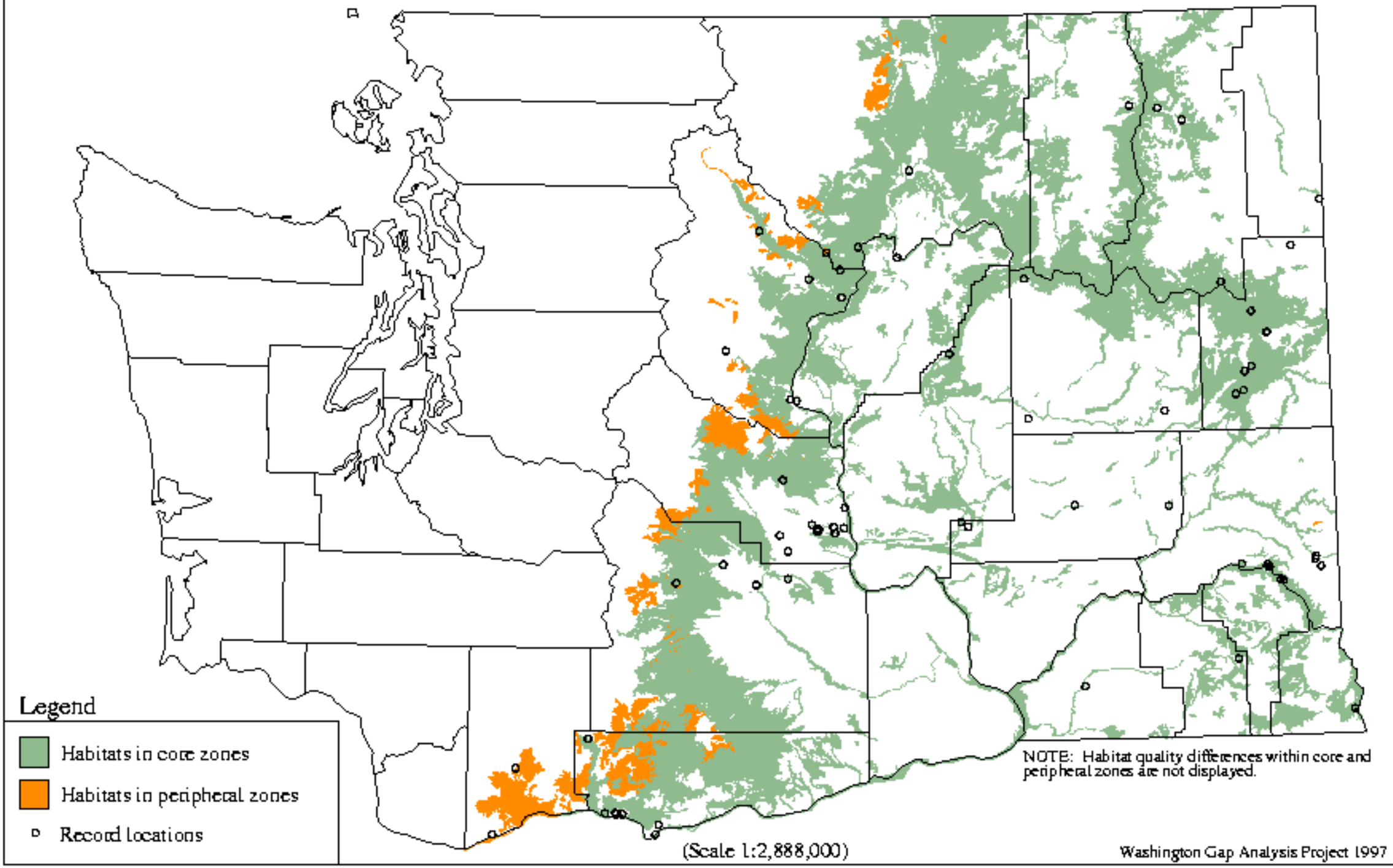
Elgaria multicarinata - Southern Alligator Lizard



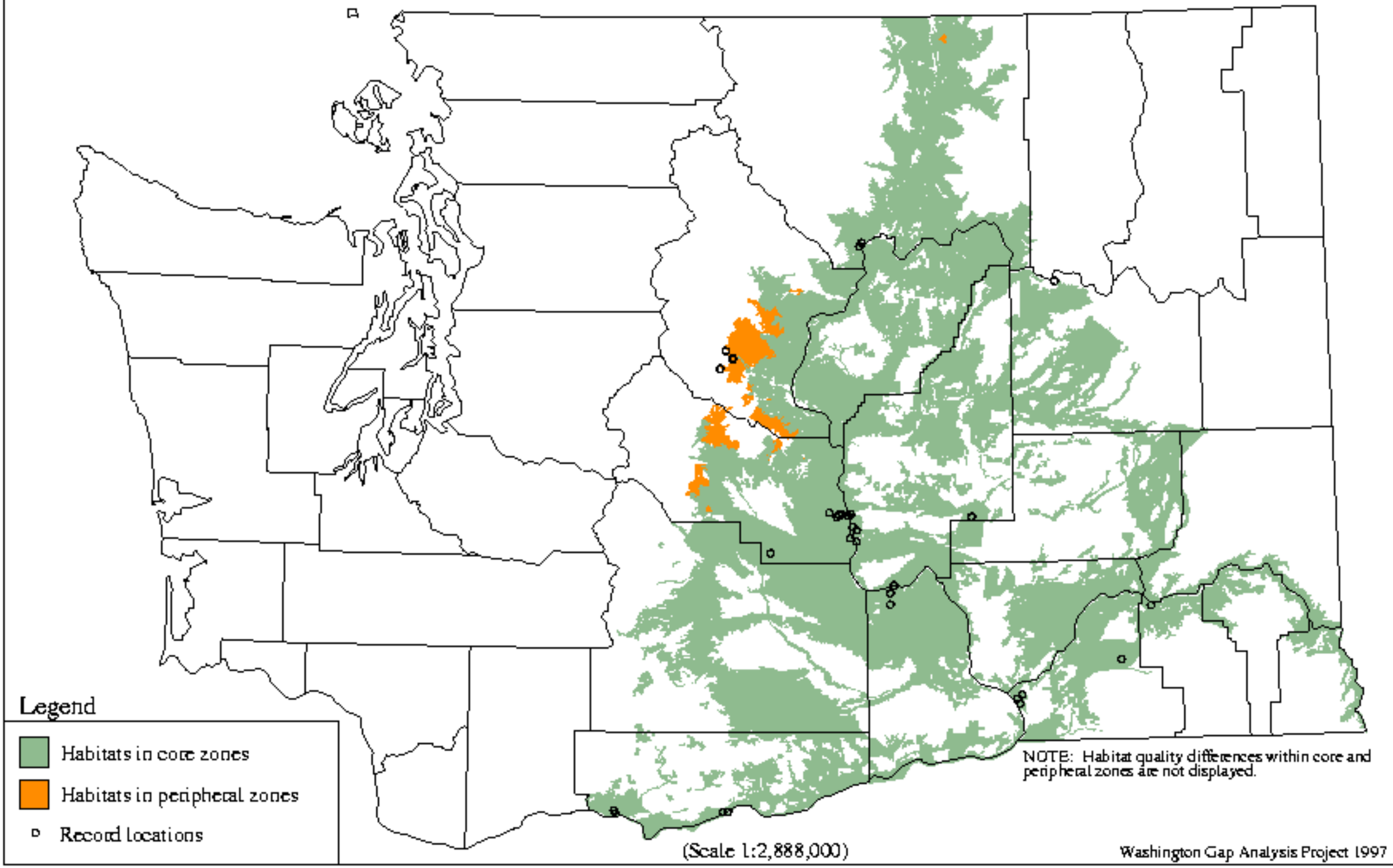
Ensatina eschscholtzii - Ensatina



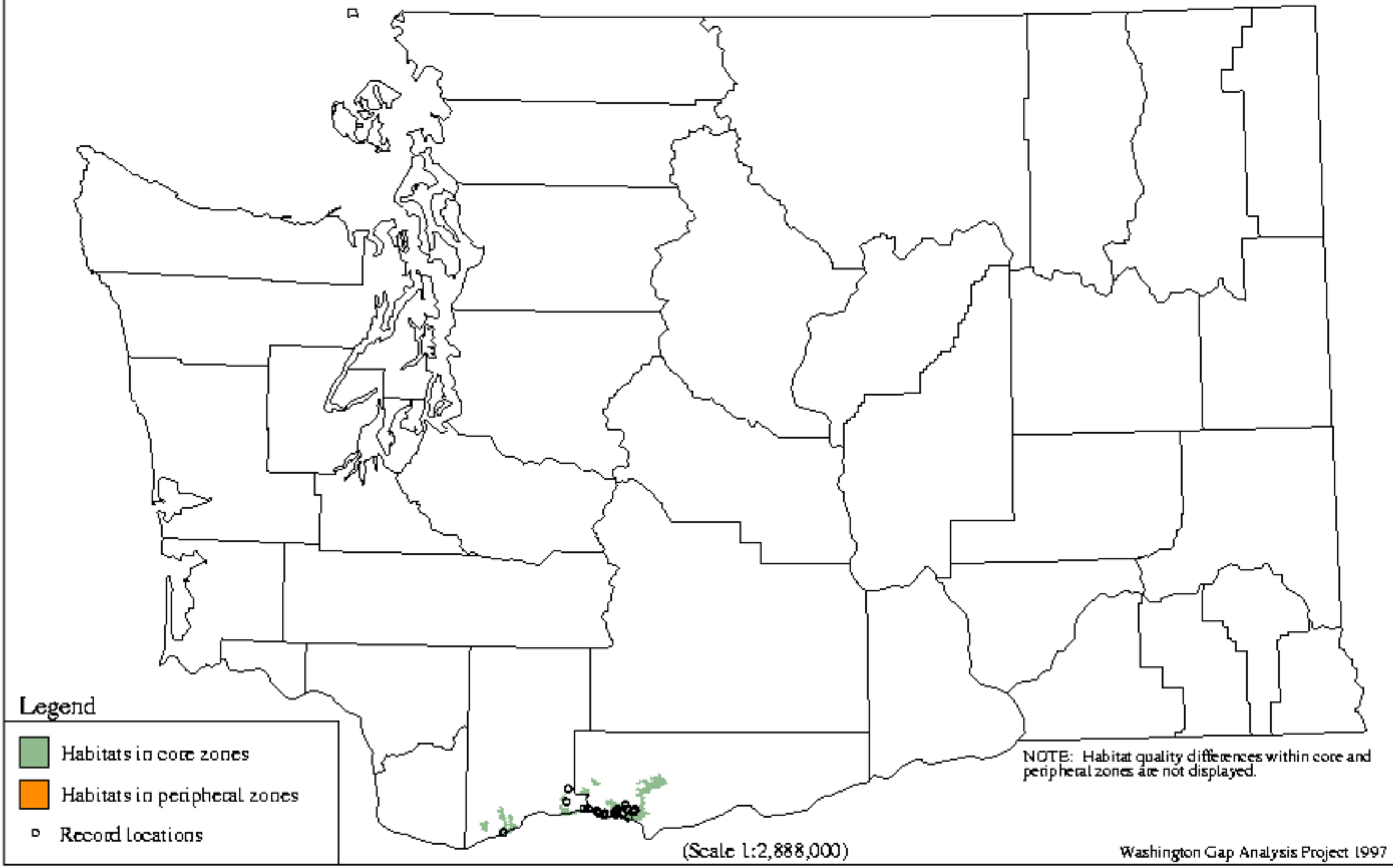
Eumeces skiltonianus - Western Skink



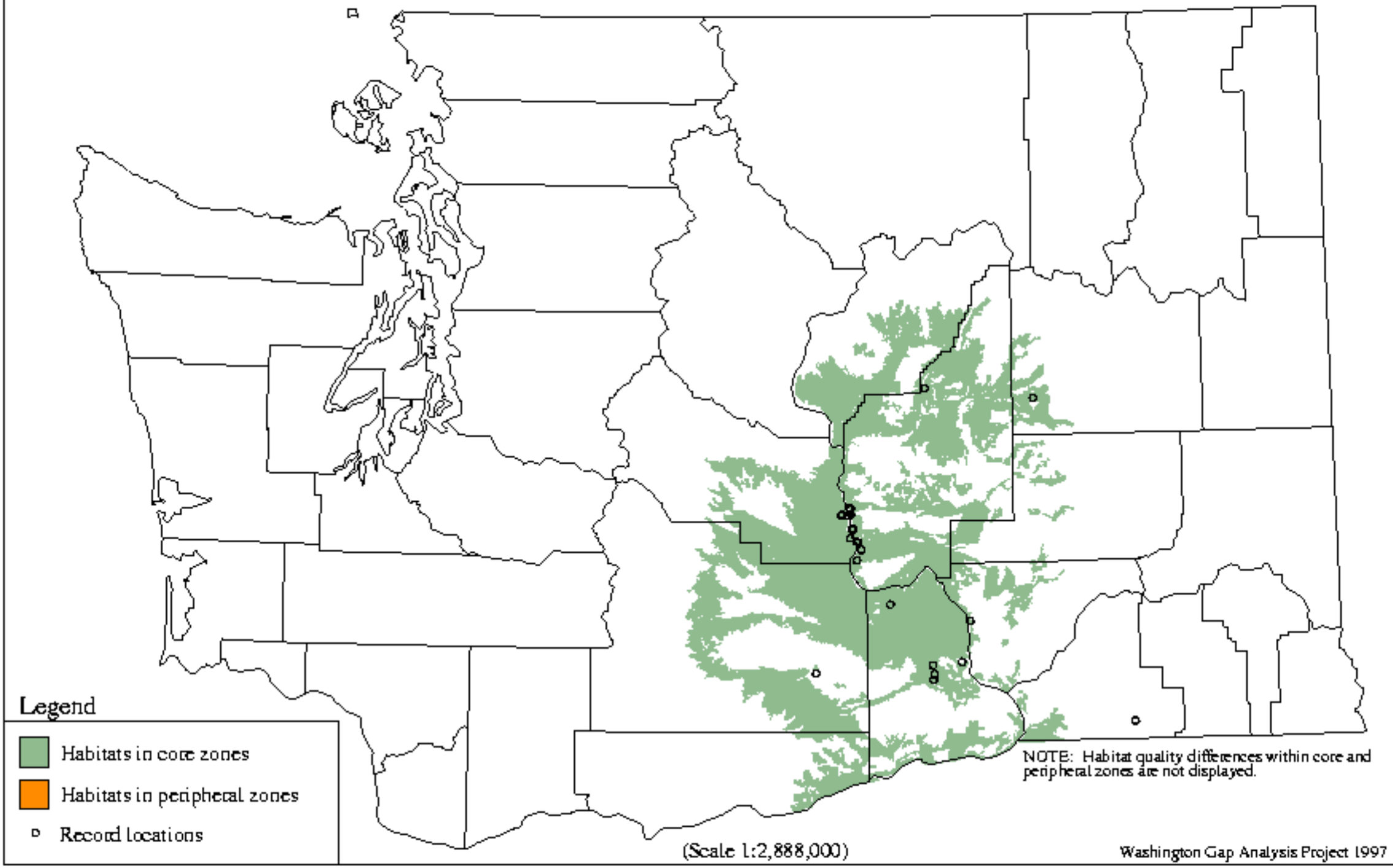
Hypsiglena torquata - Night Snake



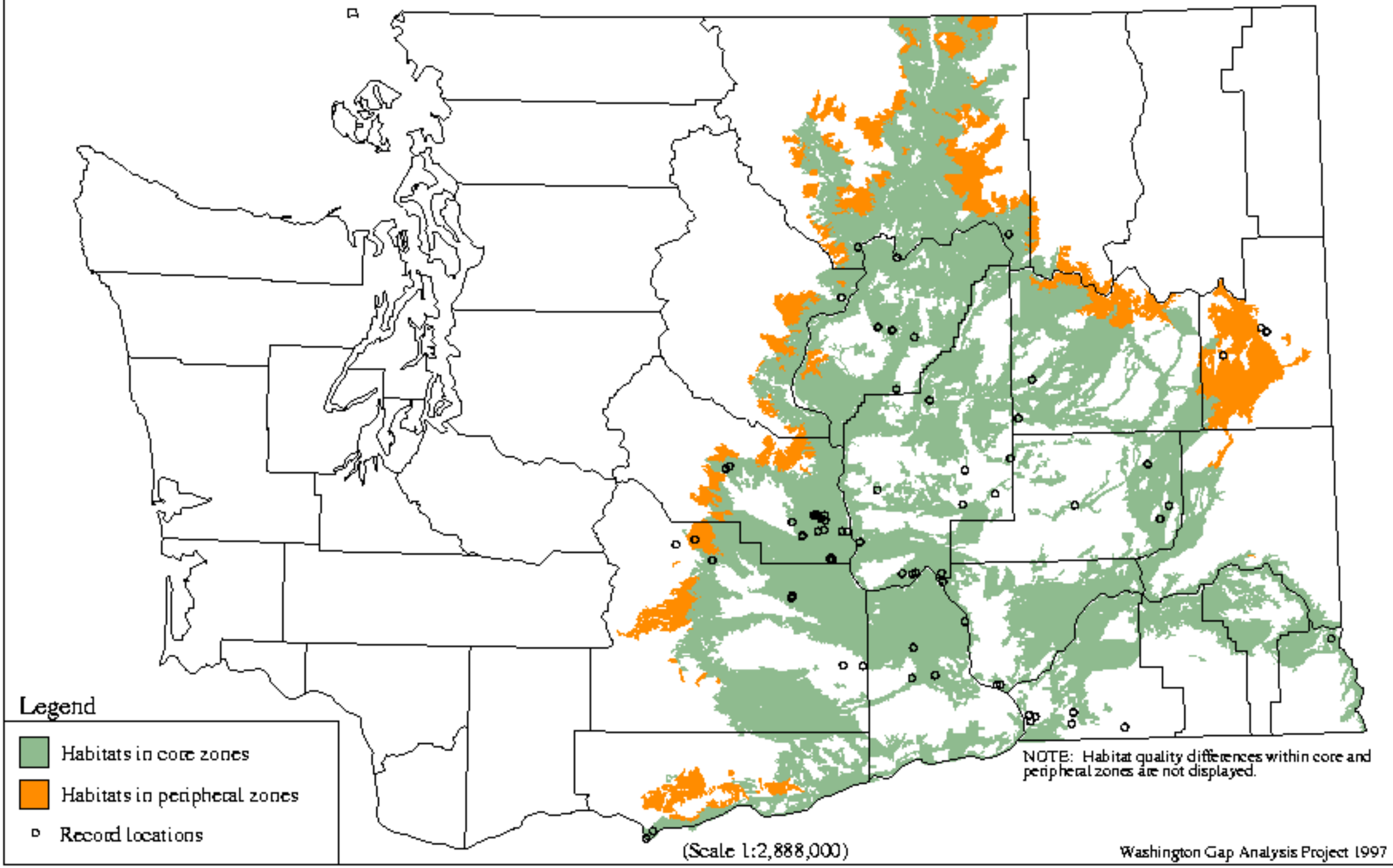
Lampropeltis zonata - California Mountain Kingsnake



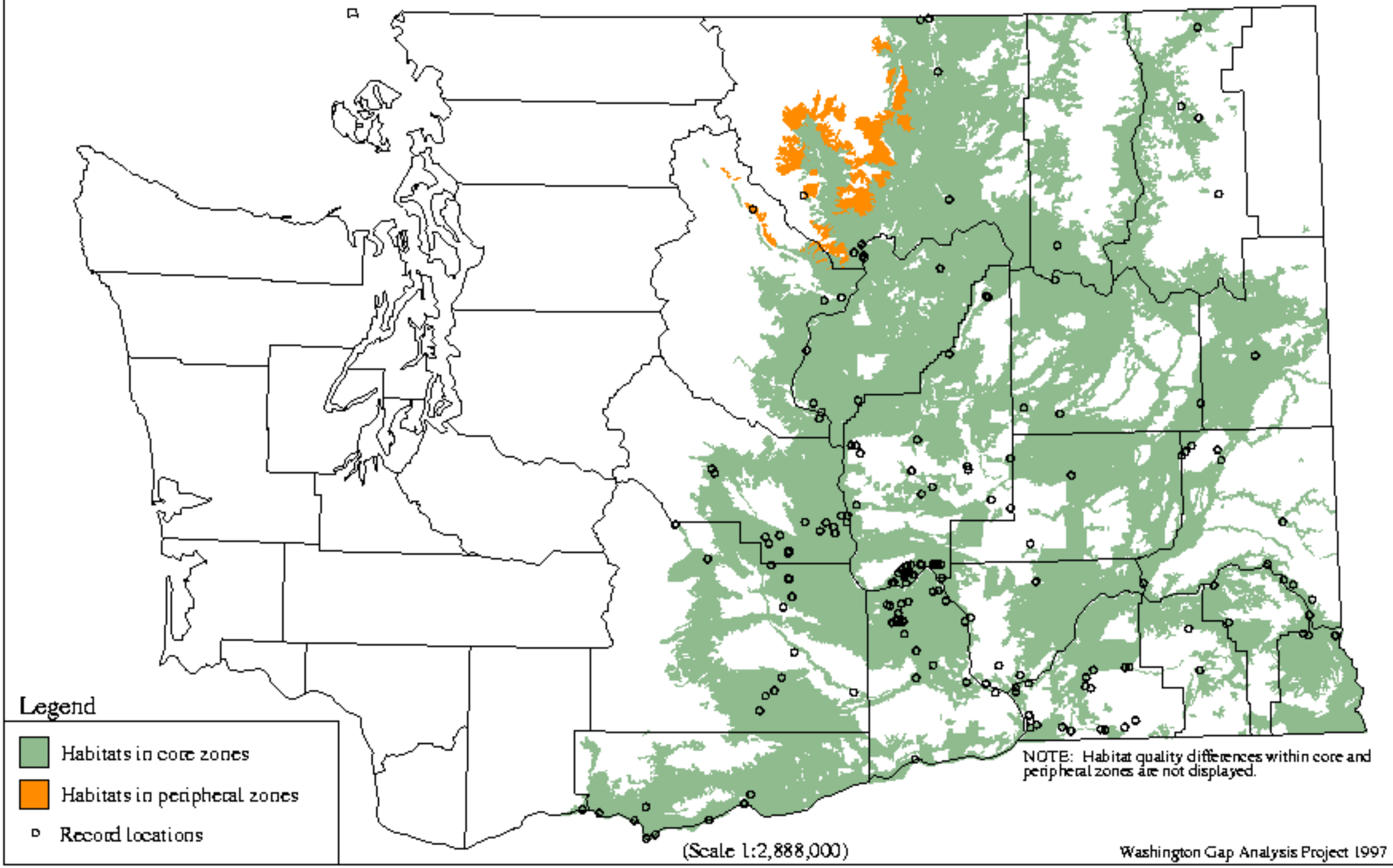
Masticophis taeniatus - Striped Whipsnake



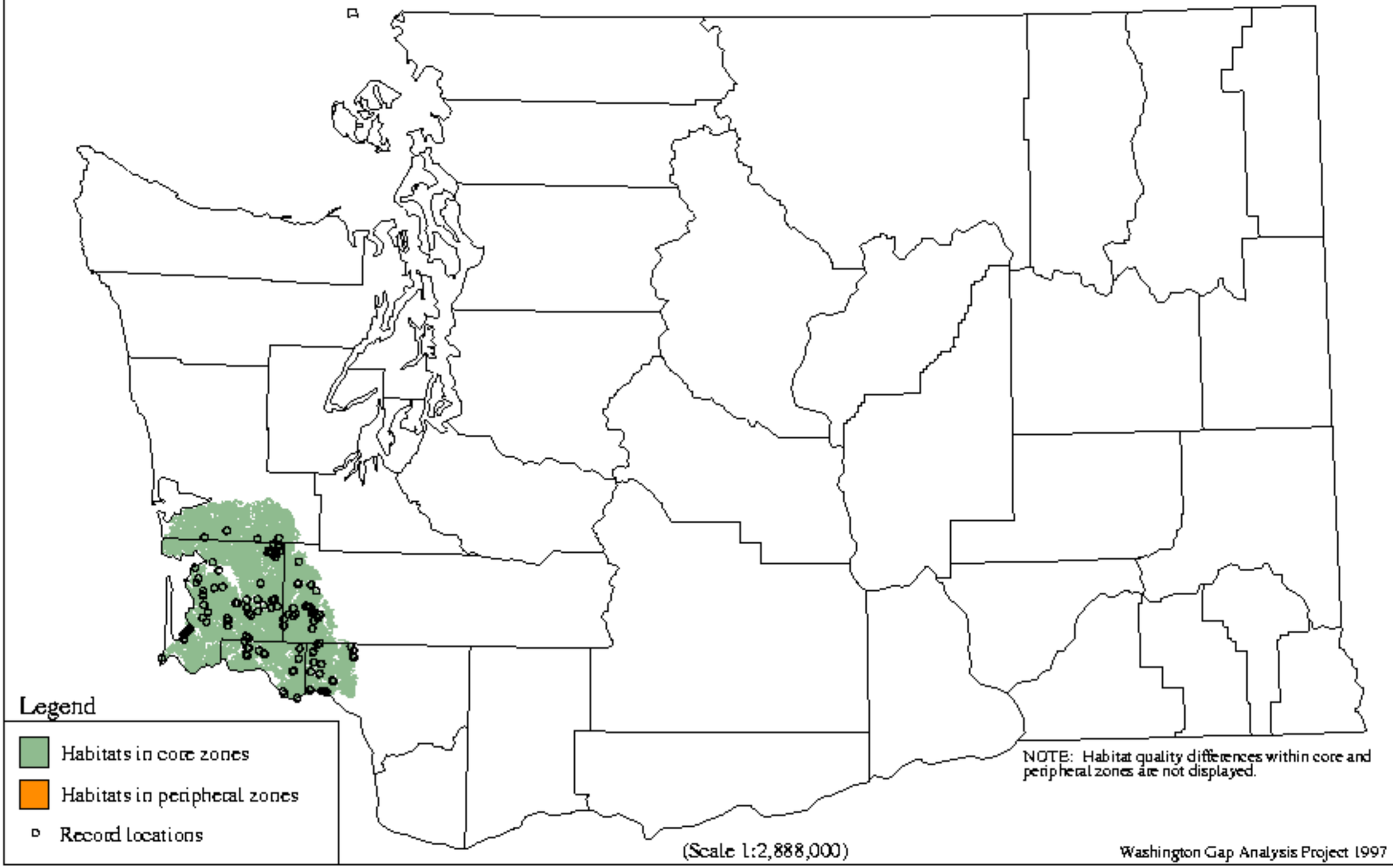
Phrynosoma douglassii - Short-horned Lizard



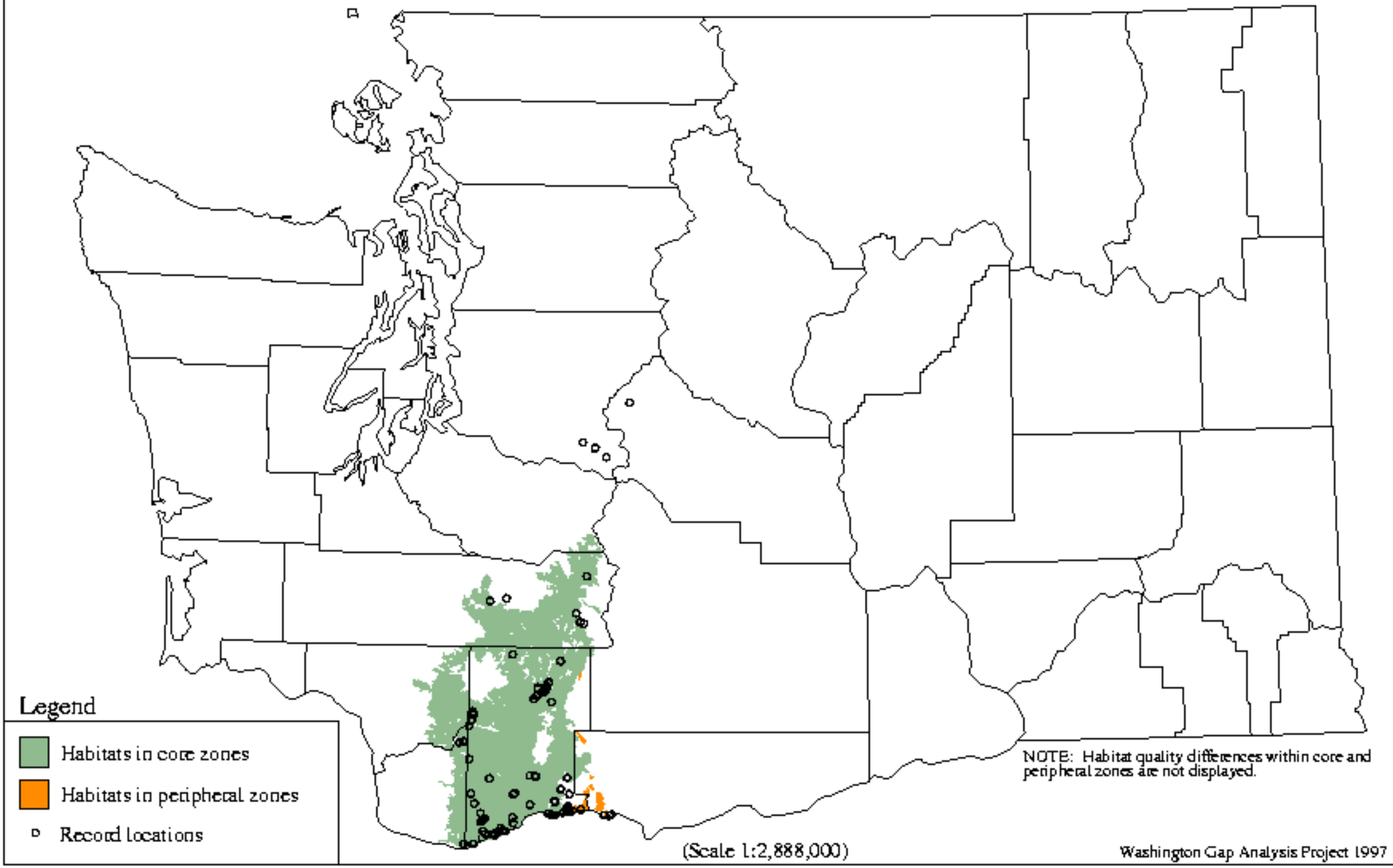
Pituophis catenifer - Gopher Snake



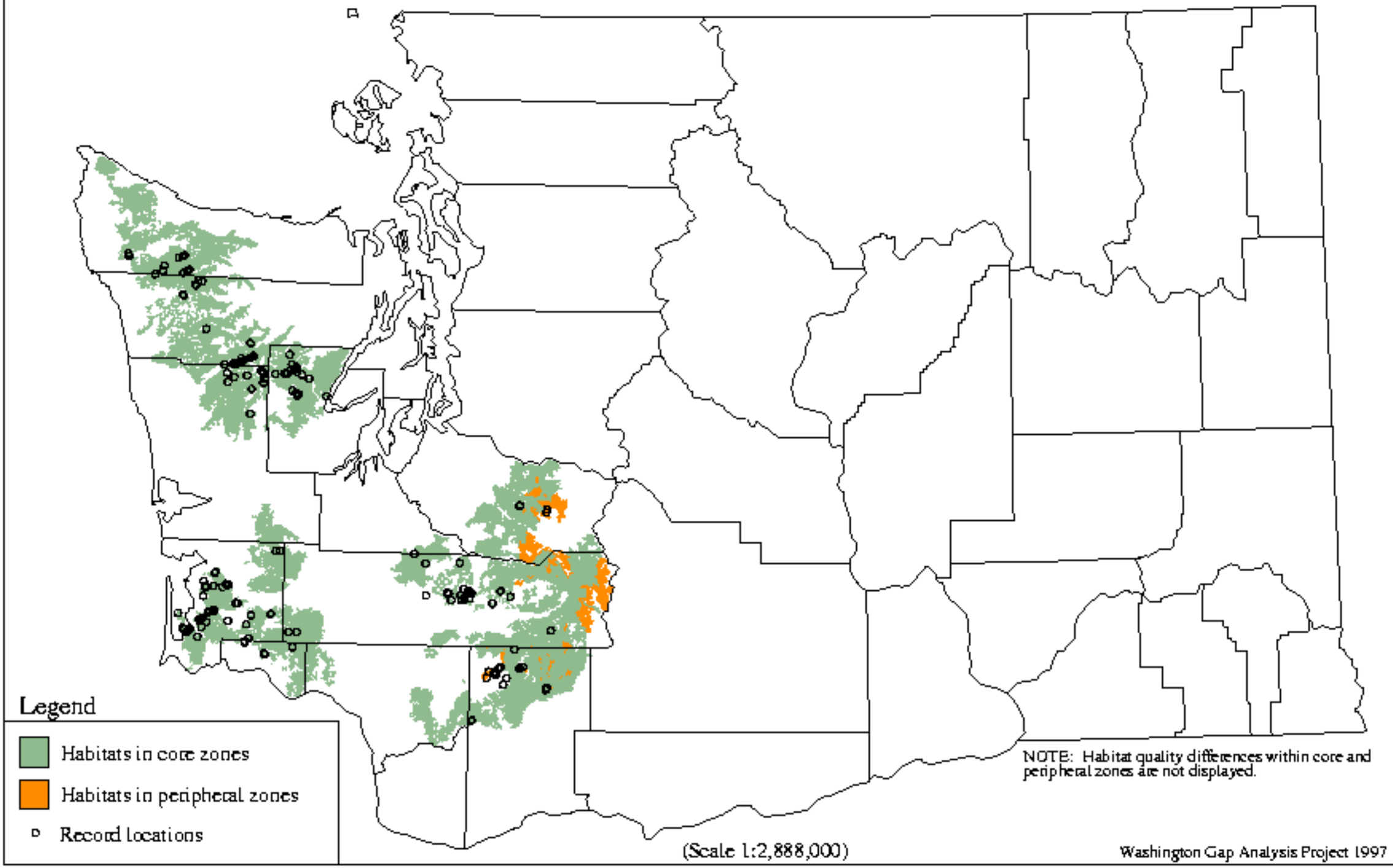
Plethodon dunni - Dunn`s Salamander



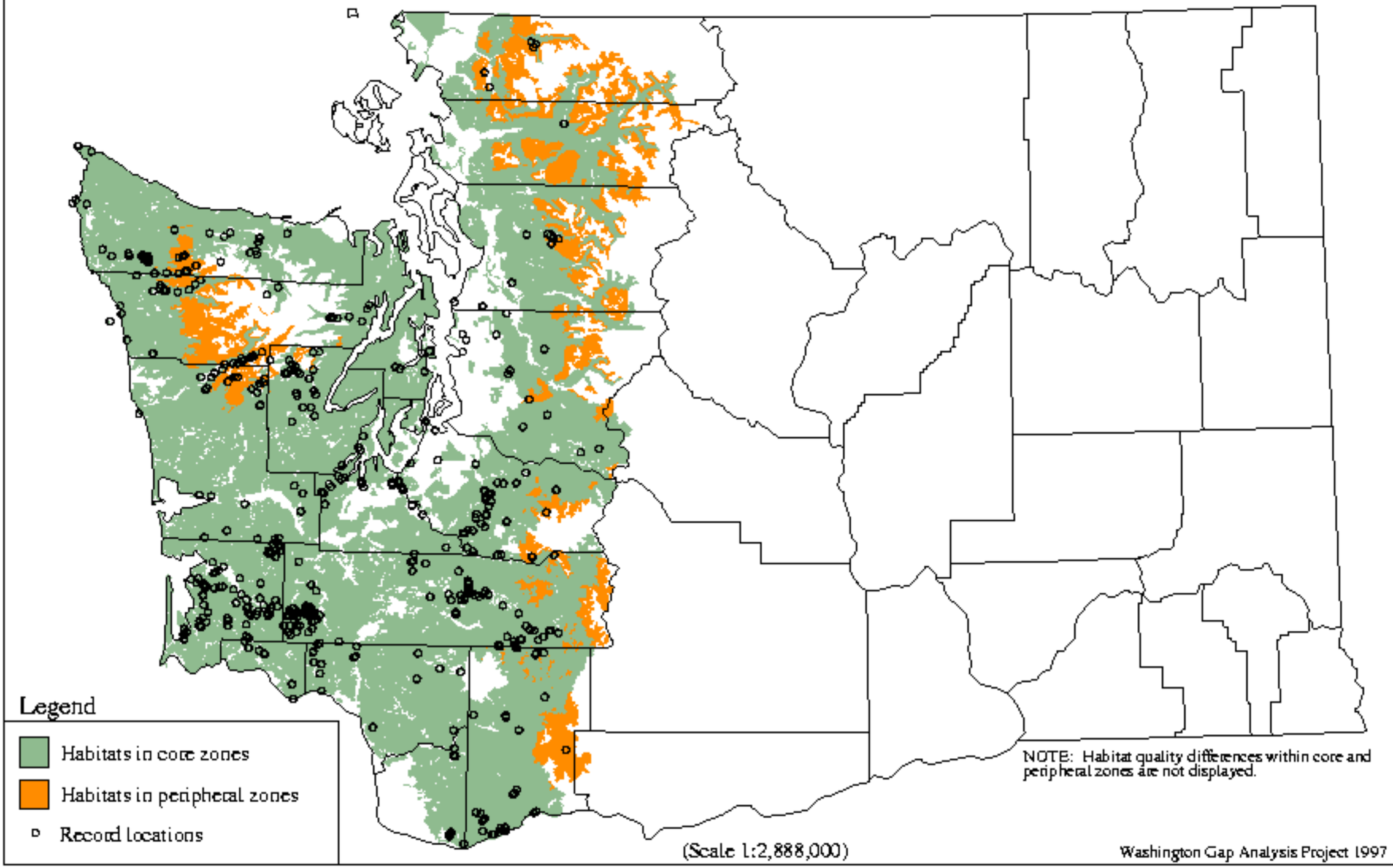
Plethodon larselli - Larch Mountain Salamander



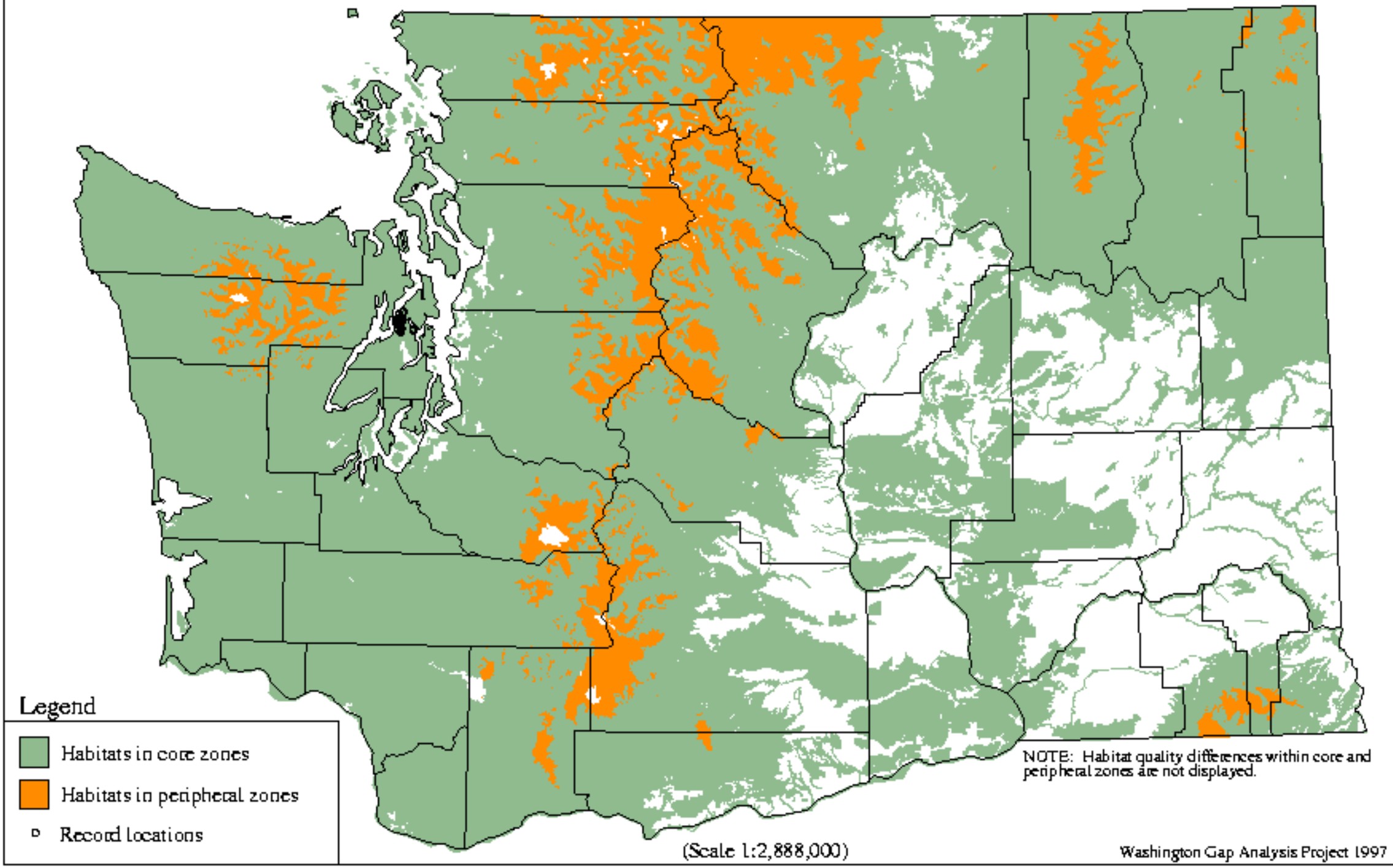
Plethodon vandykei - Van Dyke`s Salamander



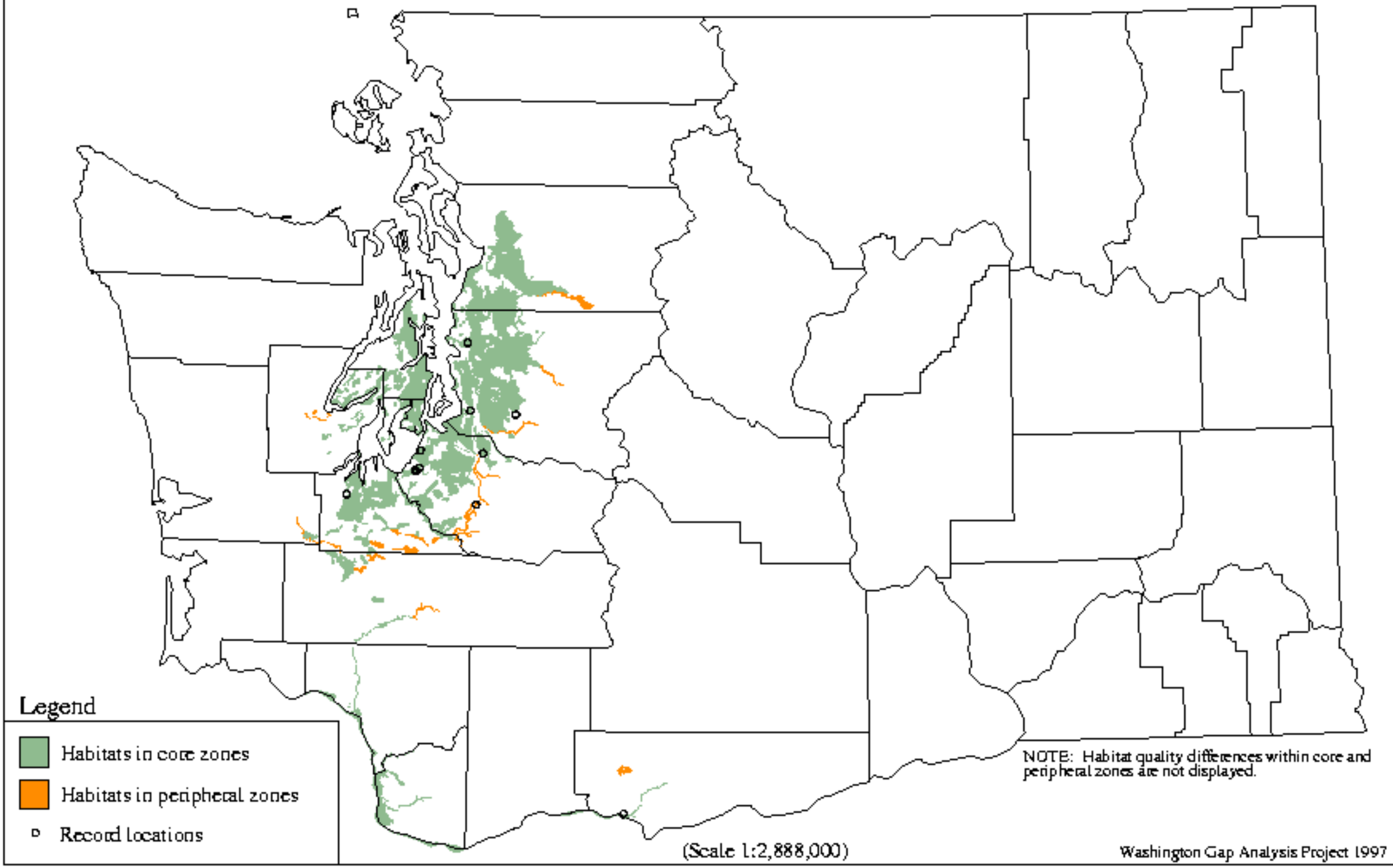
Plethodon vehiculum - Western Redback Salamander



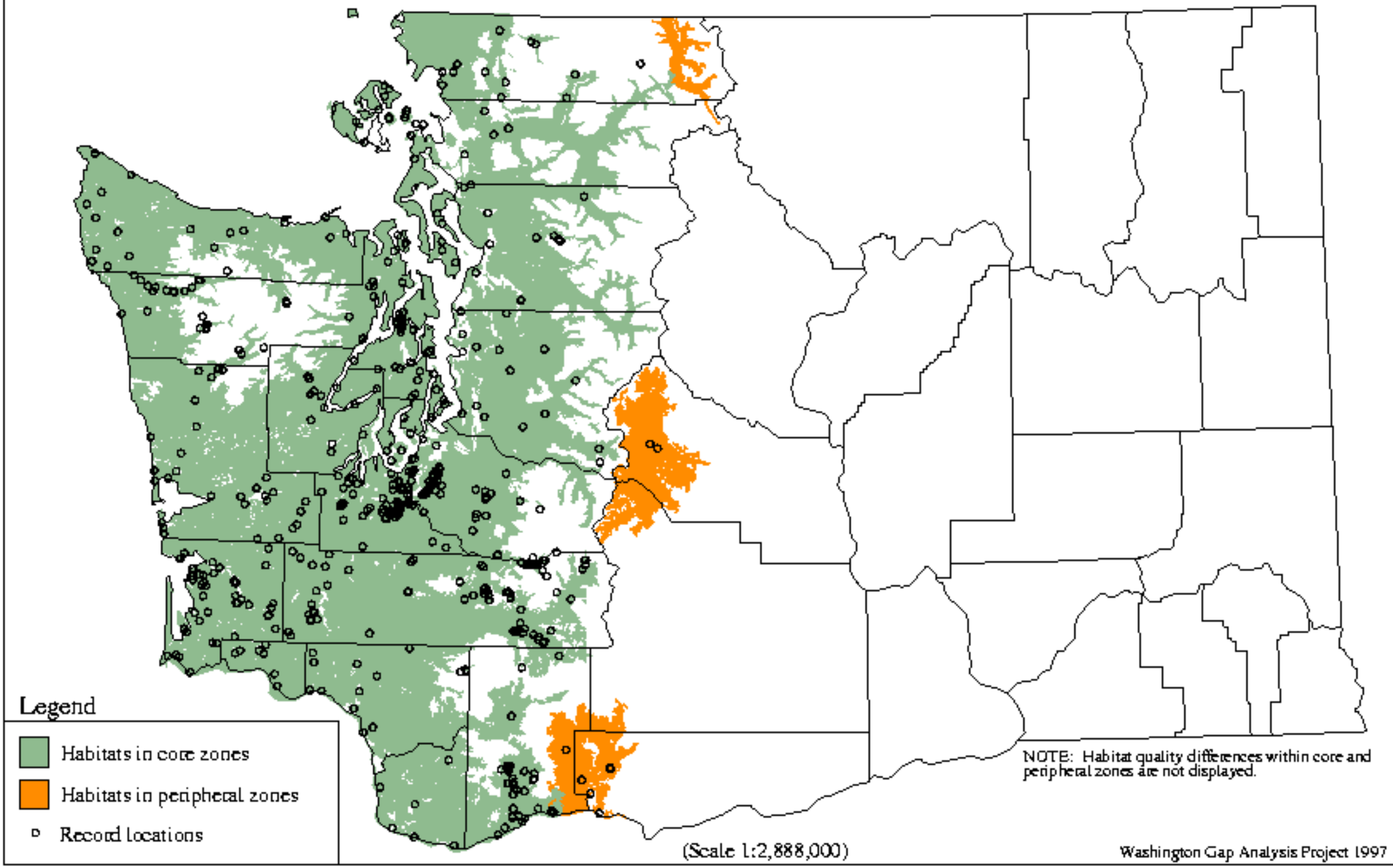
Hyla regilla - Pacific Treefrog



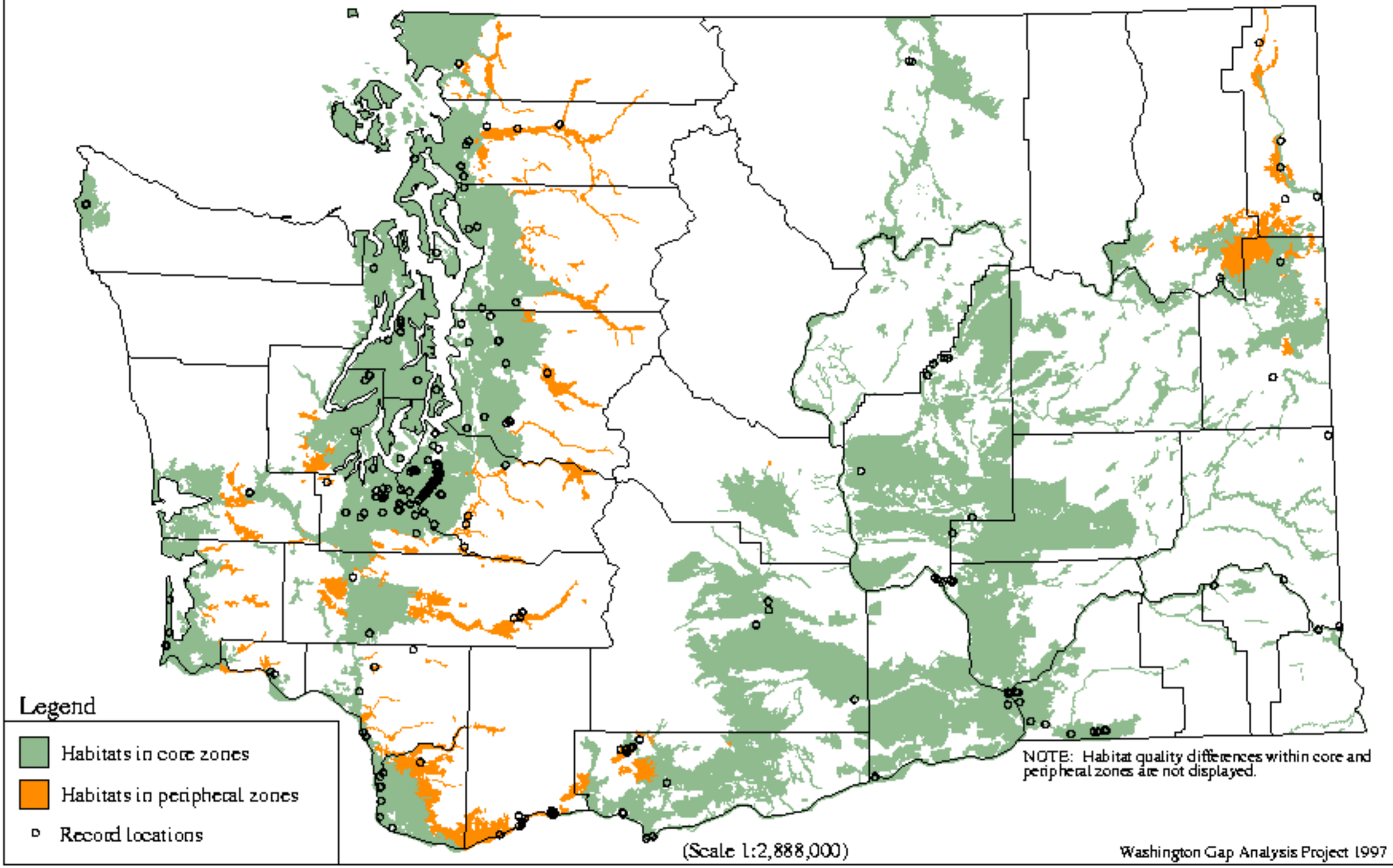
Trachemys scripta - Slider



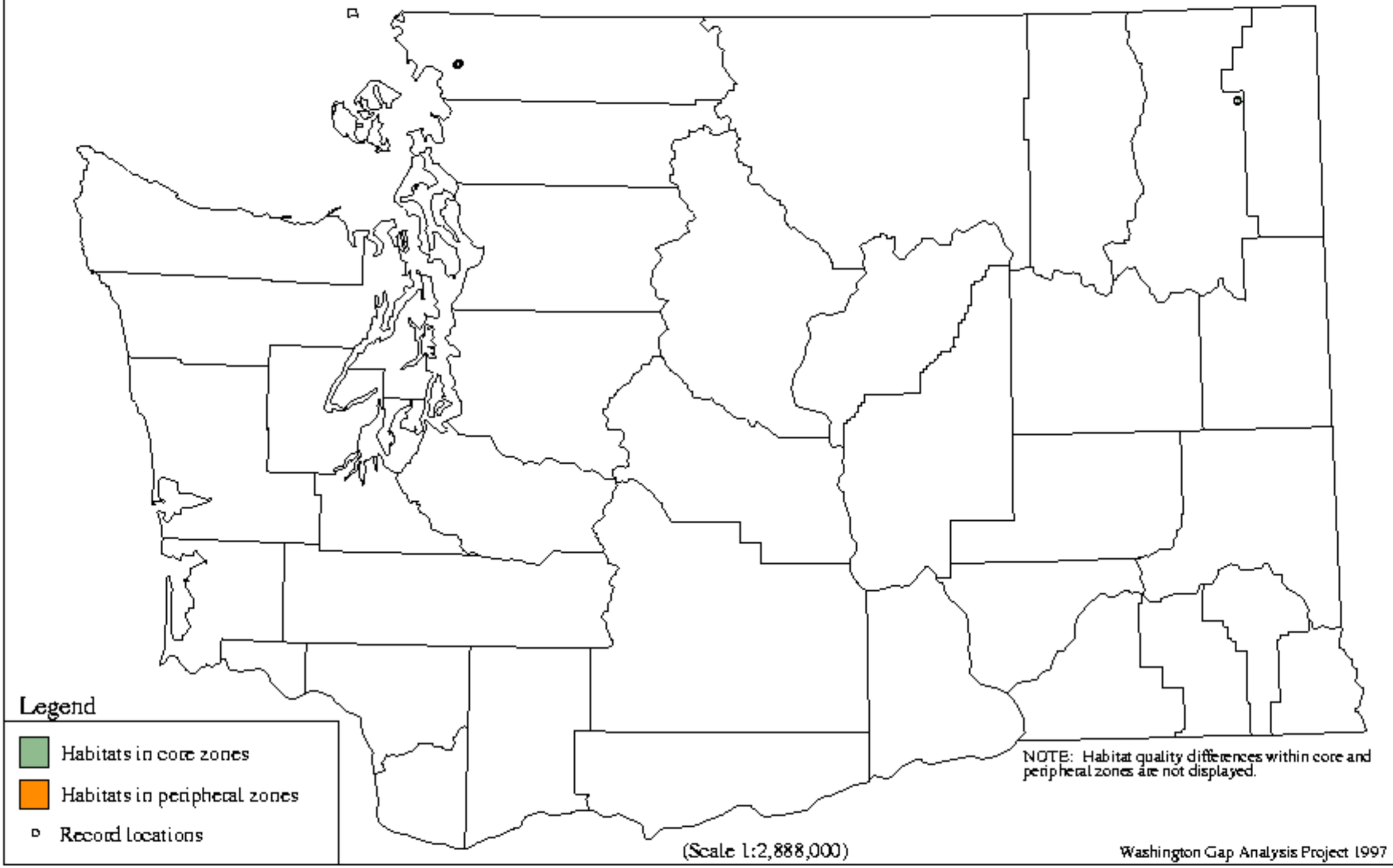
Rana aurora - Red-legged Frog



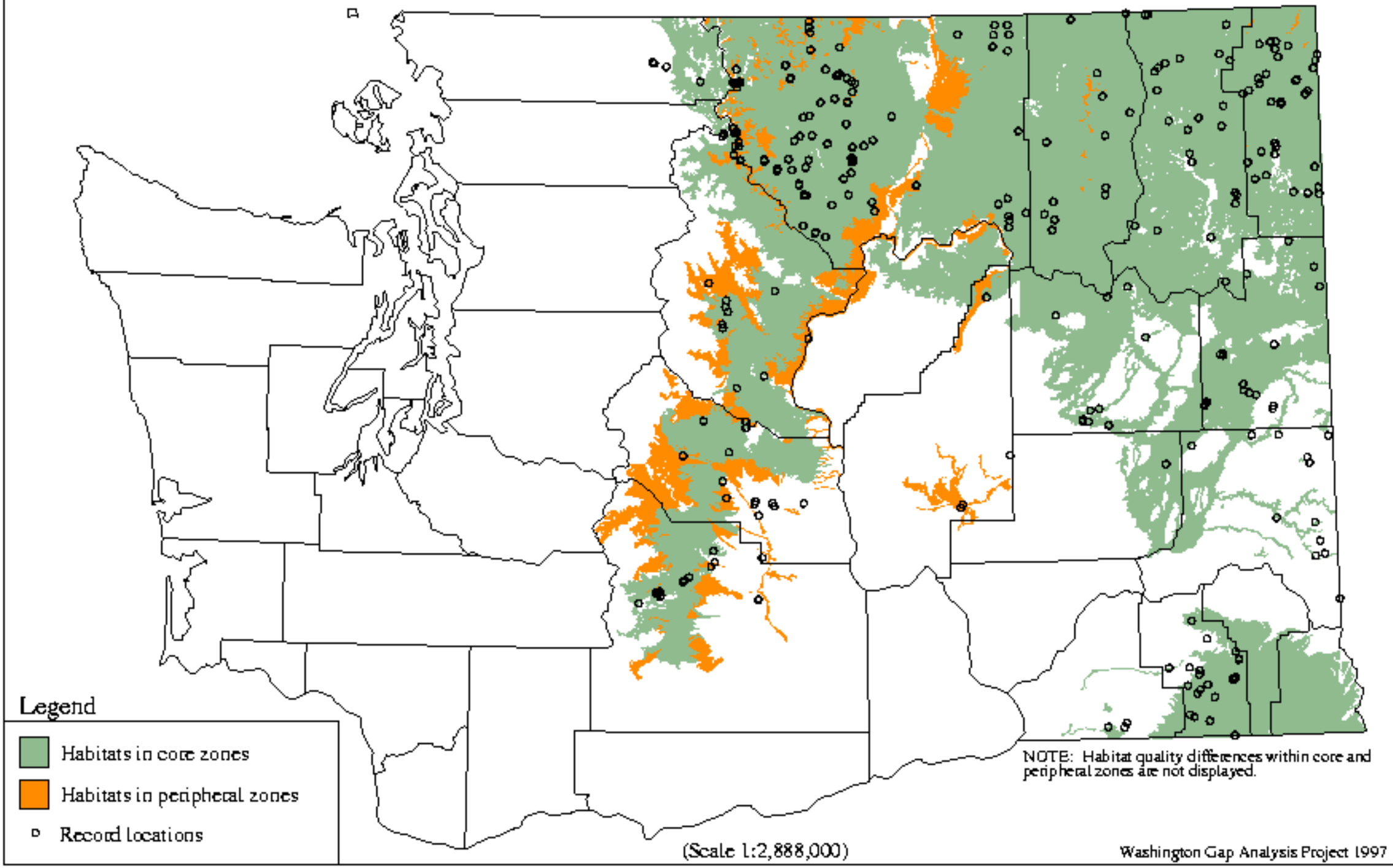
Rana catesbeiana - Bullfrog



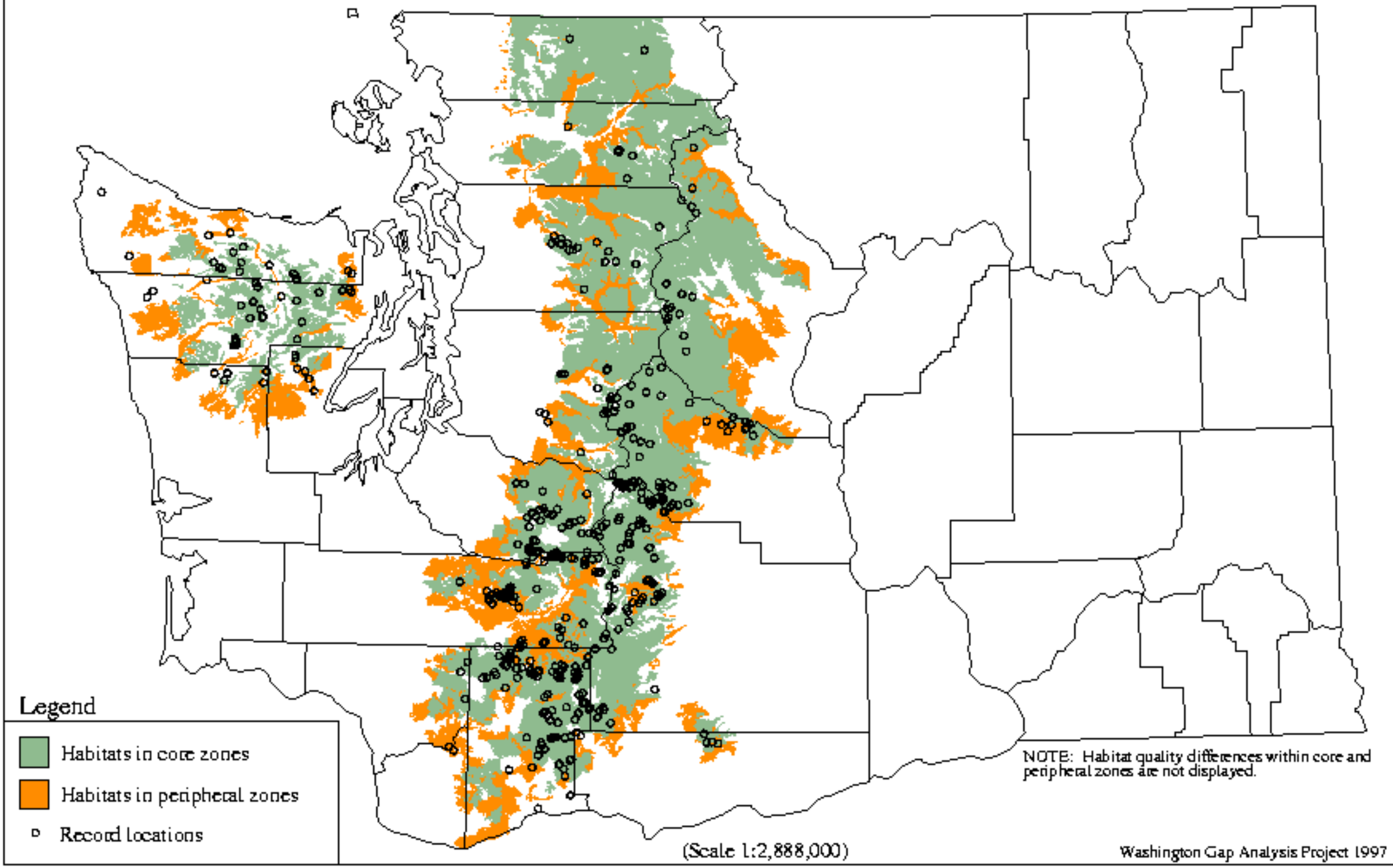
Rana clamitans - Green Frog



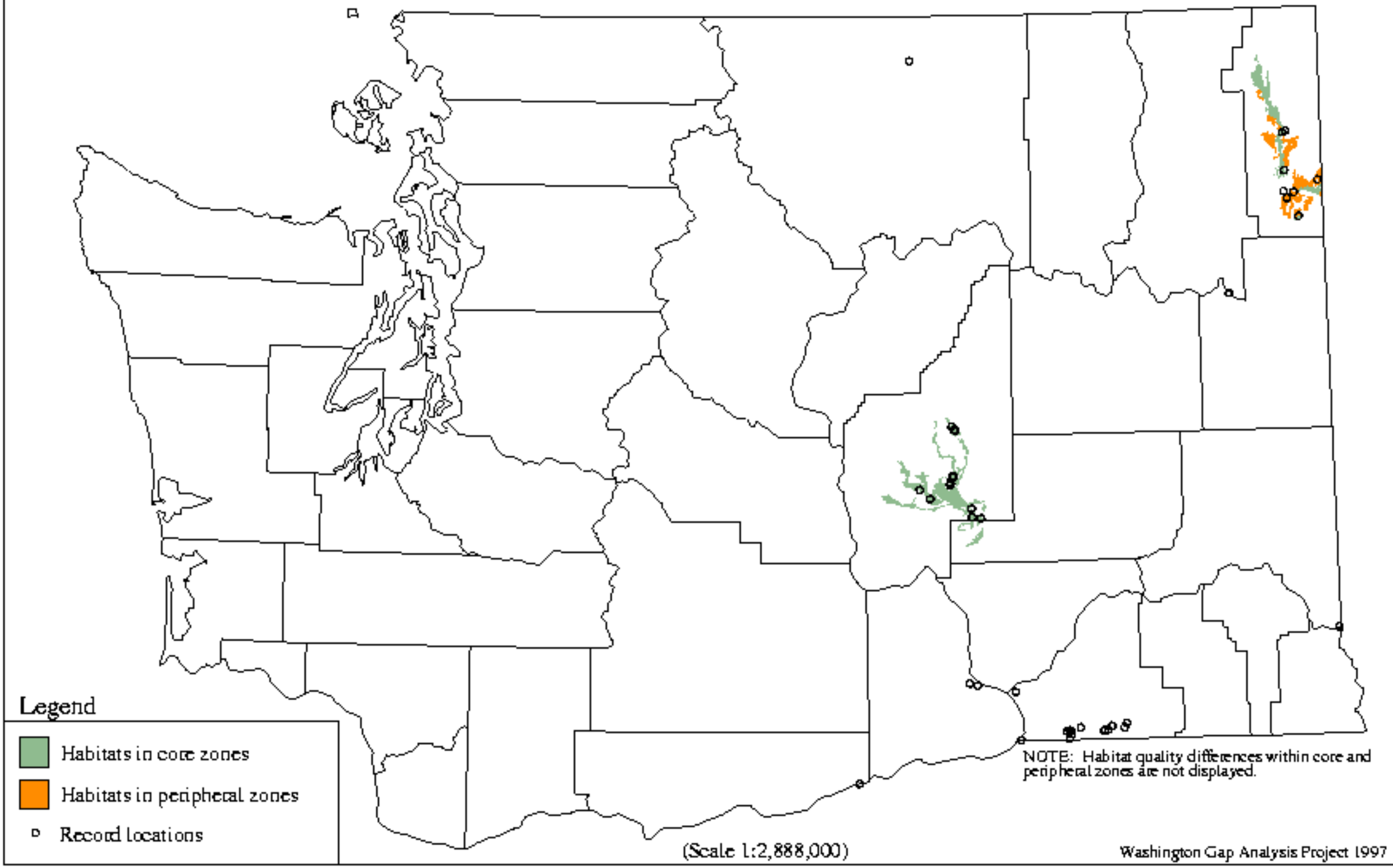
Rana luteiventris - Columbia Spotted Frog



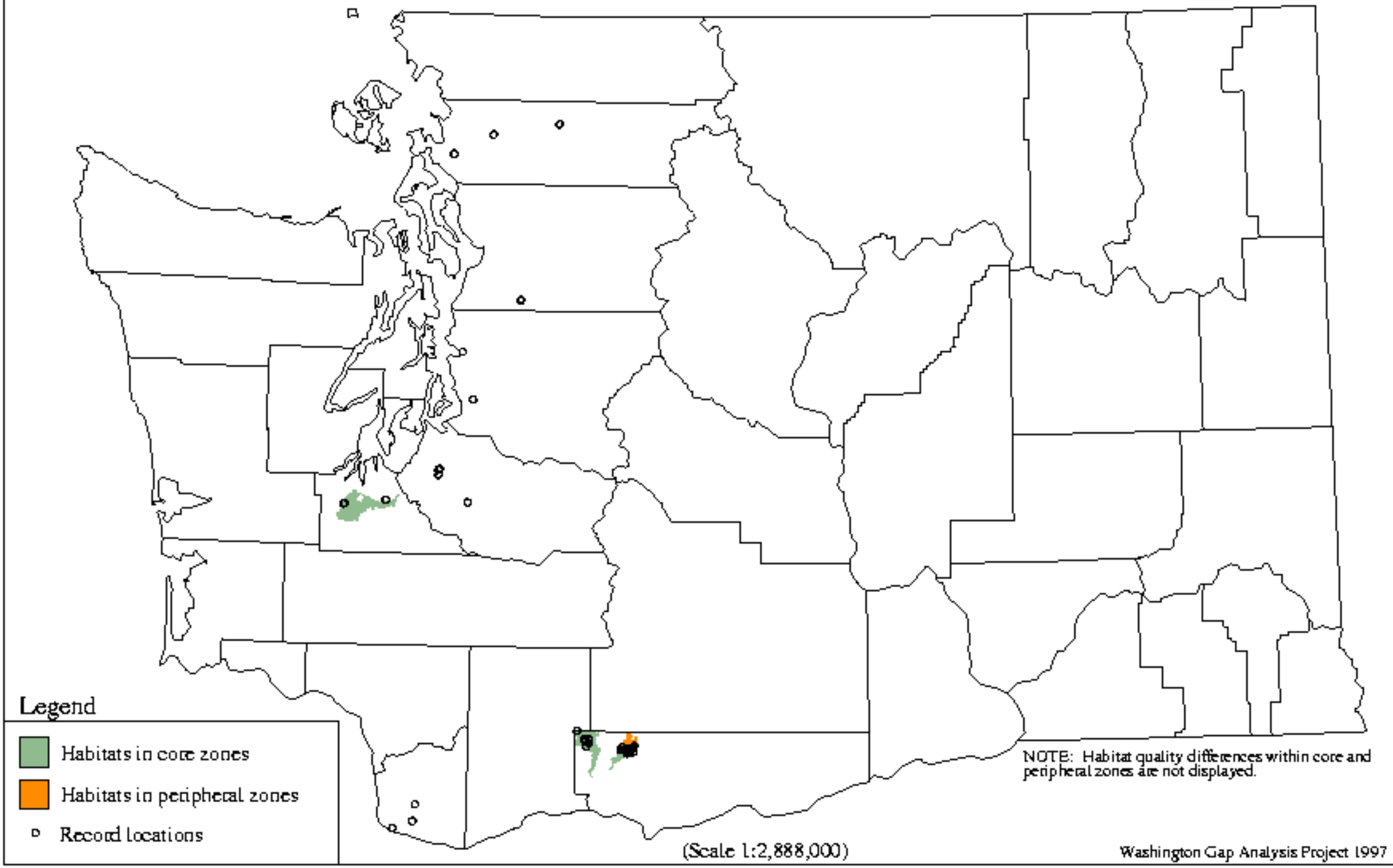
Rana cascadae - Cascades Frog



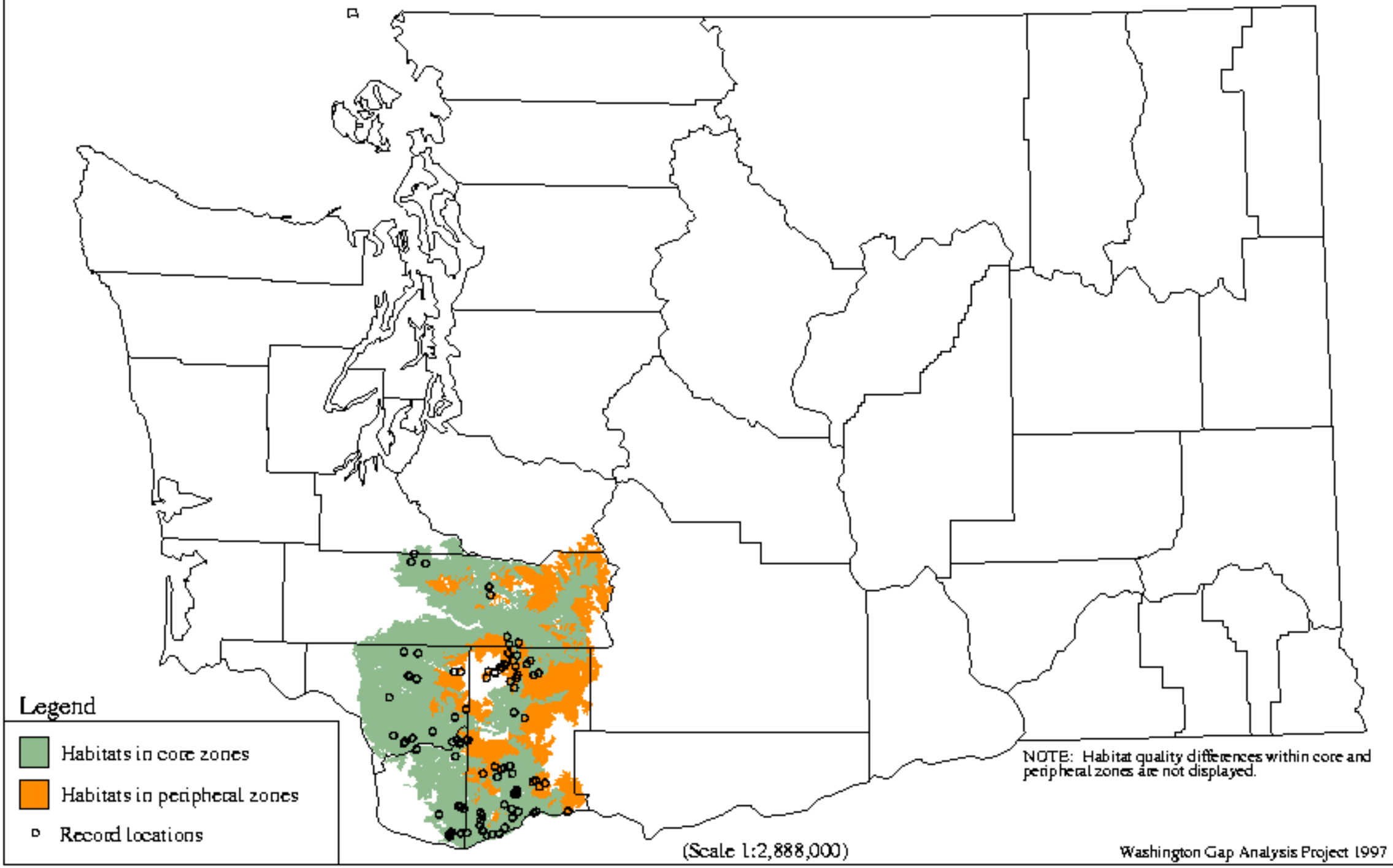
Rana pipiens - Northern Leopard Frog



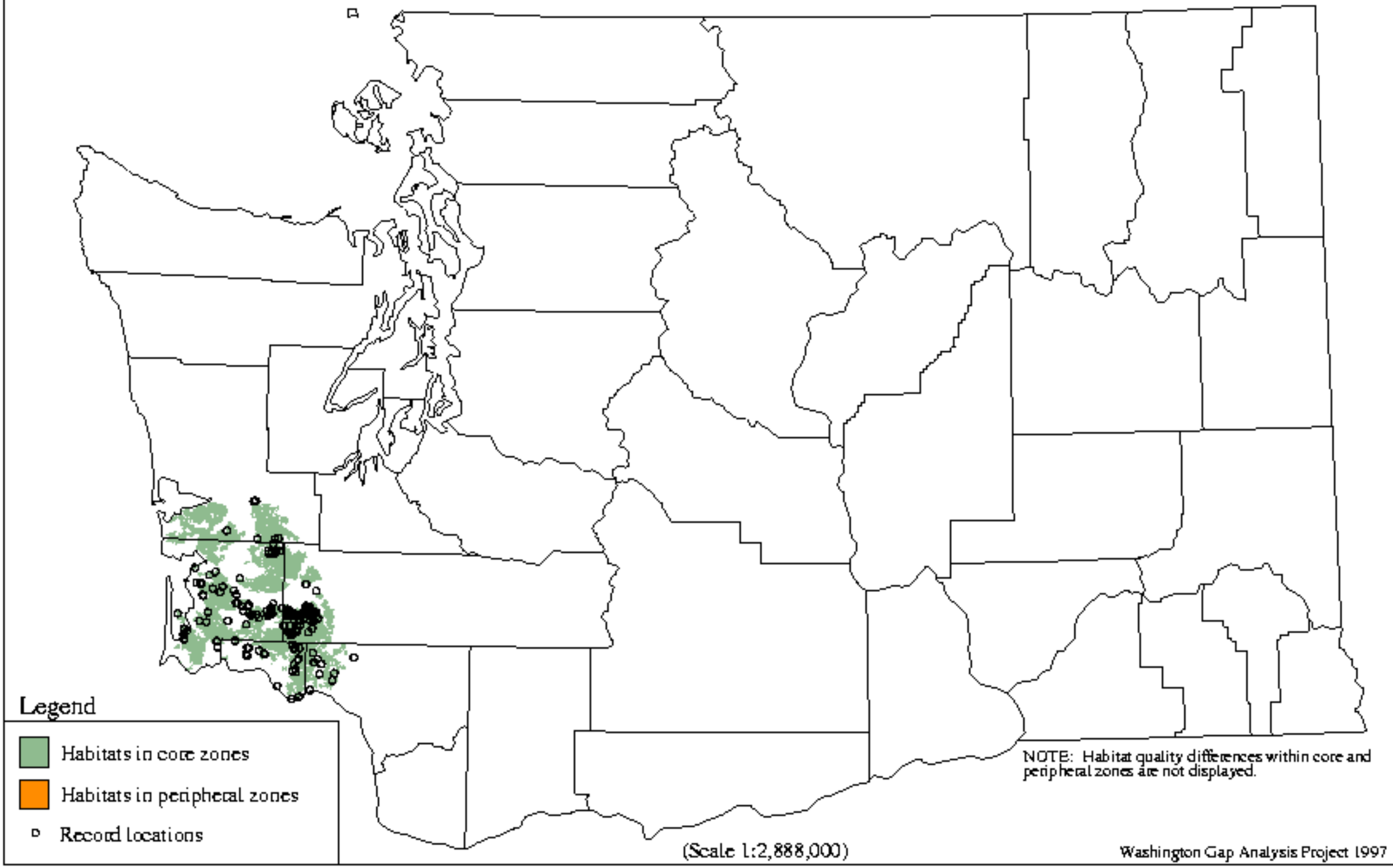
Rana pretiosa Species A - Oregon spotted frog



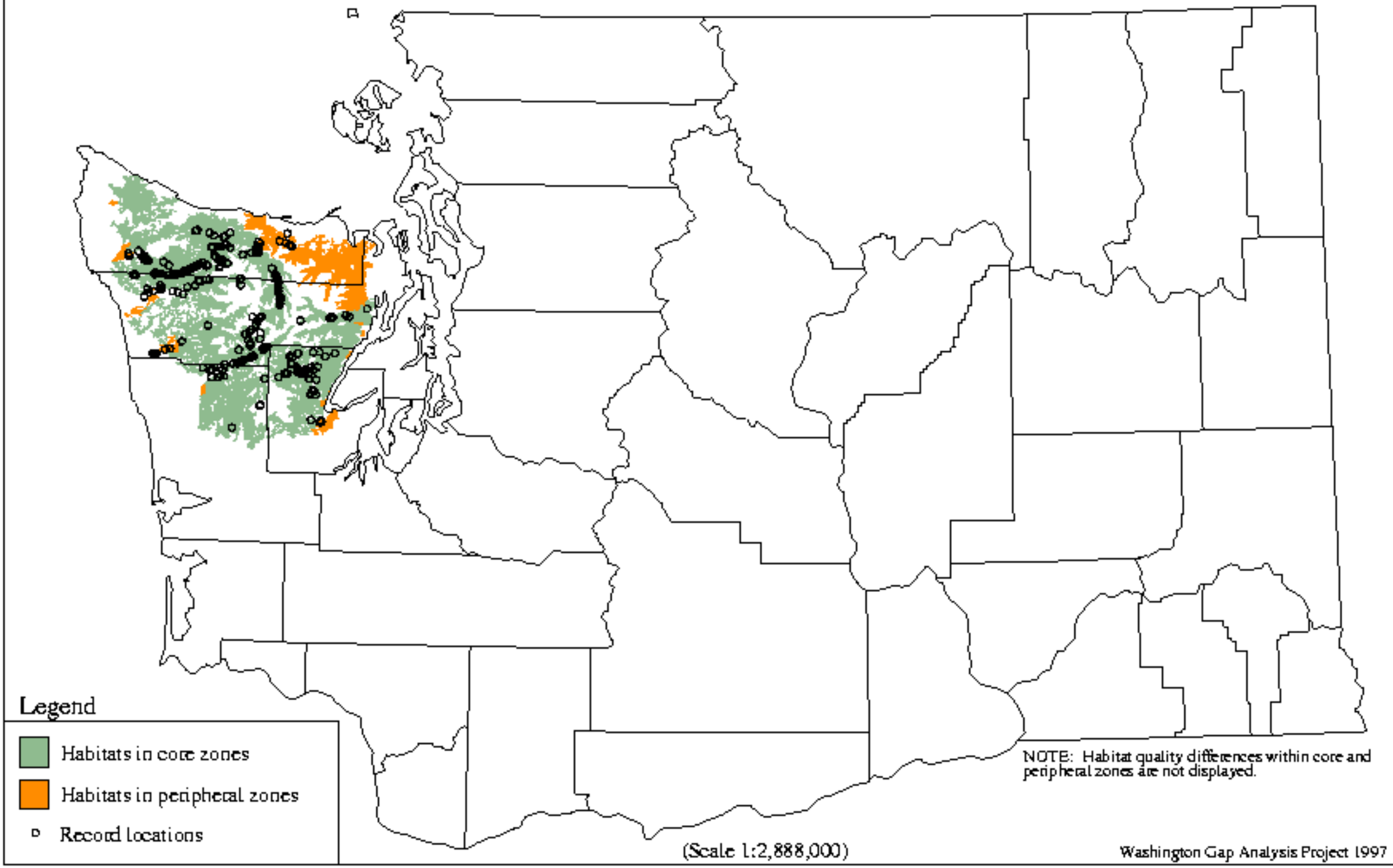
Rhyacotriton cascadae - Cascades Torrent Salamander



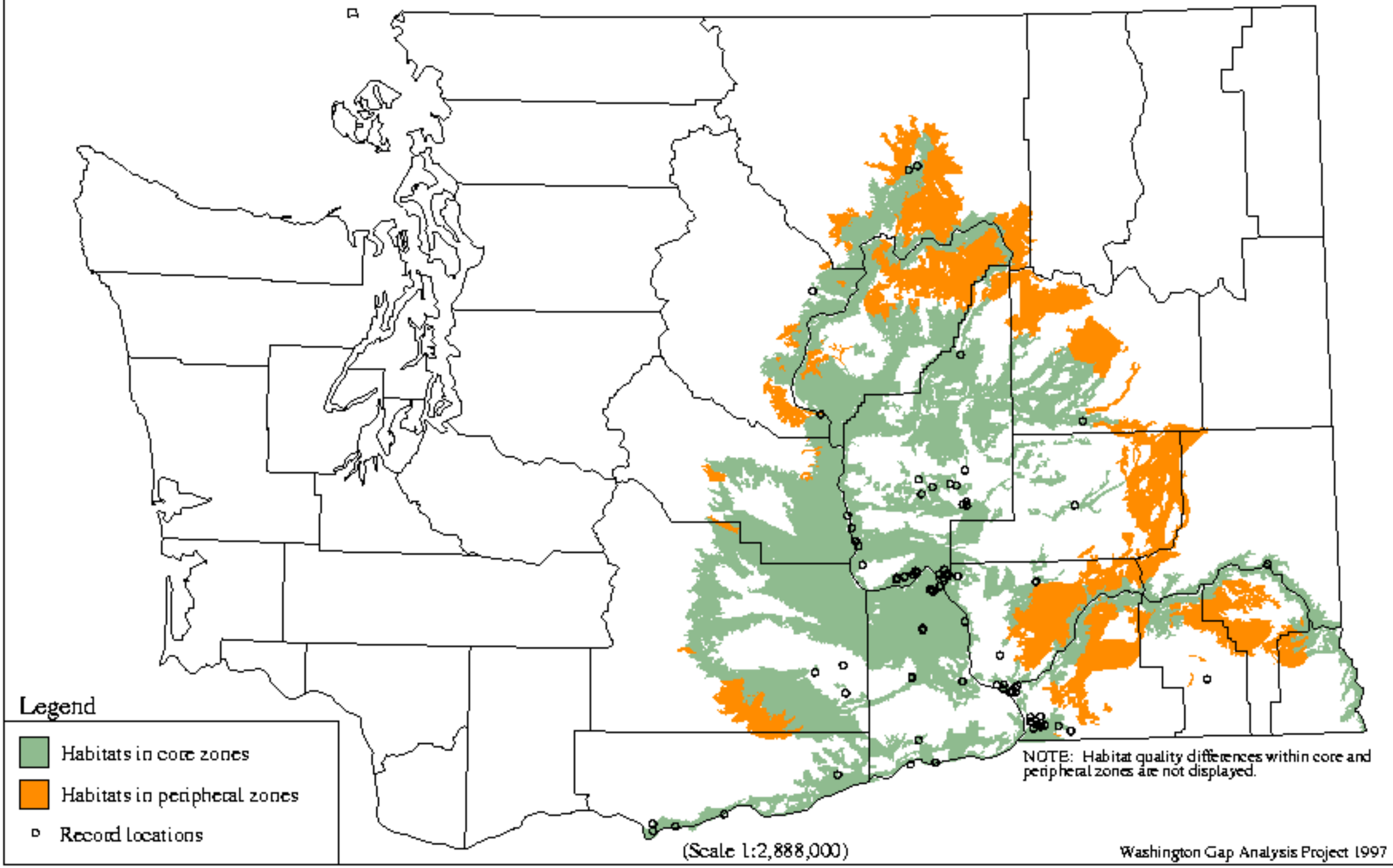
Rhyacotriton kezeri - Columbia Torrent Salamander



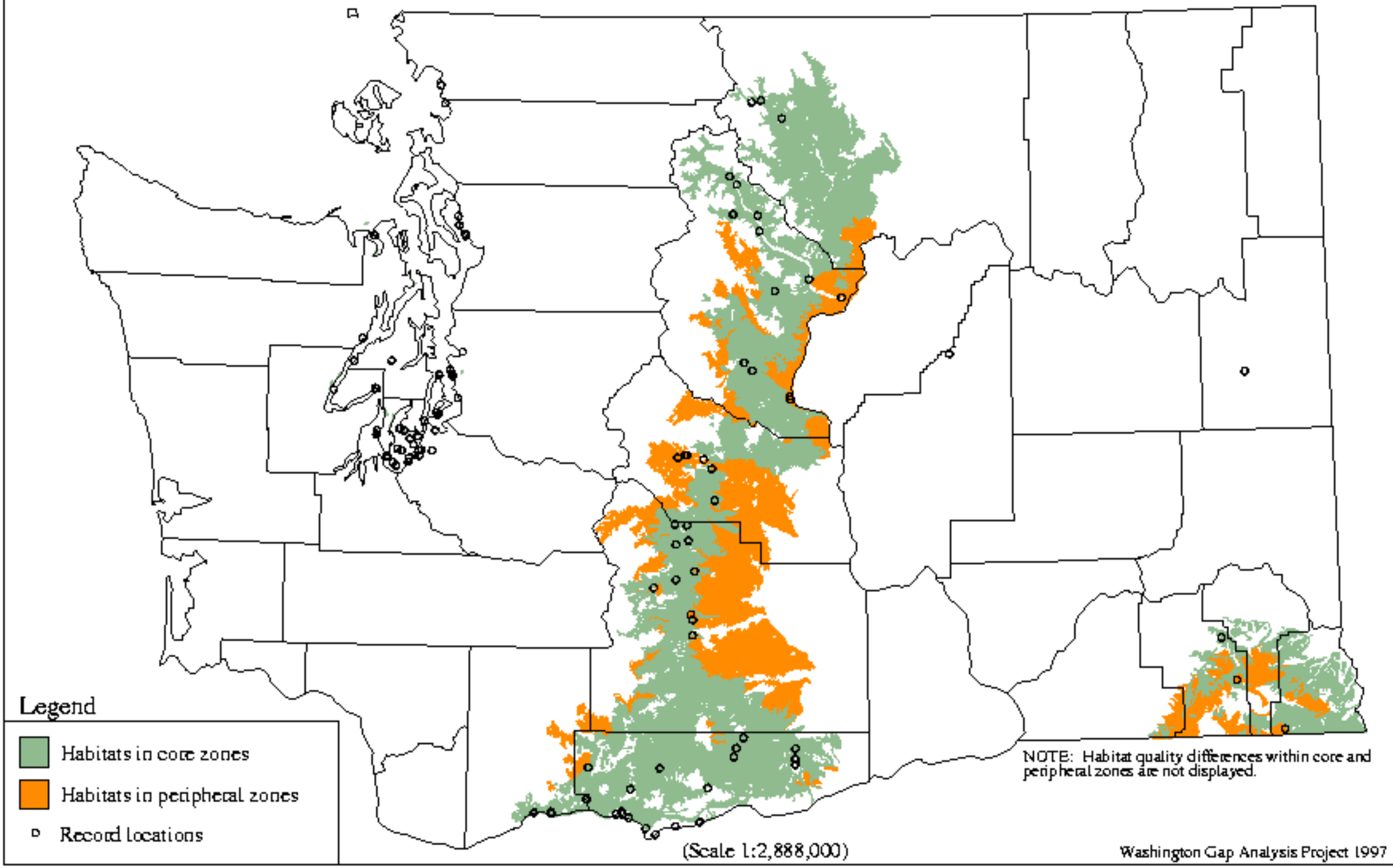
Rhyacotriton olympicus - Olympic Torrent Salamander



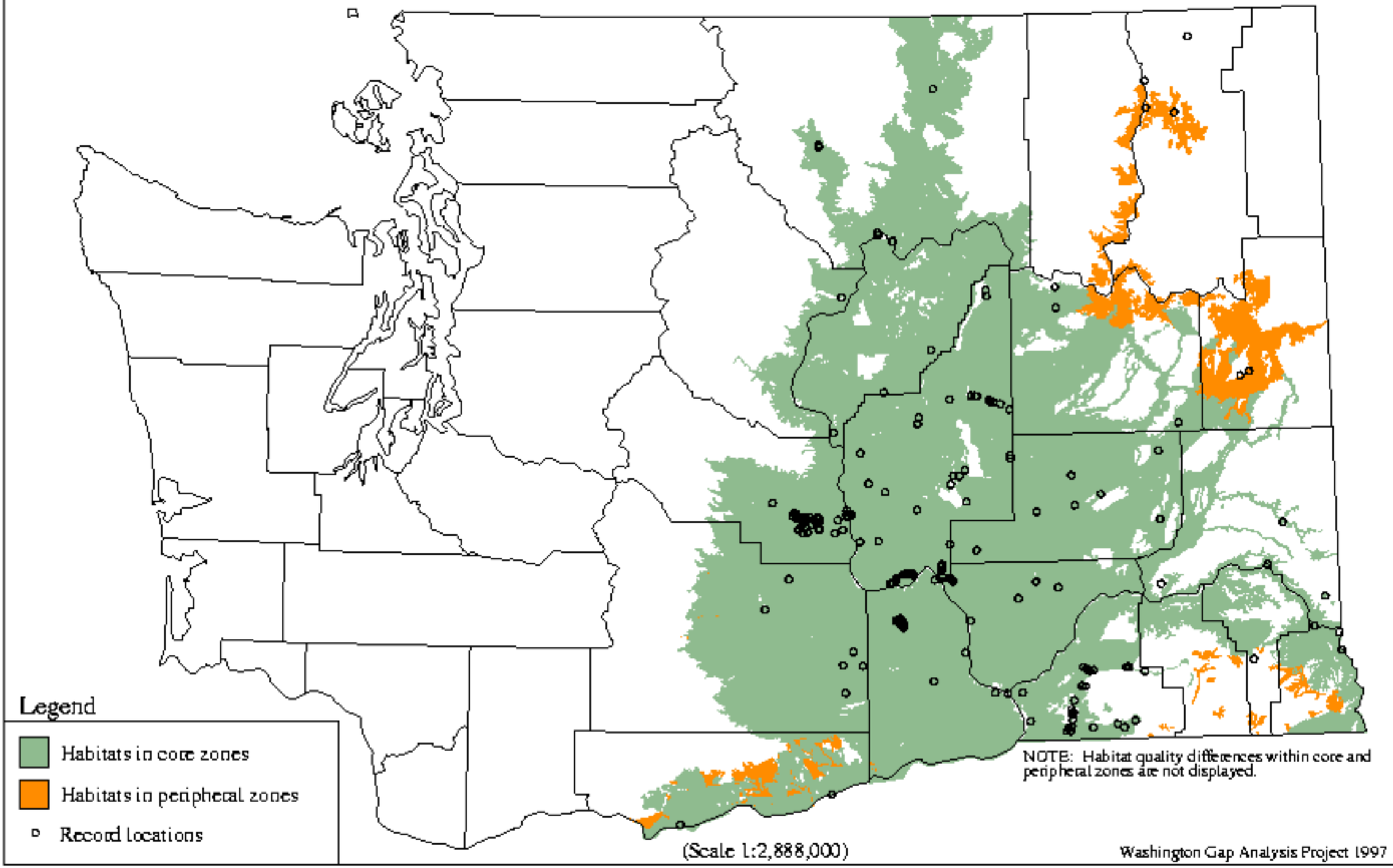
Sceloporus graciosus - Sagebrush Lizard



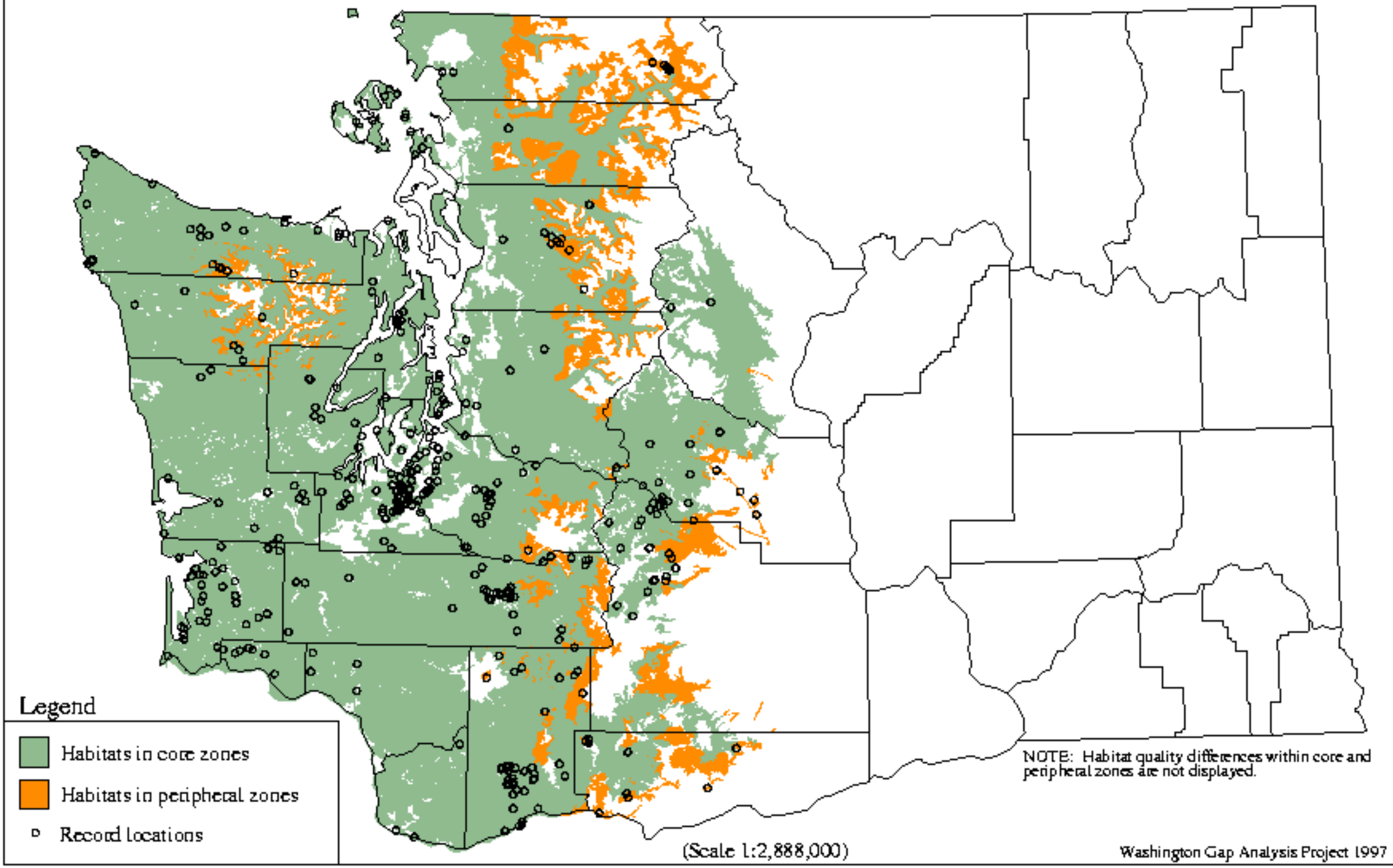
Sceloporus occidentalis - Western Fence Lizard



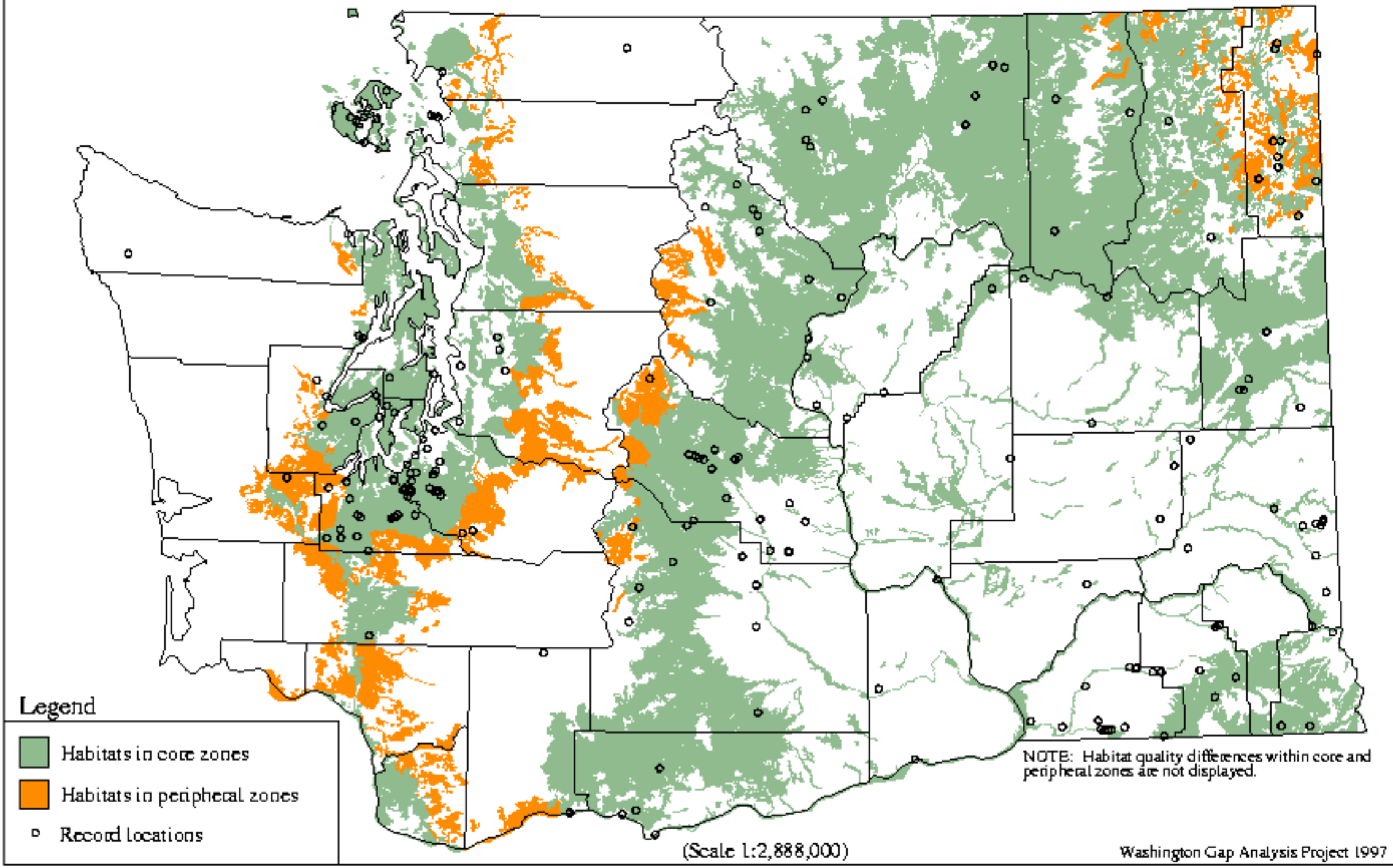
Scaphiopus intermontanus - Great Basin Spadefoot



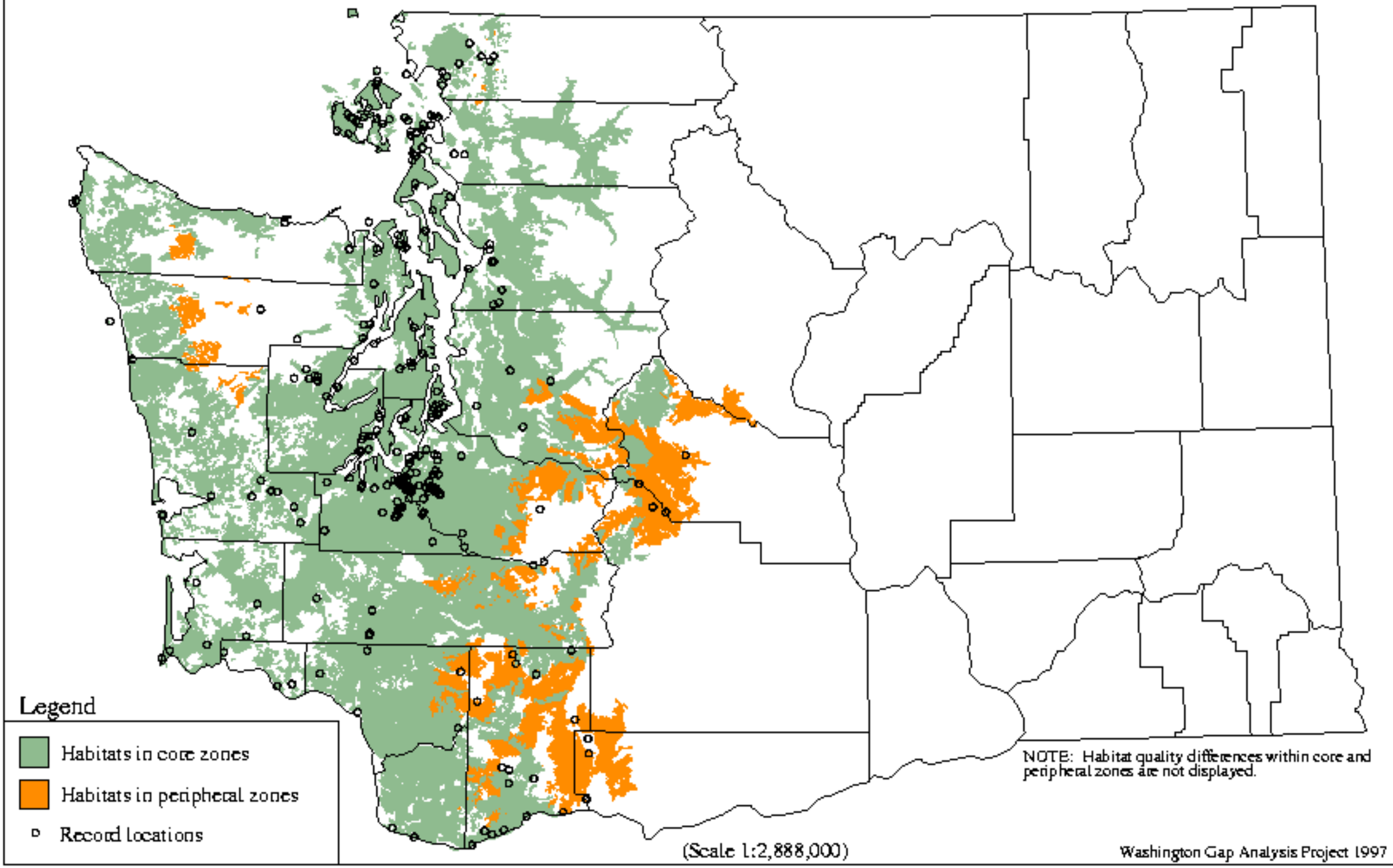
Taricha granulosa - Roughskin Newt



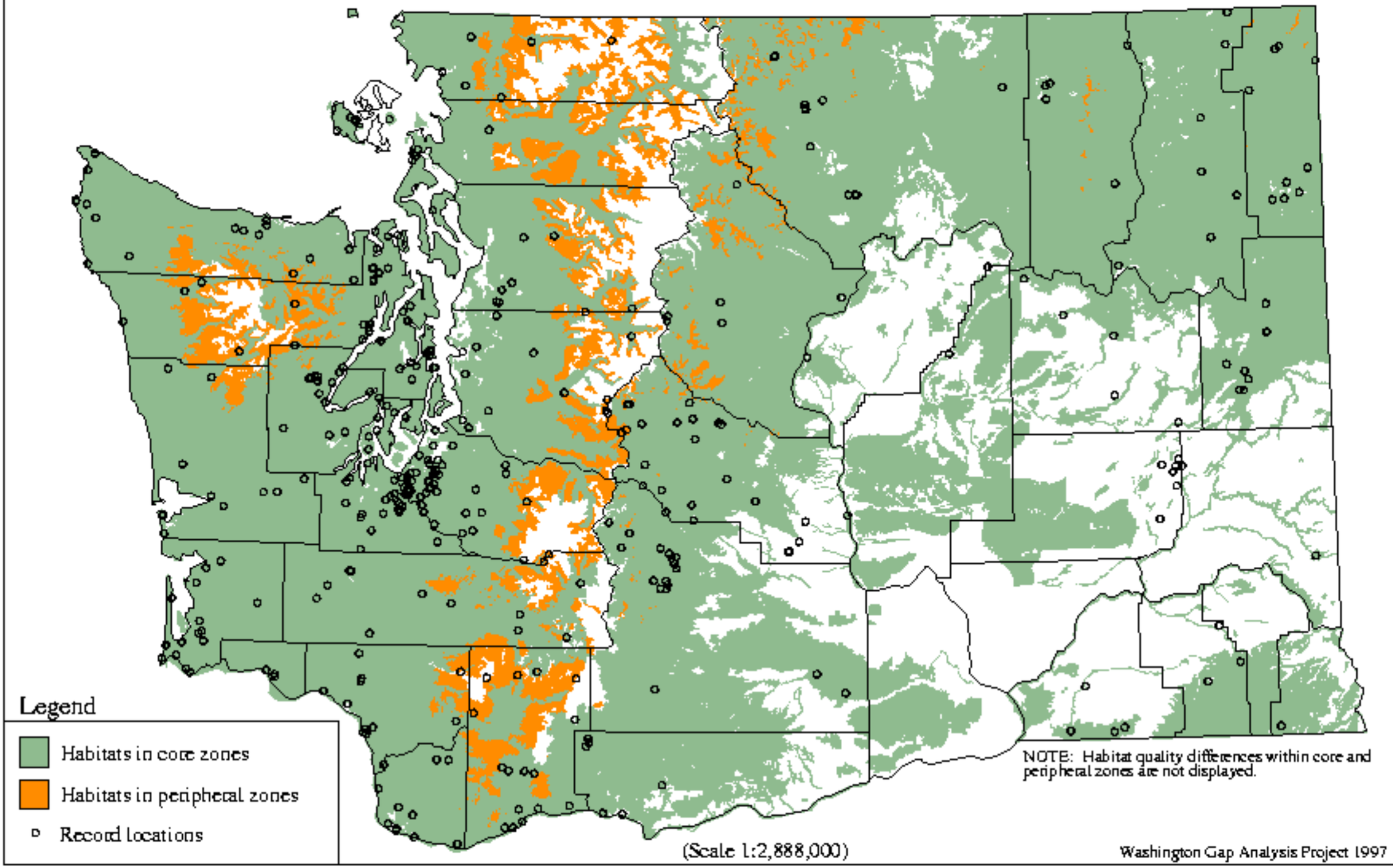
Thamnophis elegans - Western Terrestrial Garter Snake



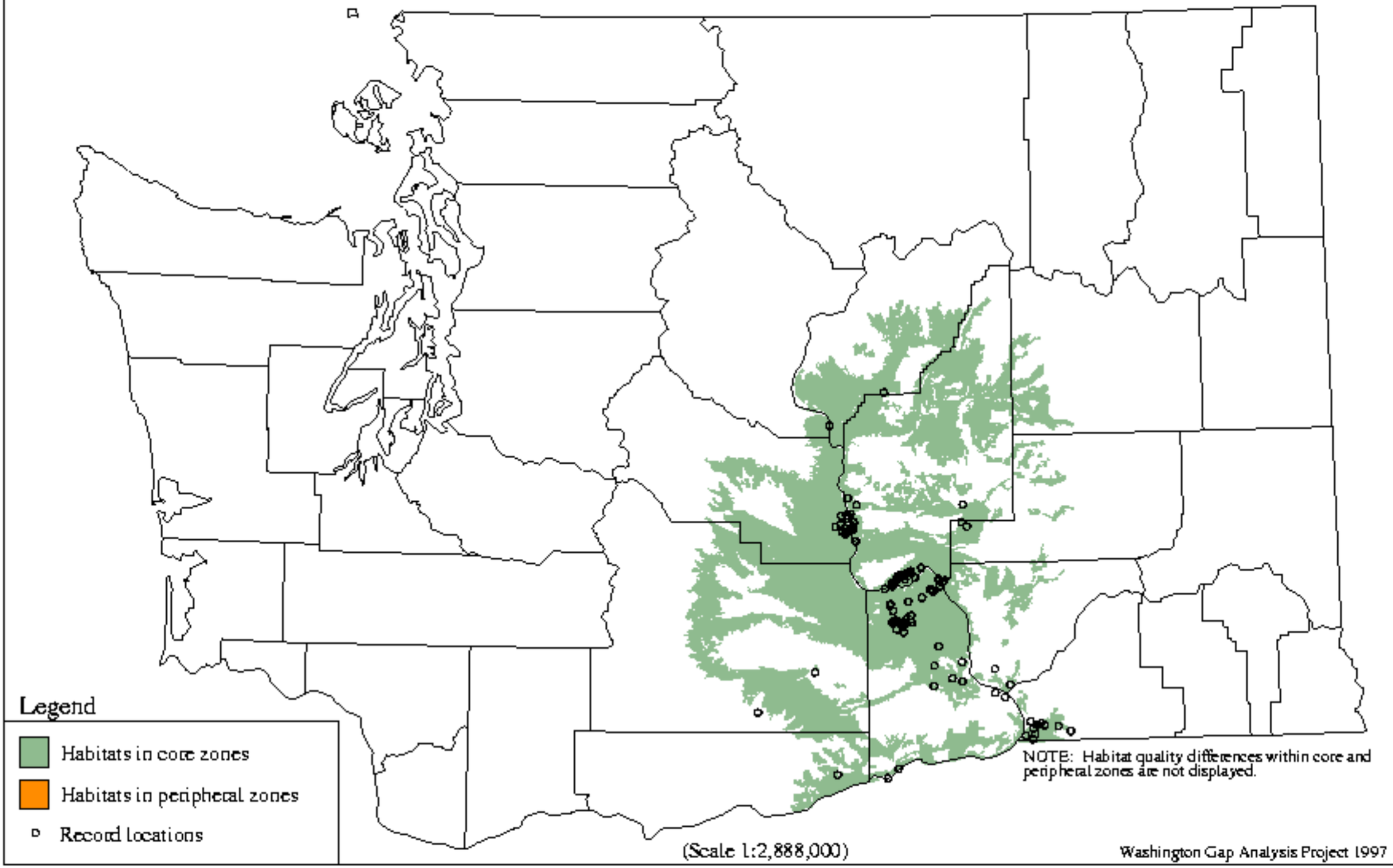
Thamnophis ordinoides - Northwestern Garter Snake



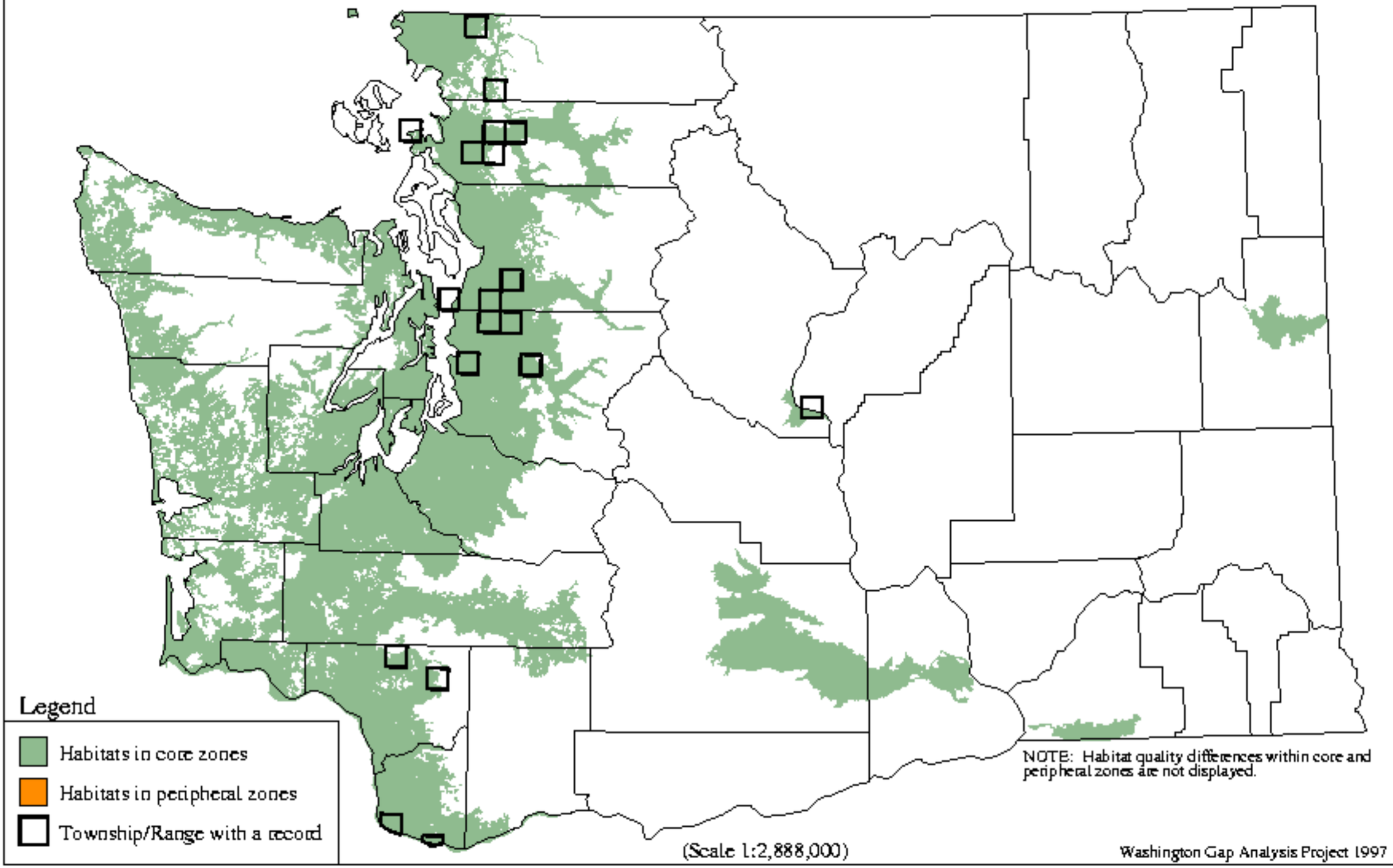
Thamnophis sirtalis - Common Garter Snake



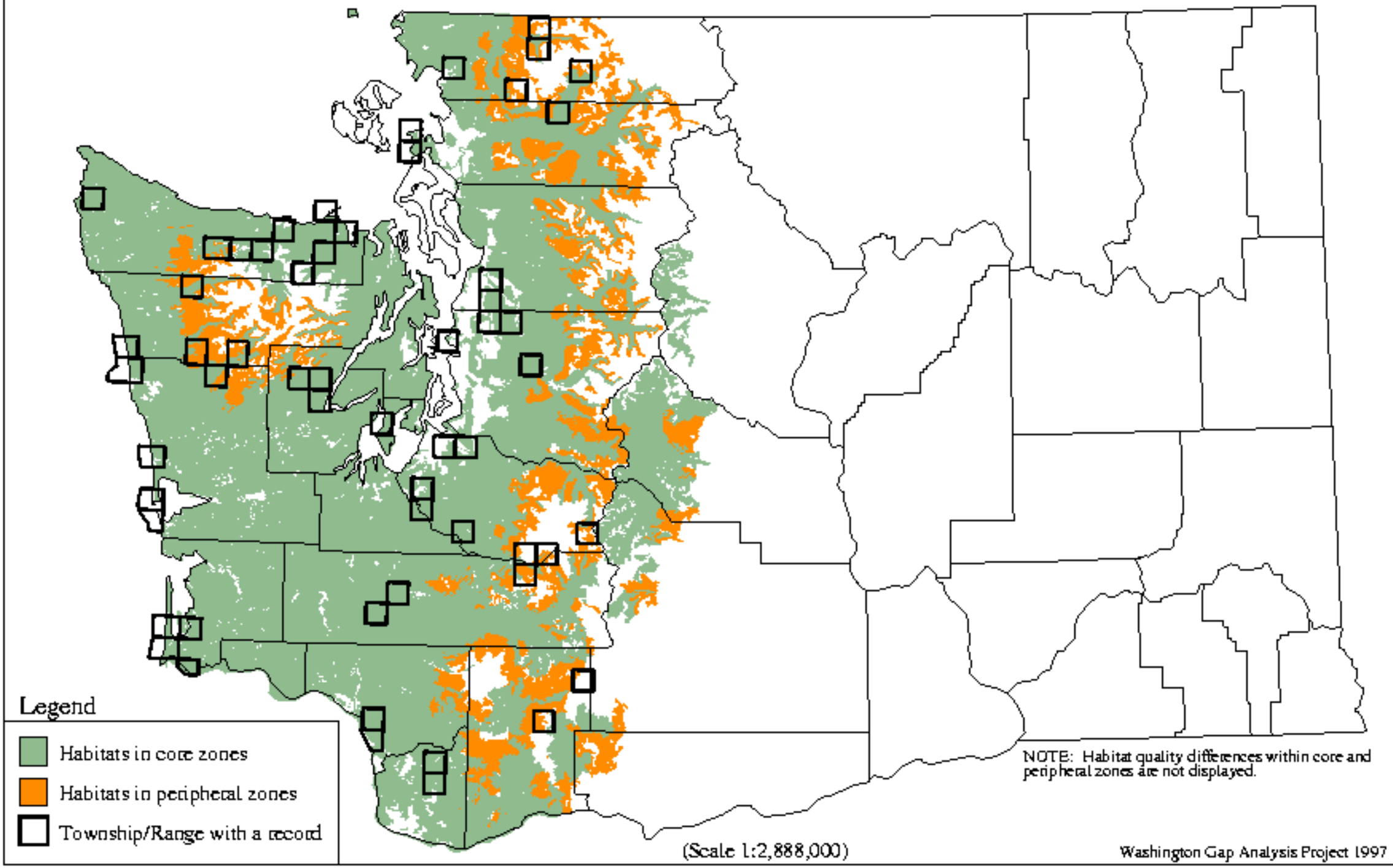
Uta stansburiana - Side-blotched Lizard



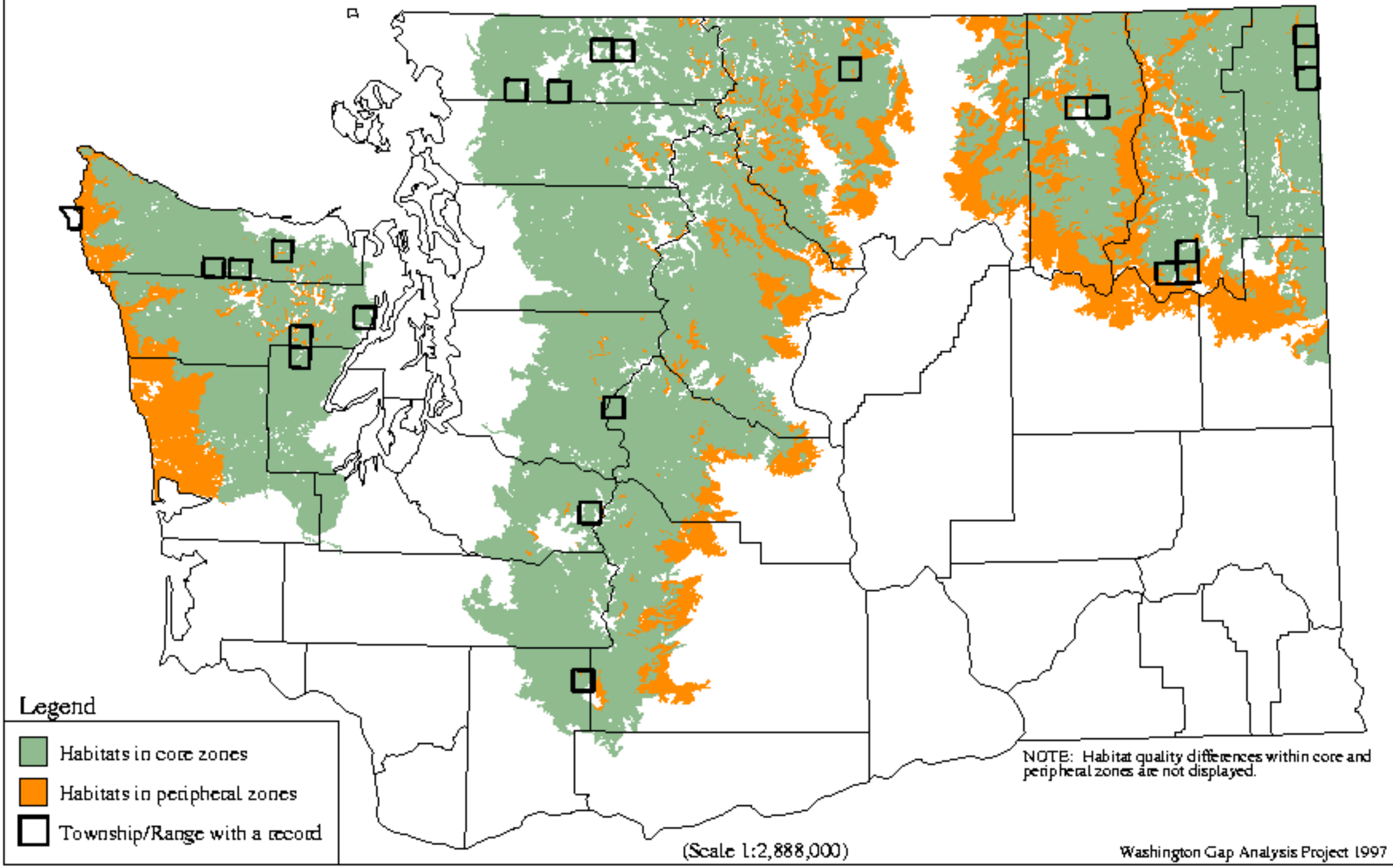
Didelphis virginiana - Virginia Opossum



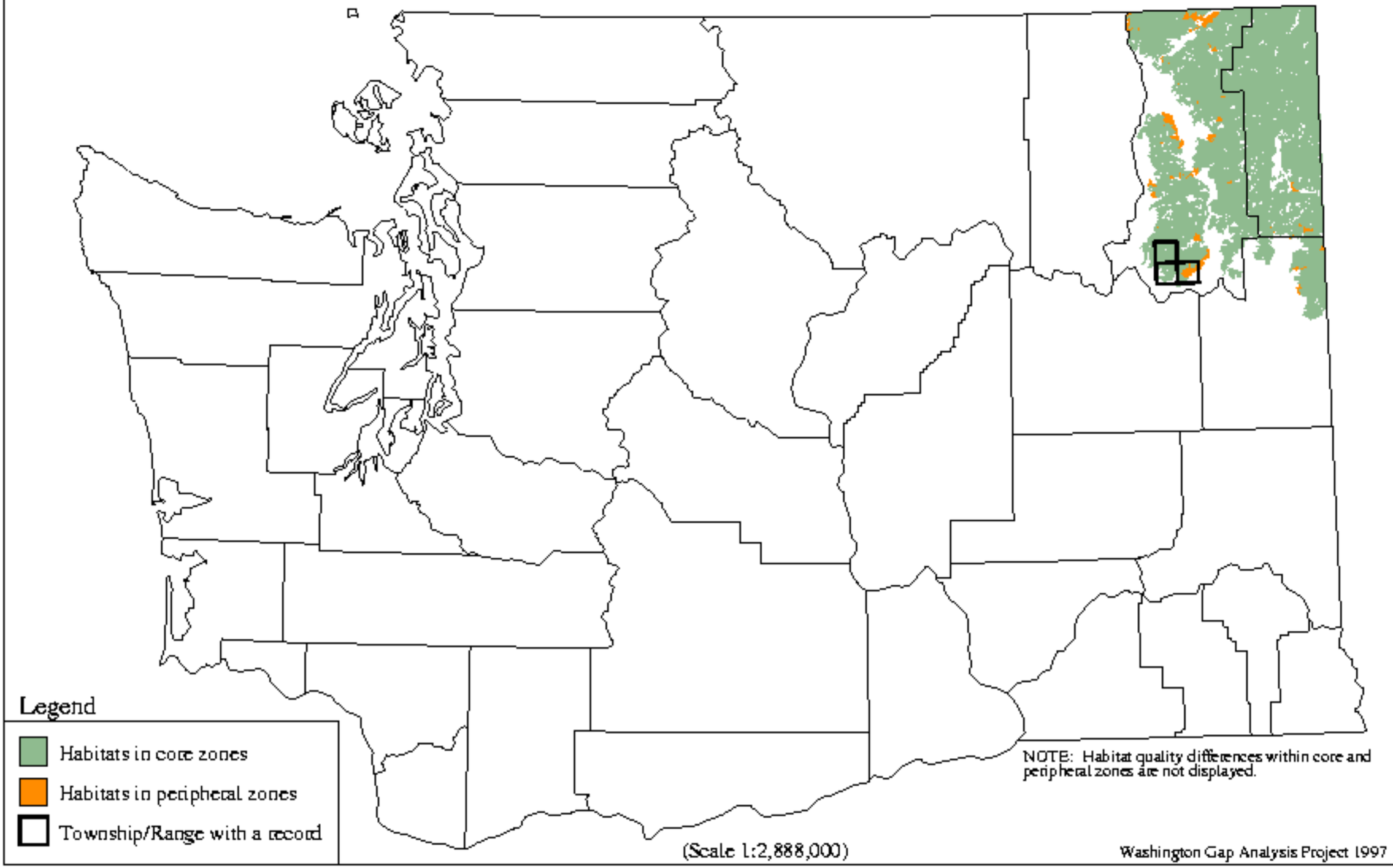
Sorex bendirii - Bendire`s Shrew



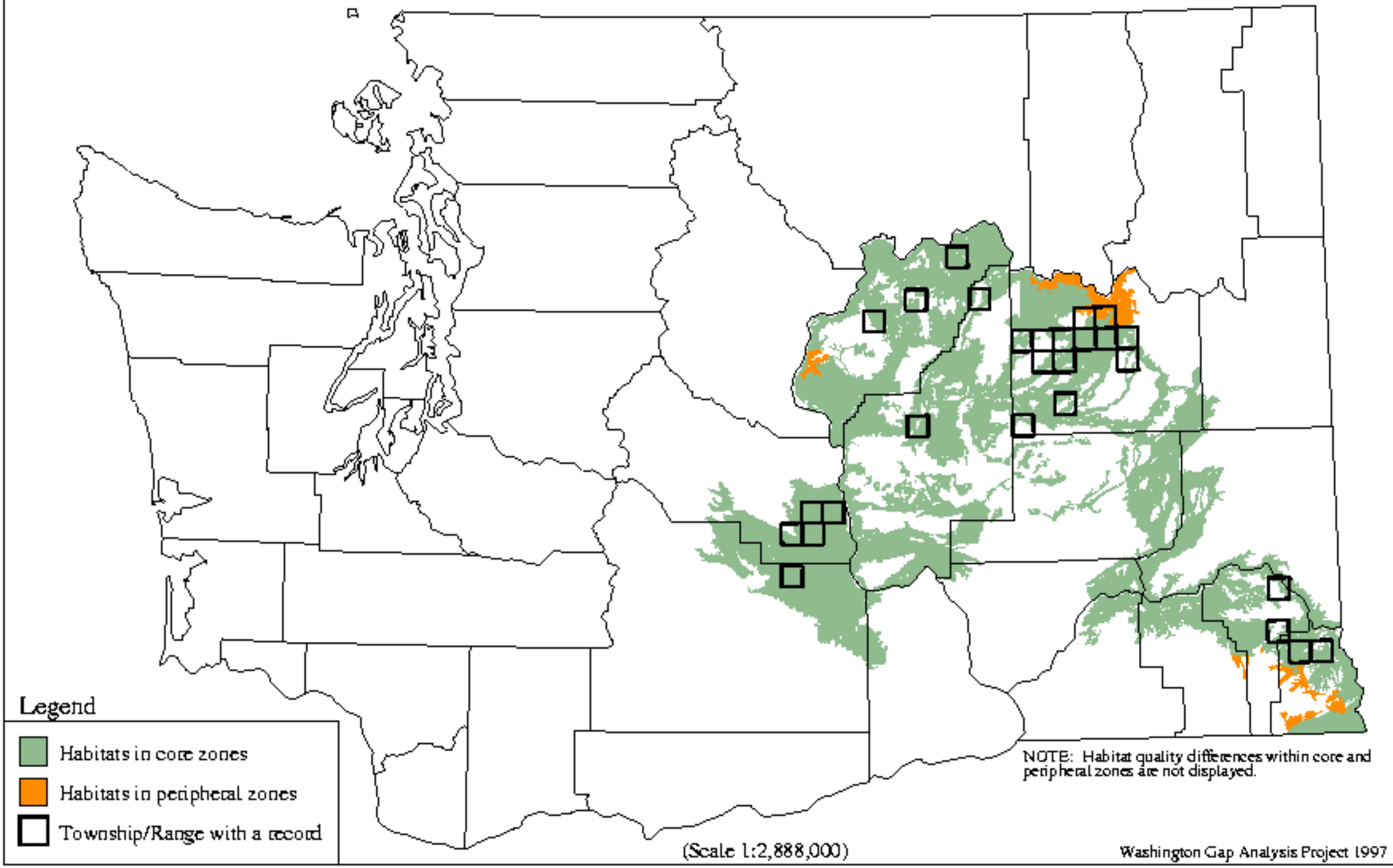
Sorex cinereus - Masked Shrew

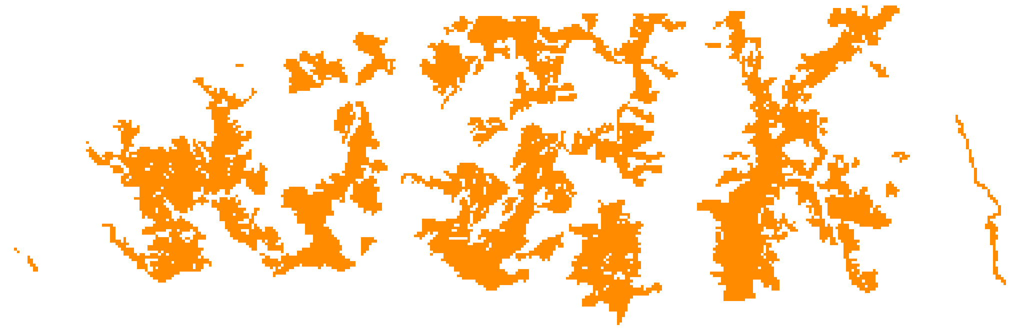


Sorex hoyi - Pygmy Shrew

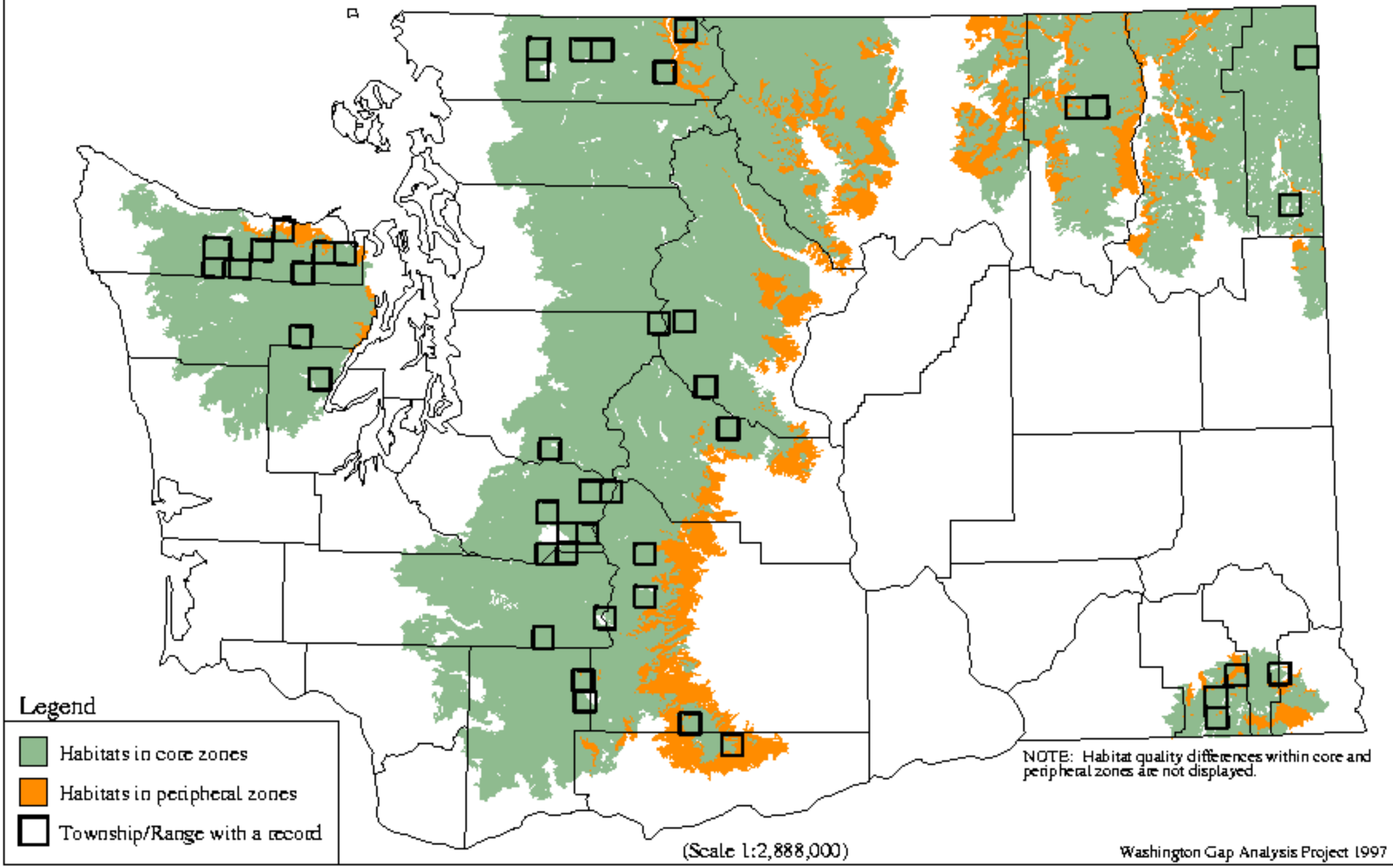


Sorex merriami - Merriam`s Shrew

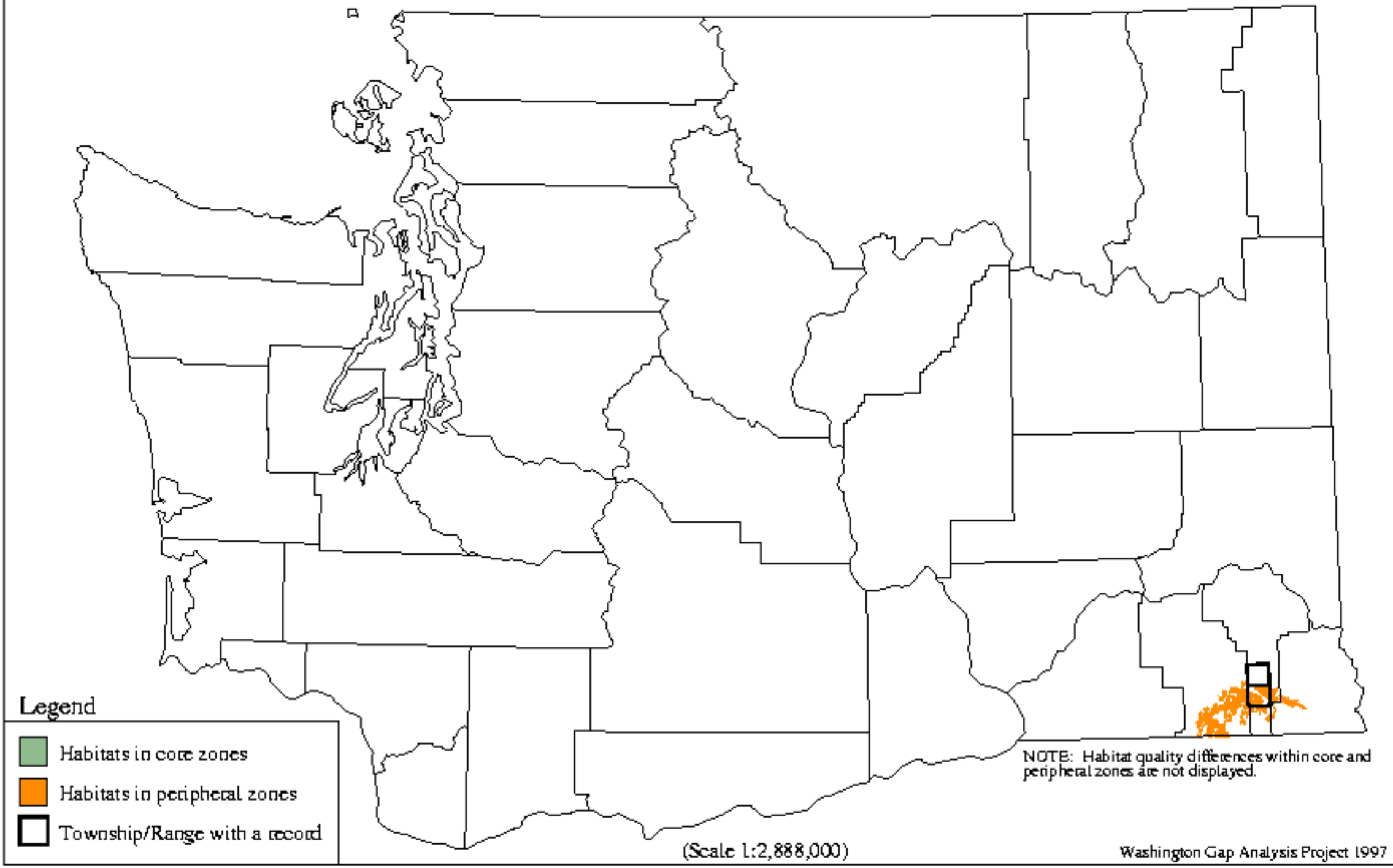




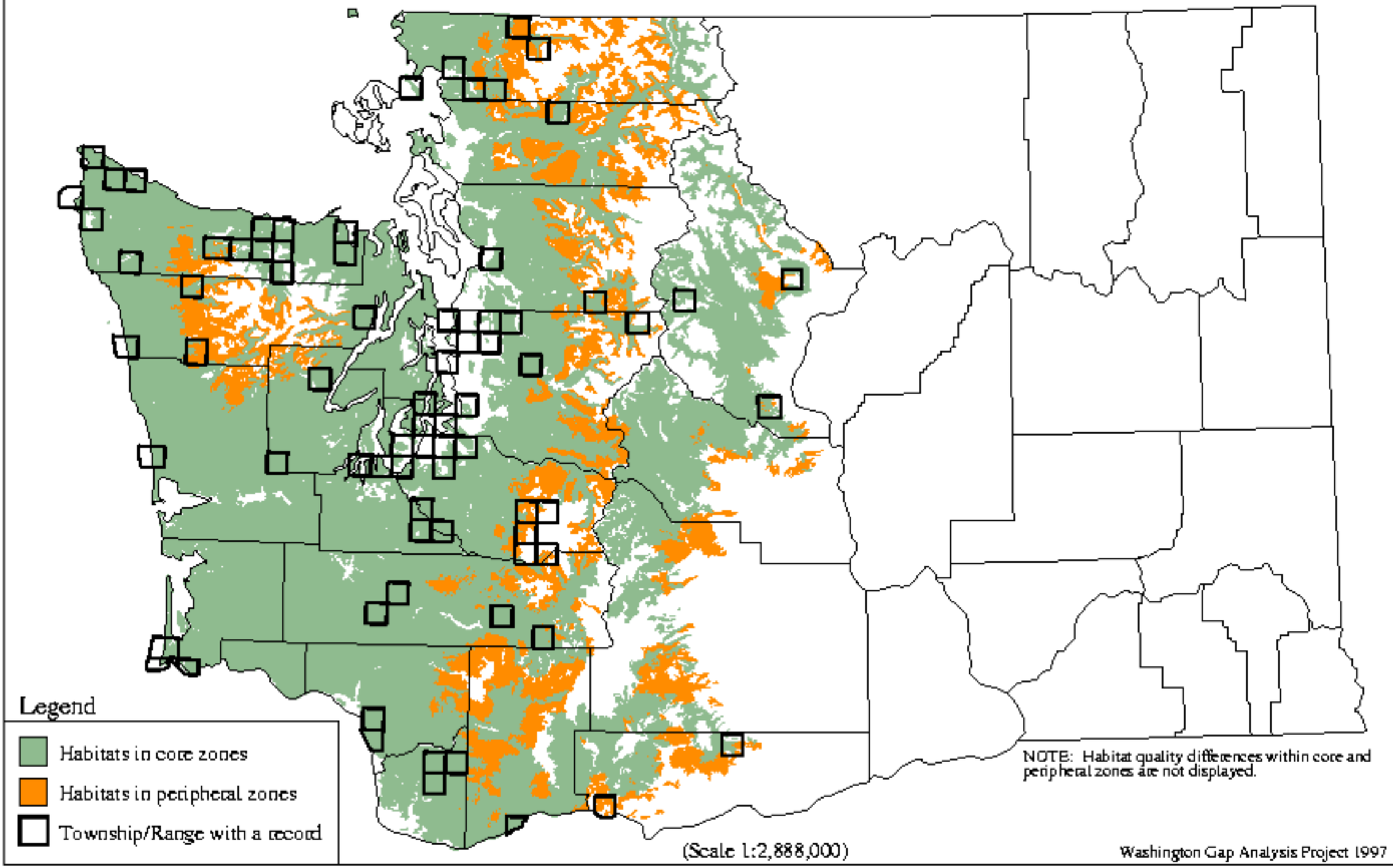
Sorex palustris - Water Shrew



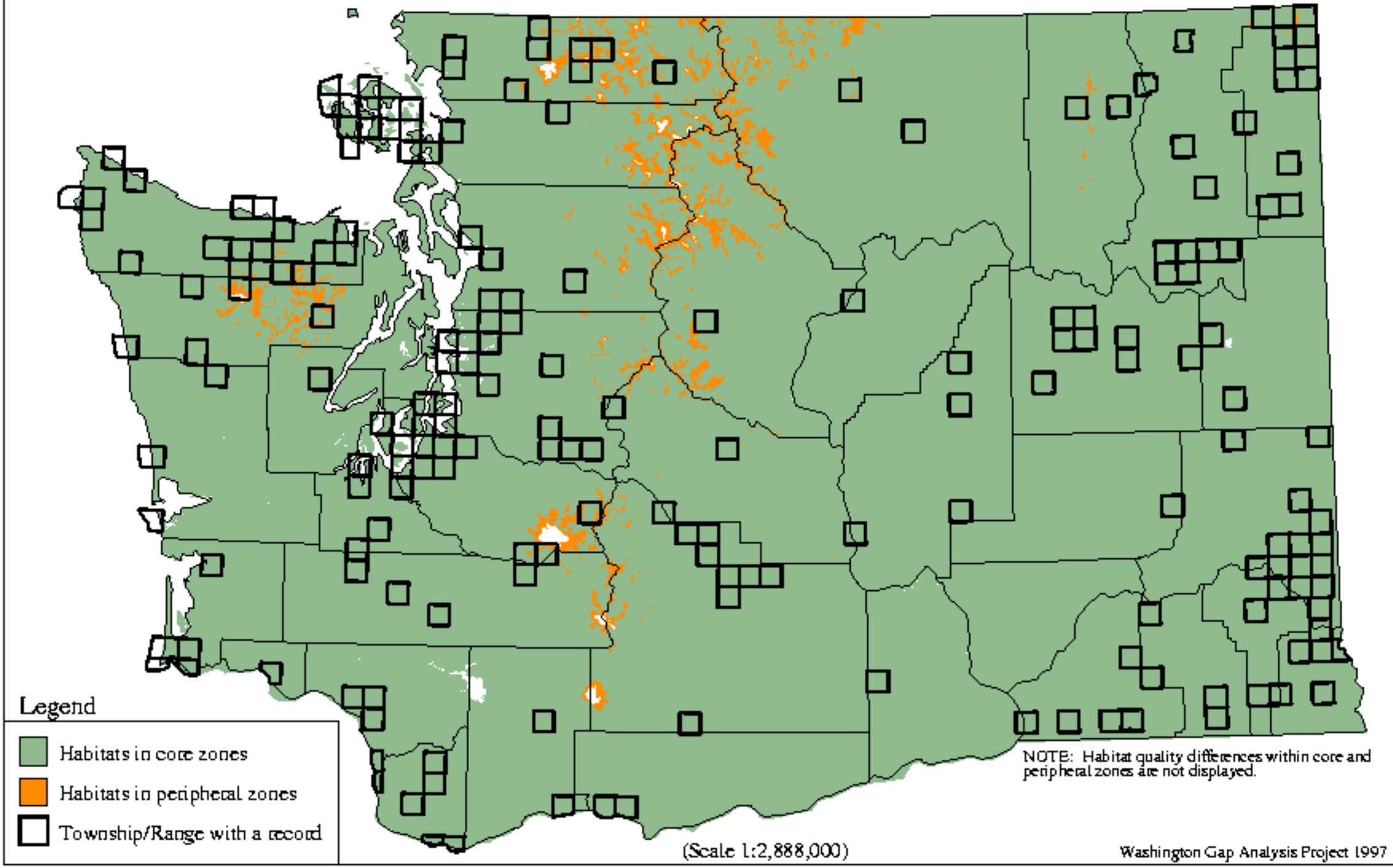
Sorex preblei - Preble`s Shrew



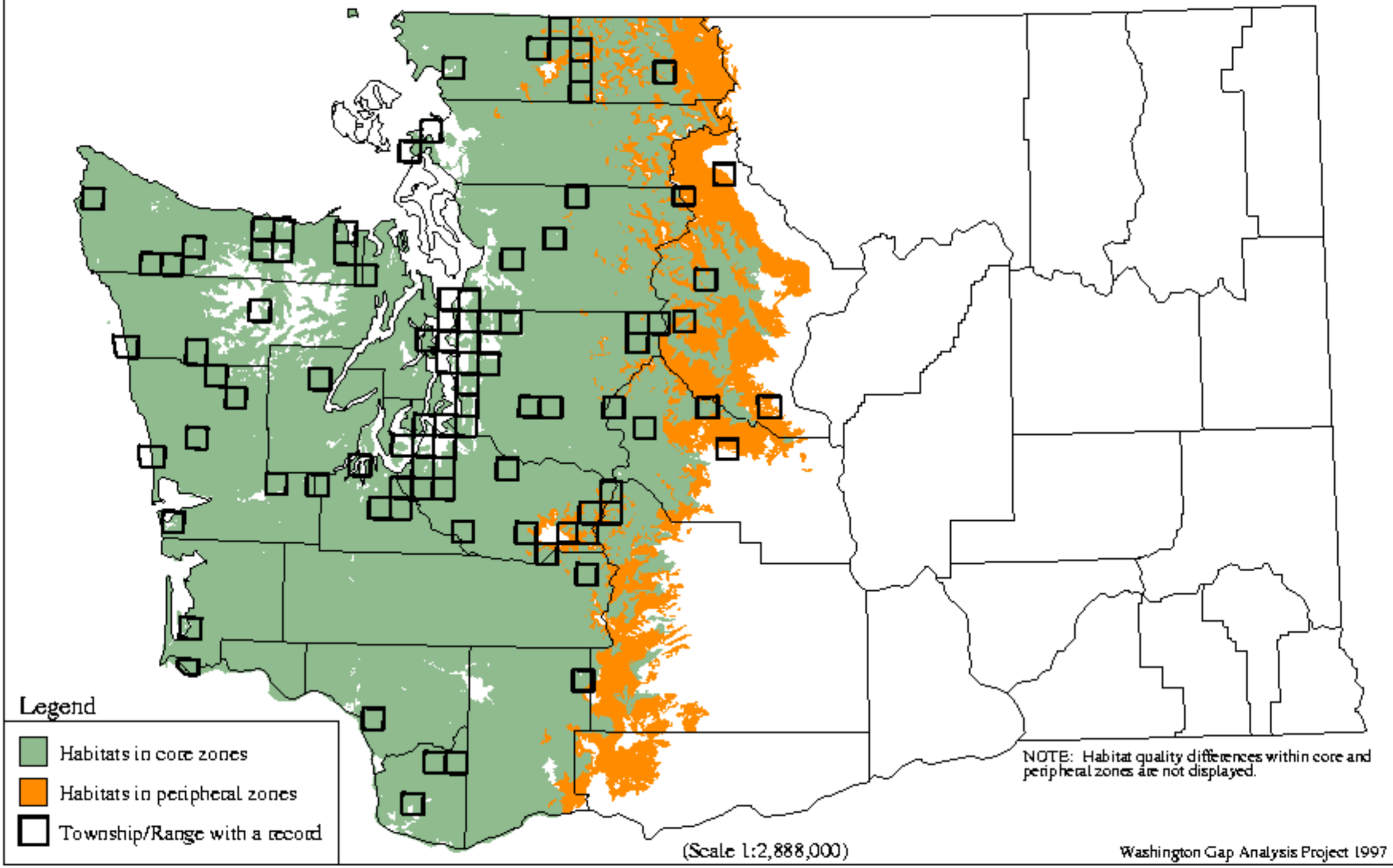
Sorex trowbridgii - Trowbridge`s Shrew



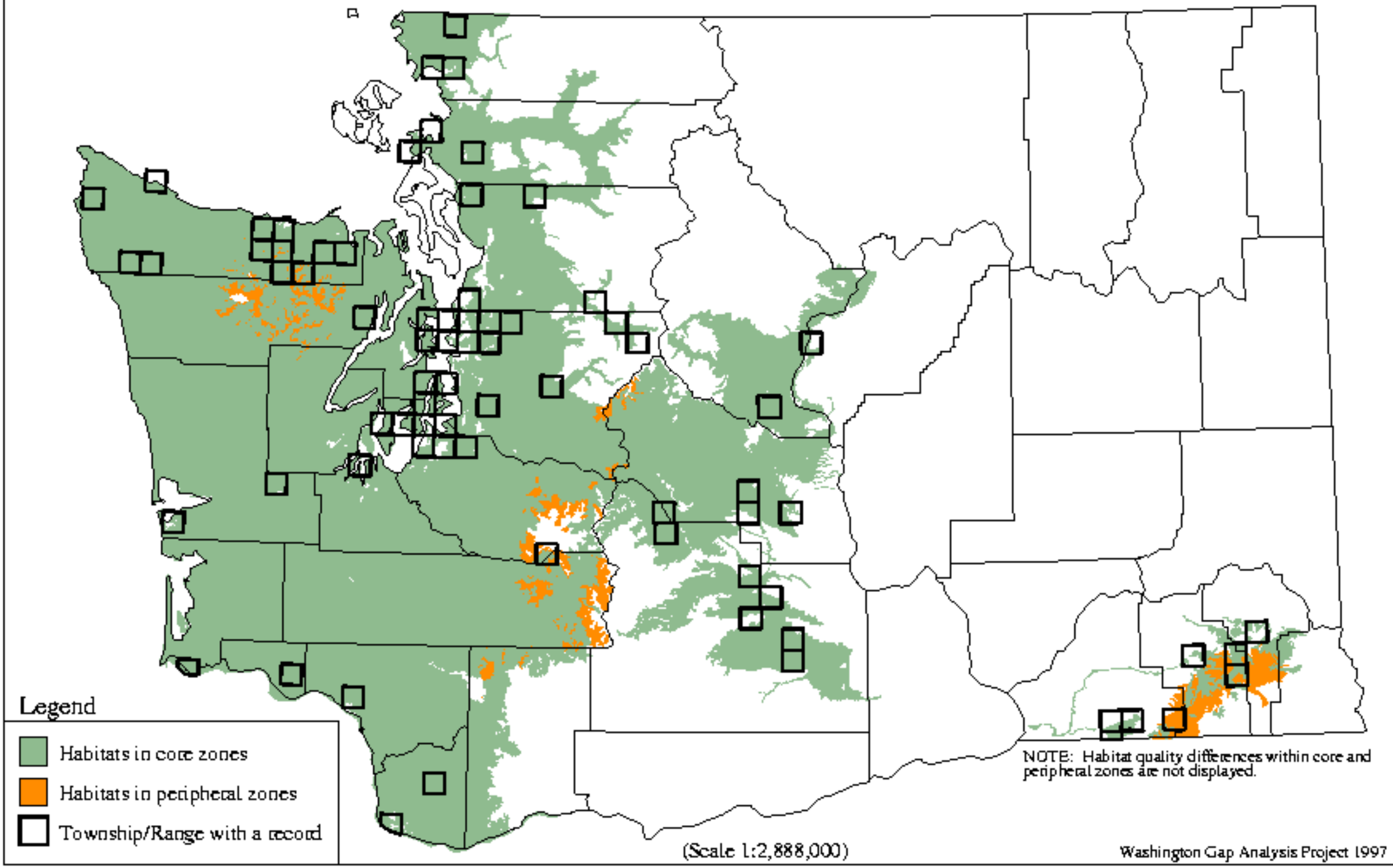
Sorex vagrans - Vagrant Shrew



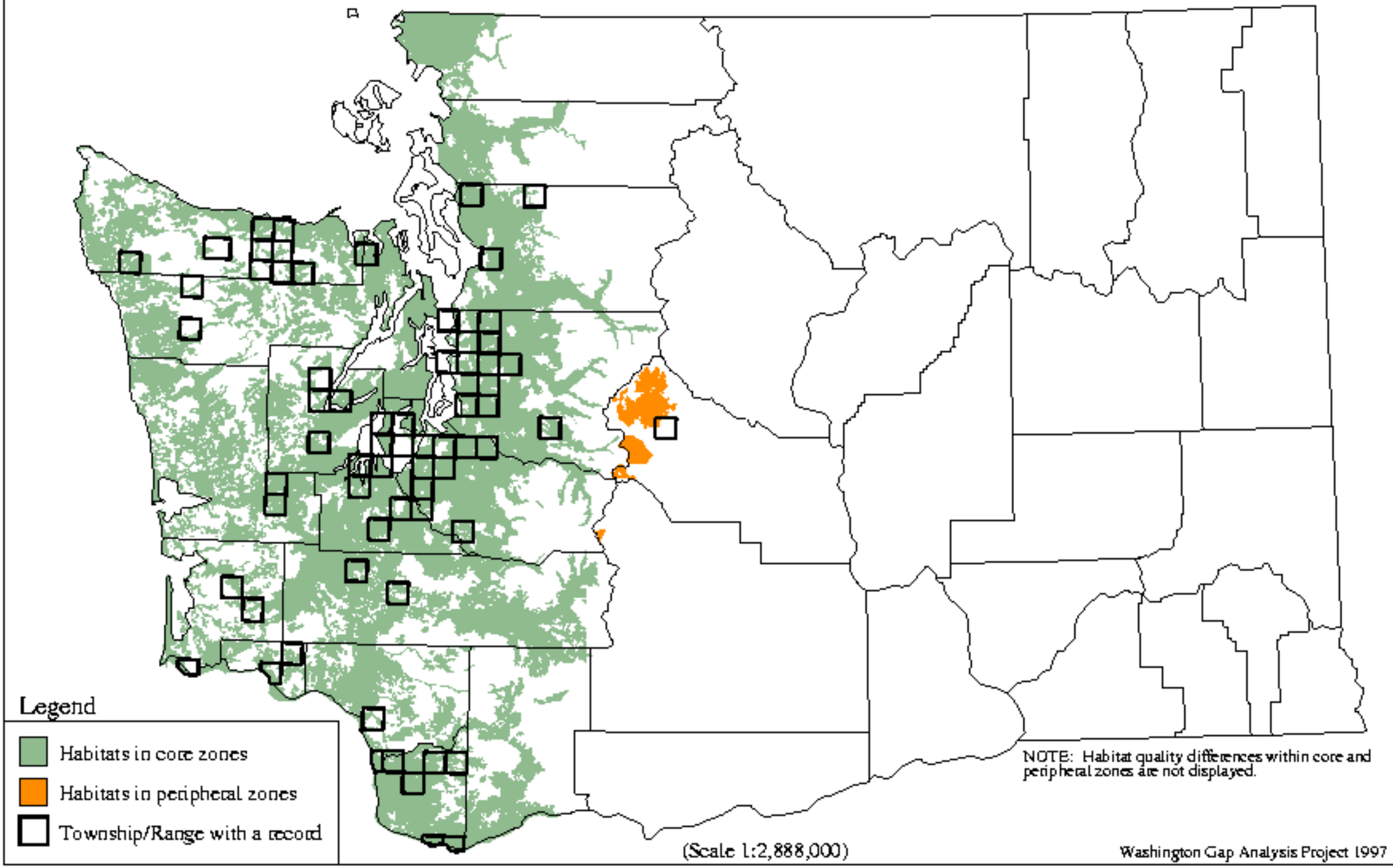
Neurotrichus gibbsii - Shrew-mole



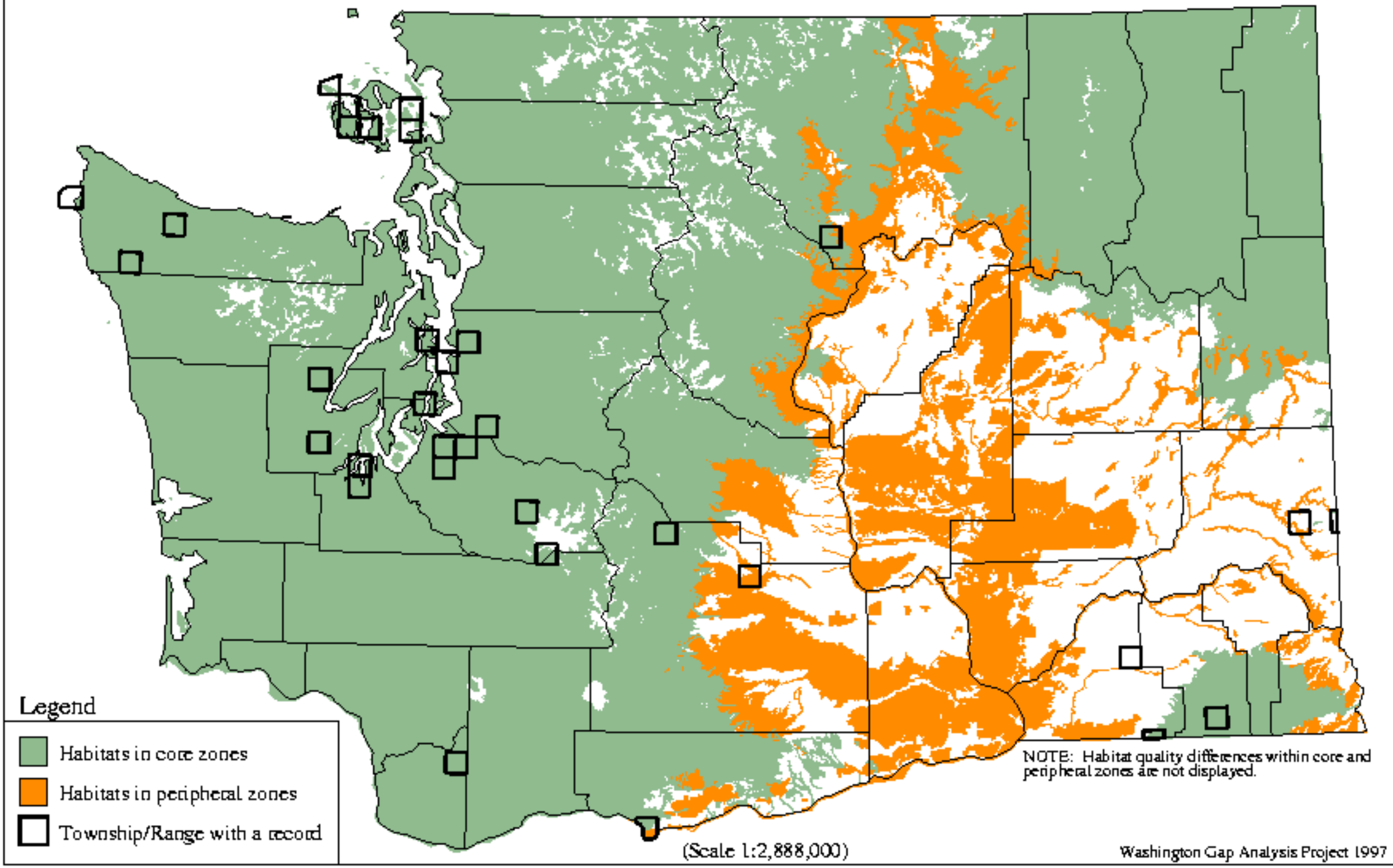
Scapanus orarius - Coast Mole



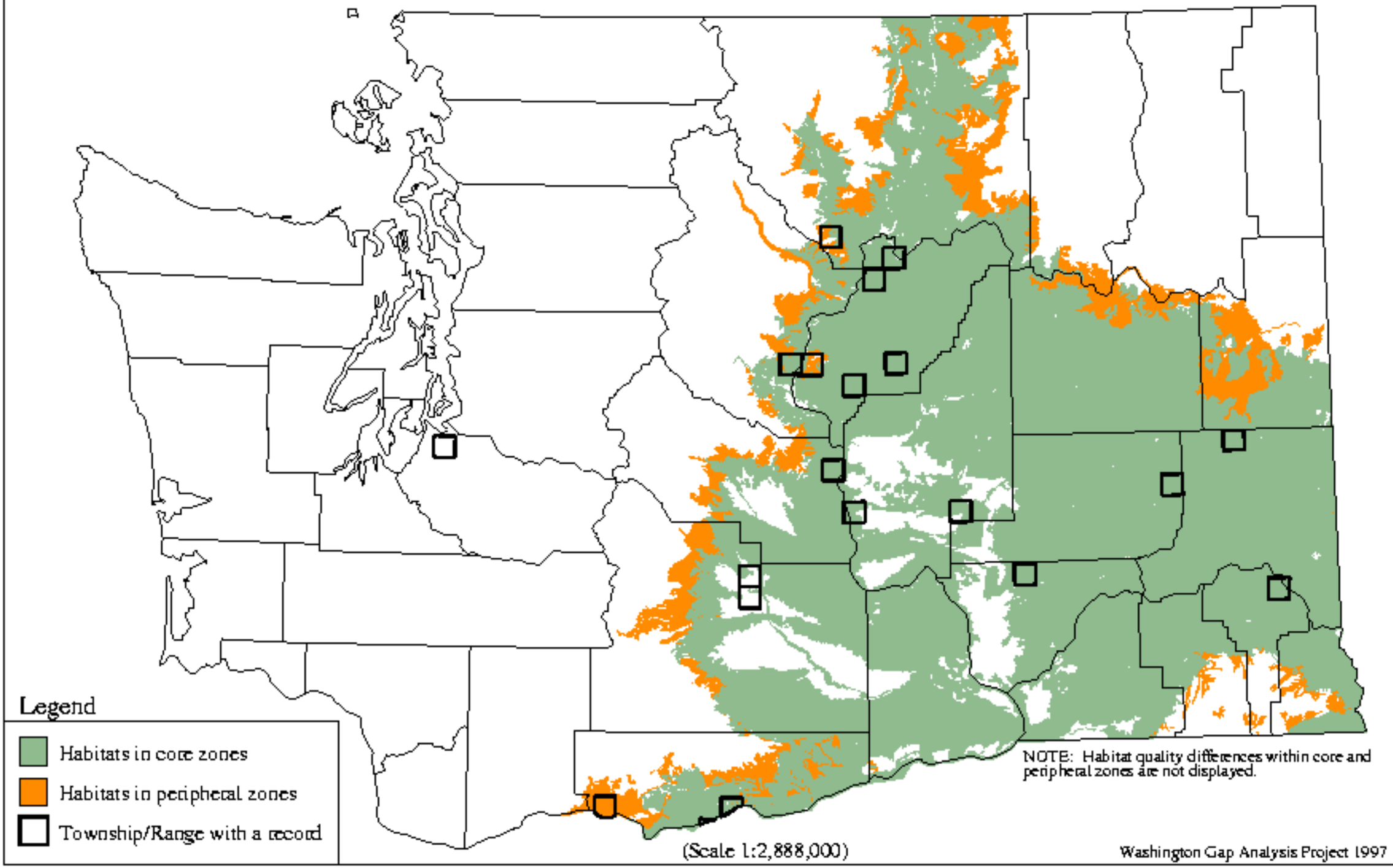
Scapanus townsendii - Townsend`s Mole



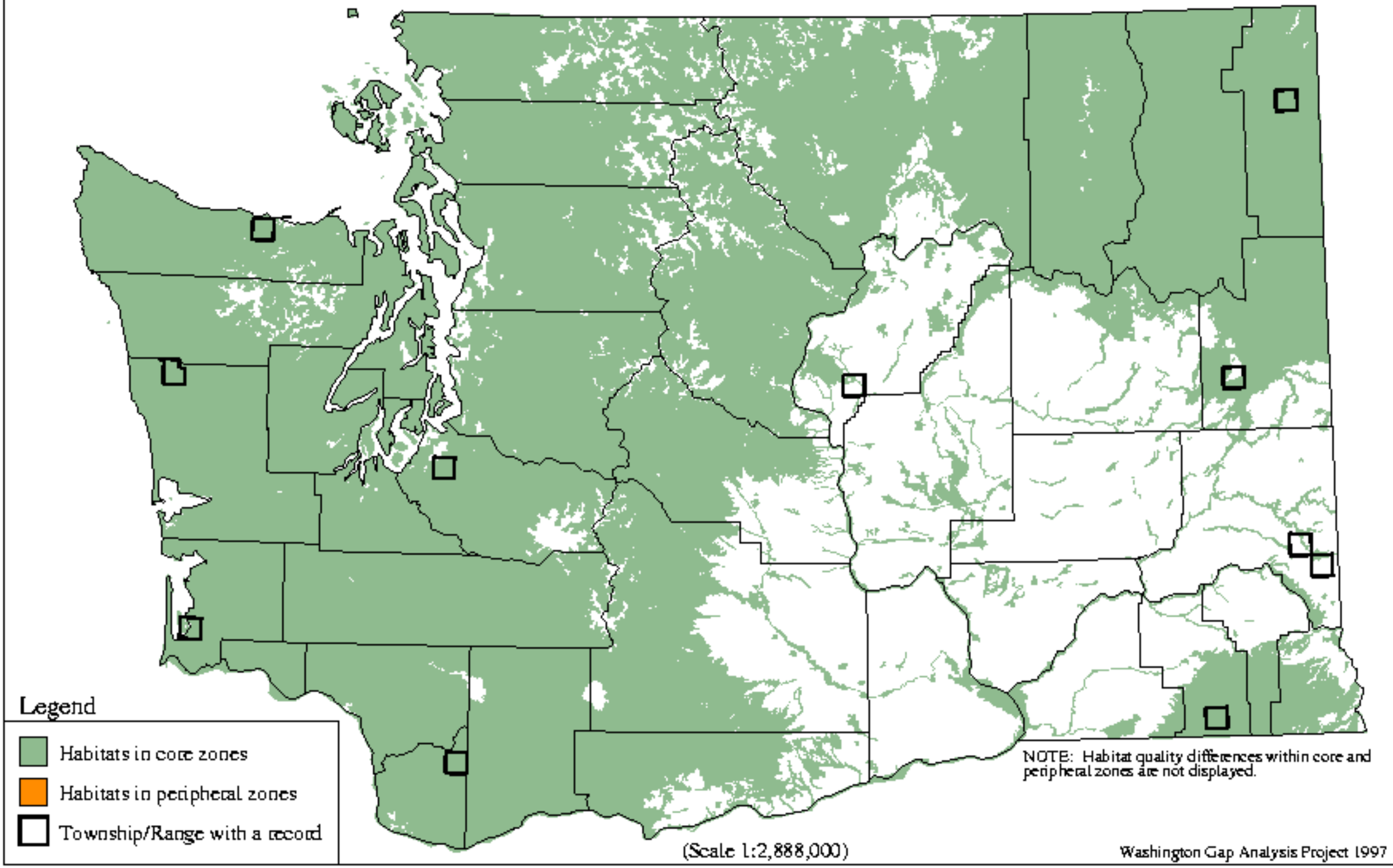
Myotis californicus - California Myotis



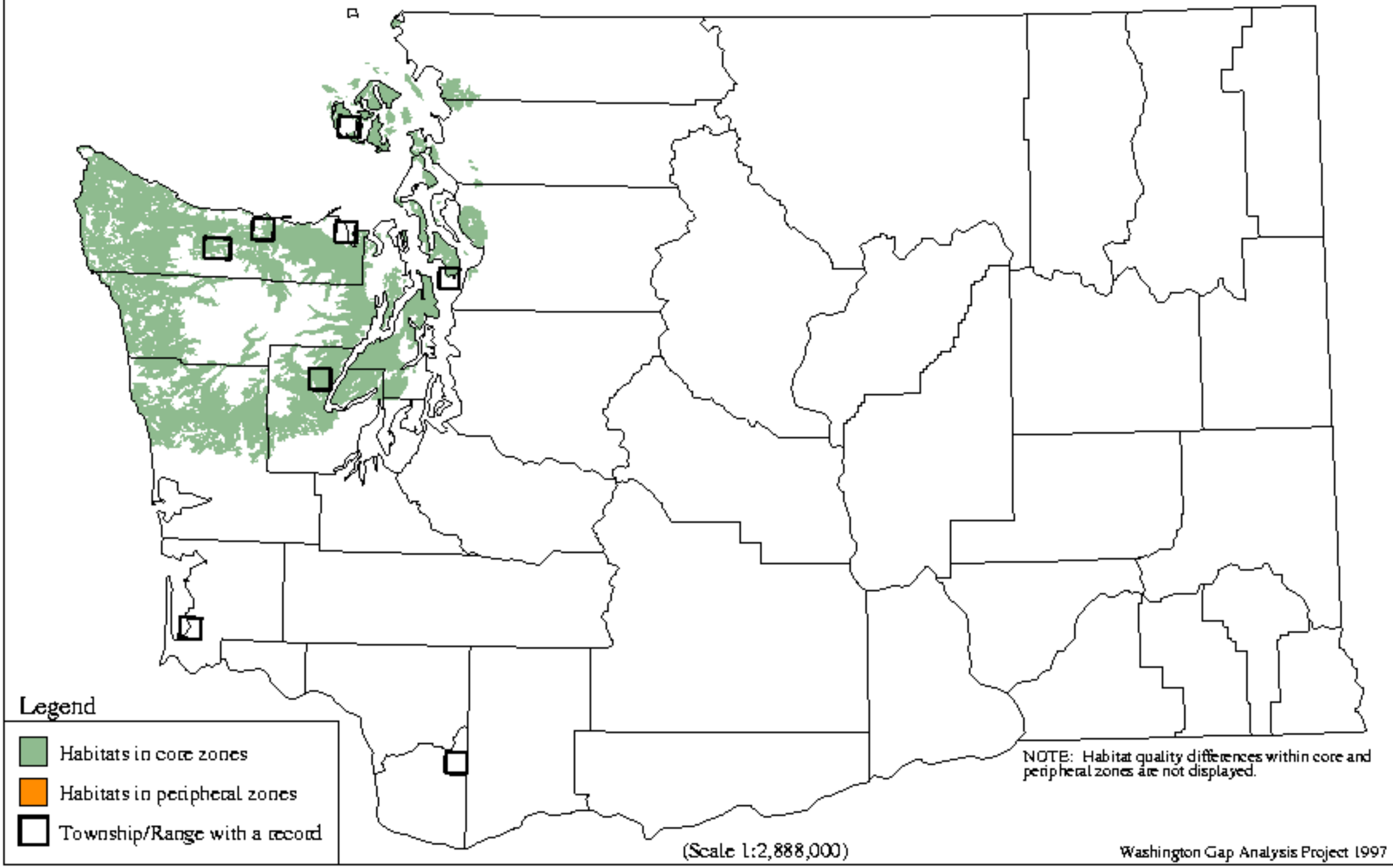
Myotis ciliolabrum - Small-footed Myotis



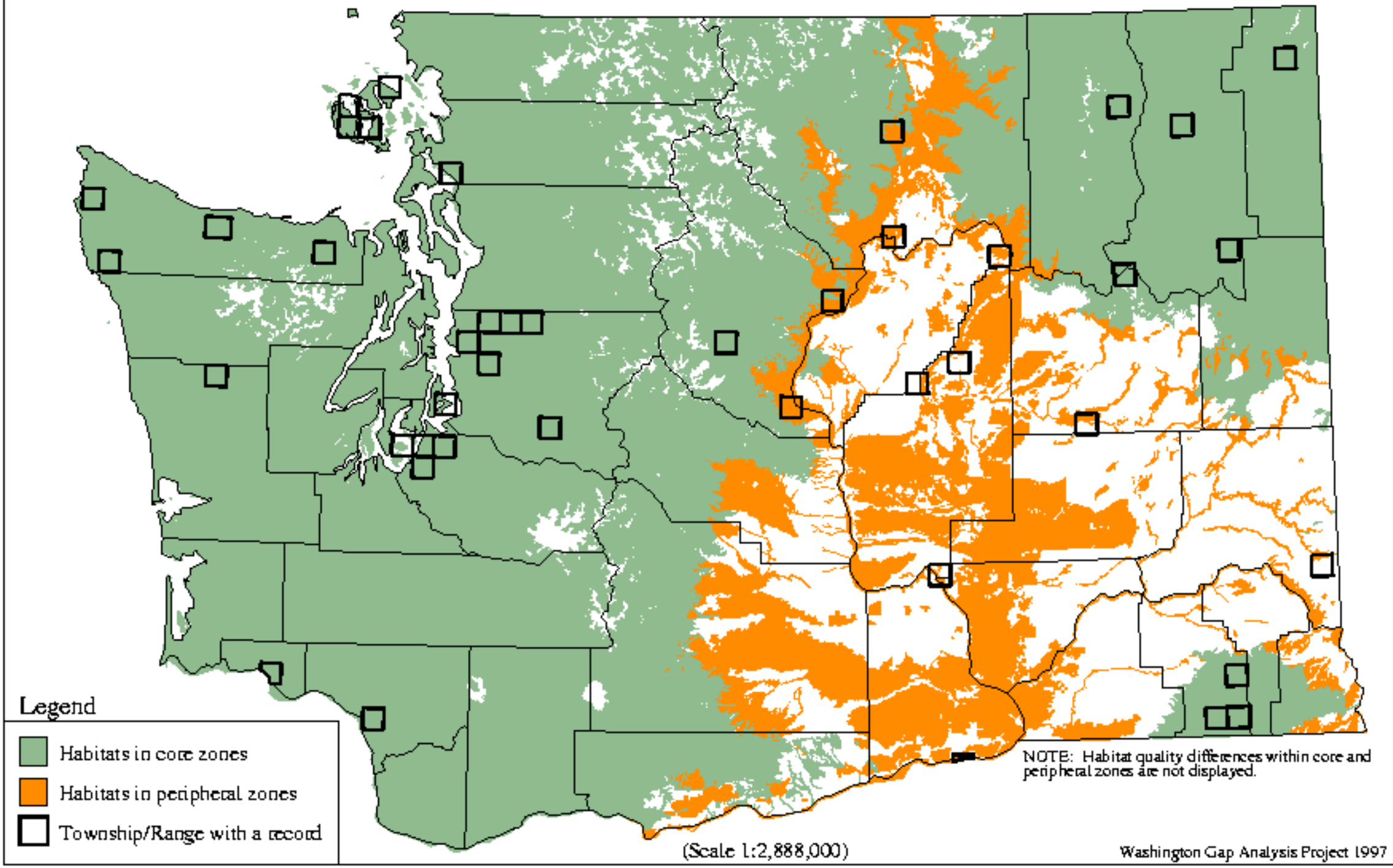
Myotis evotis - Long-eared Myotis



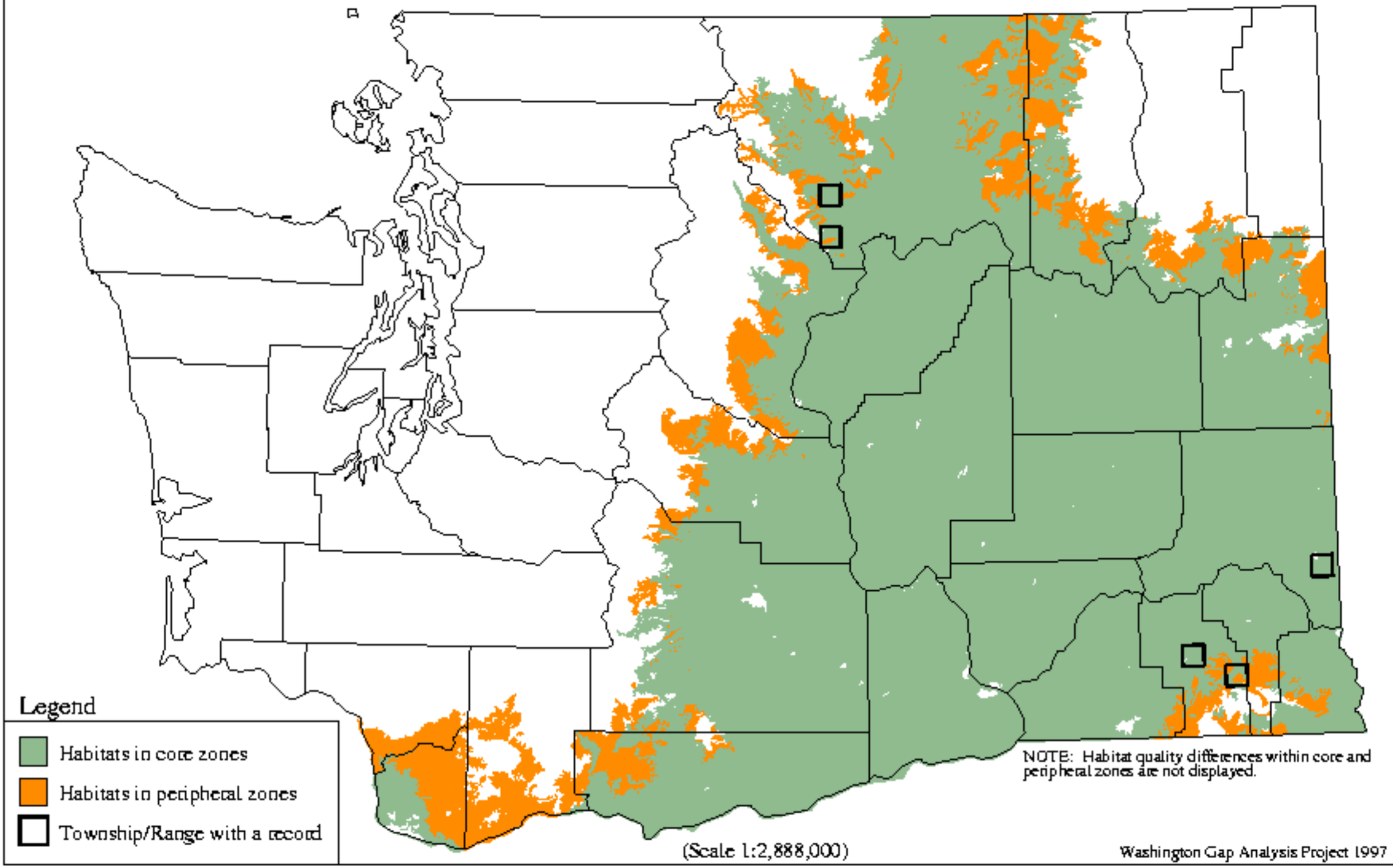
Myotis keenii - Keen`s Myotis



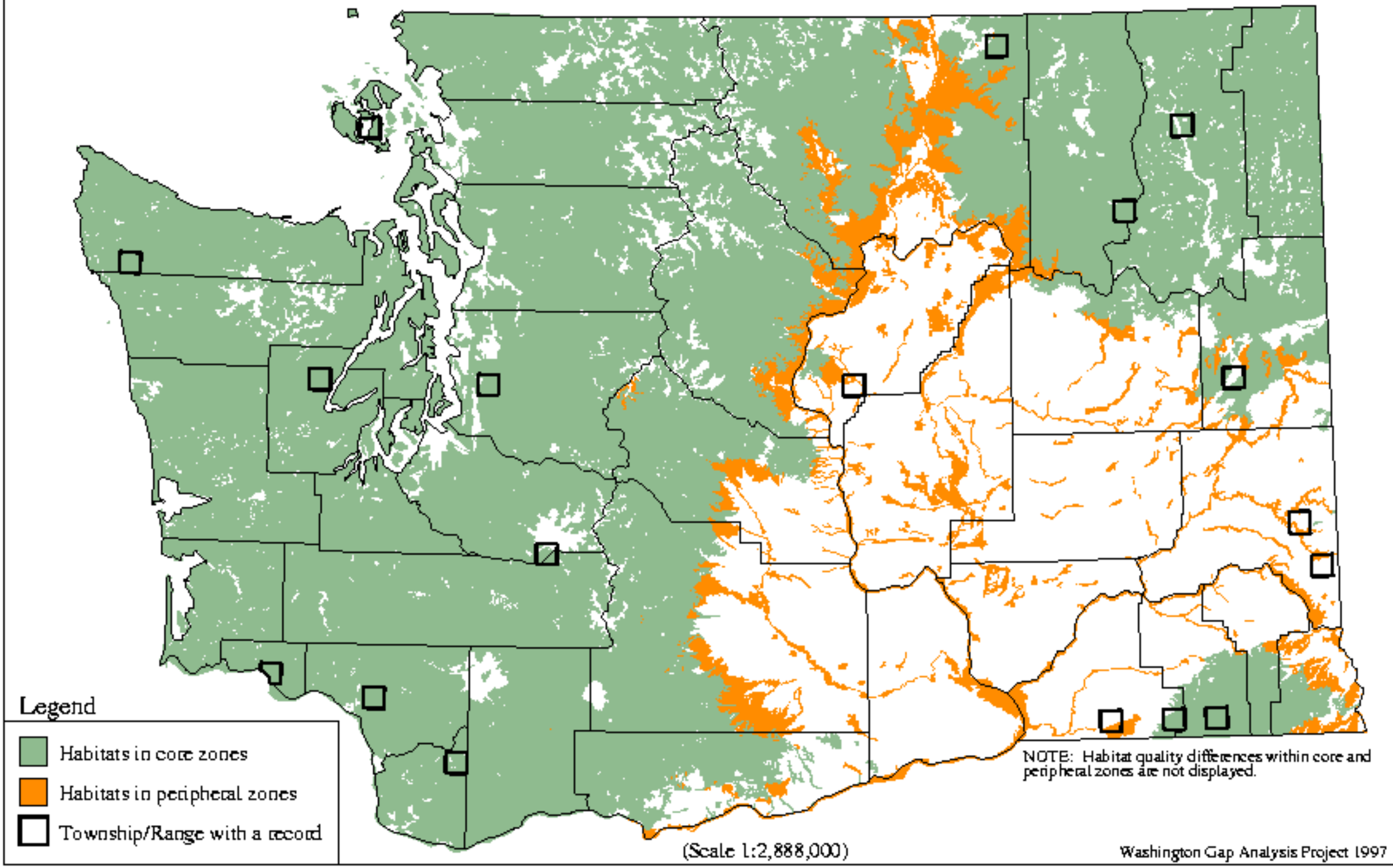
Myotis lucifugus - Little Brown Myotis



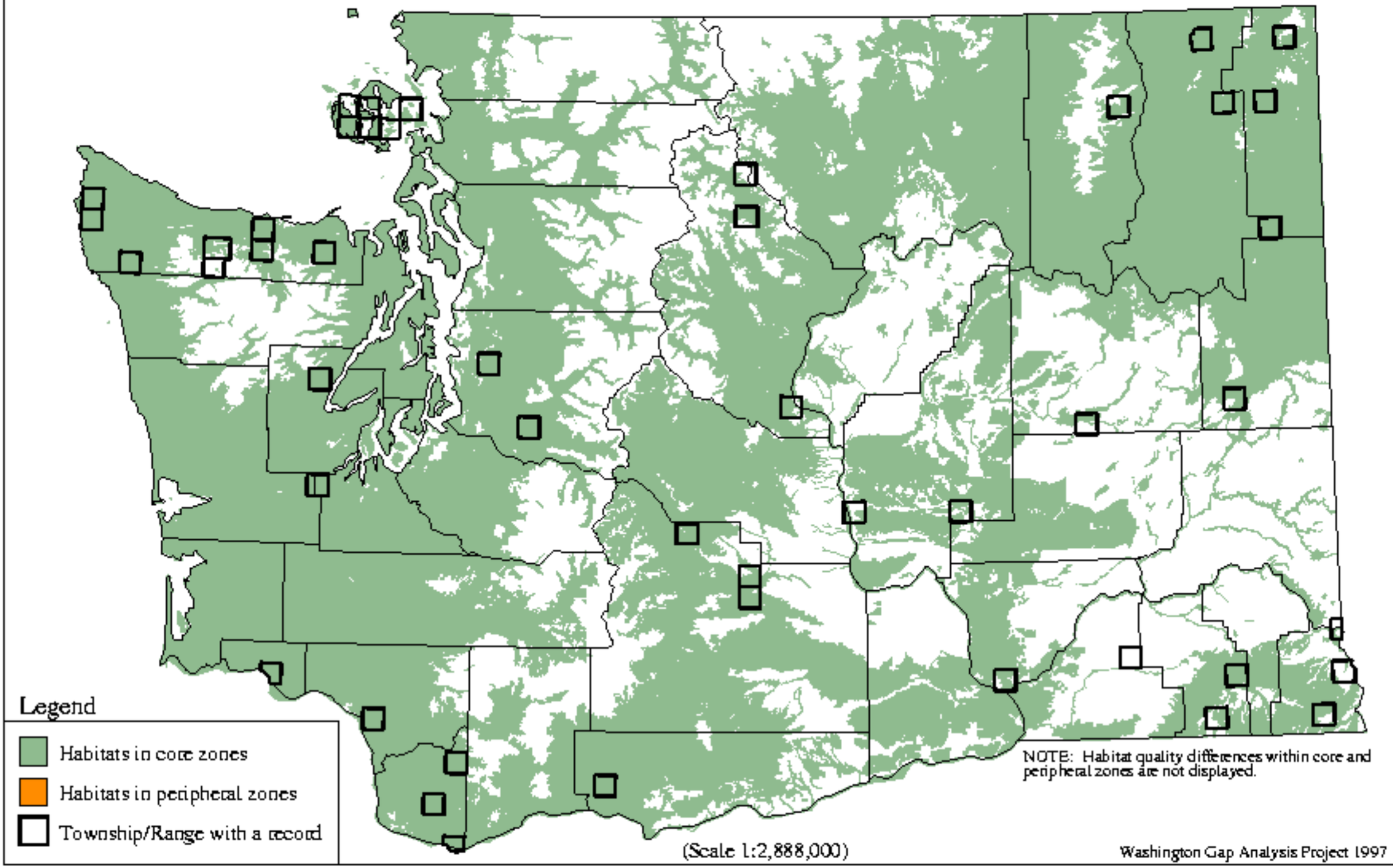
Myotis thysanodes - Fringed Myotis



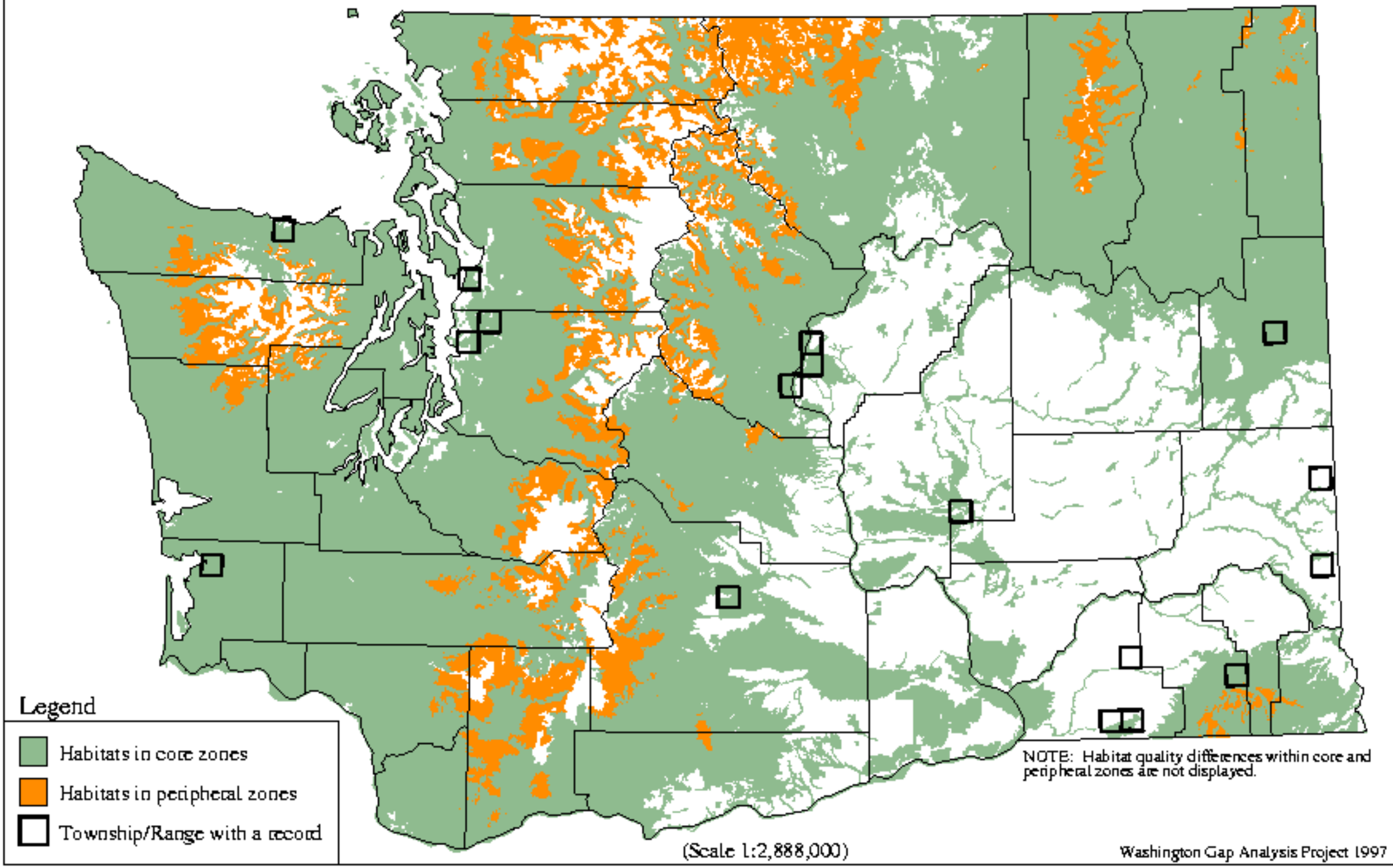
Myotis volans - Long-legged Myotis



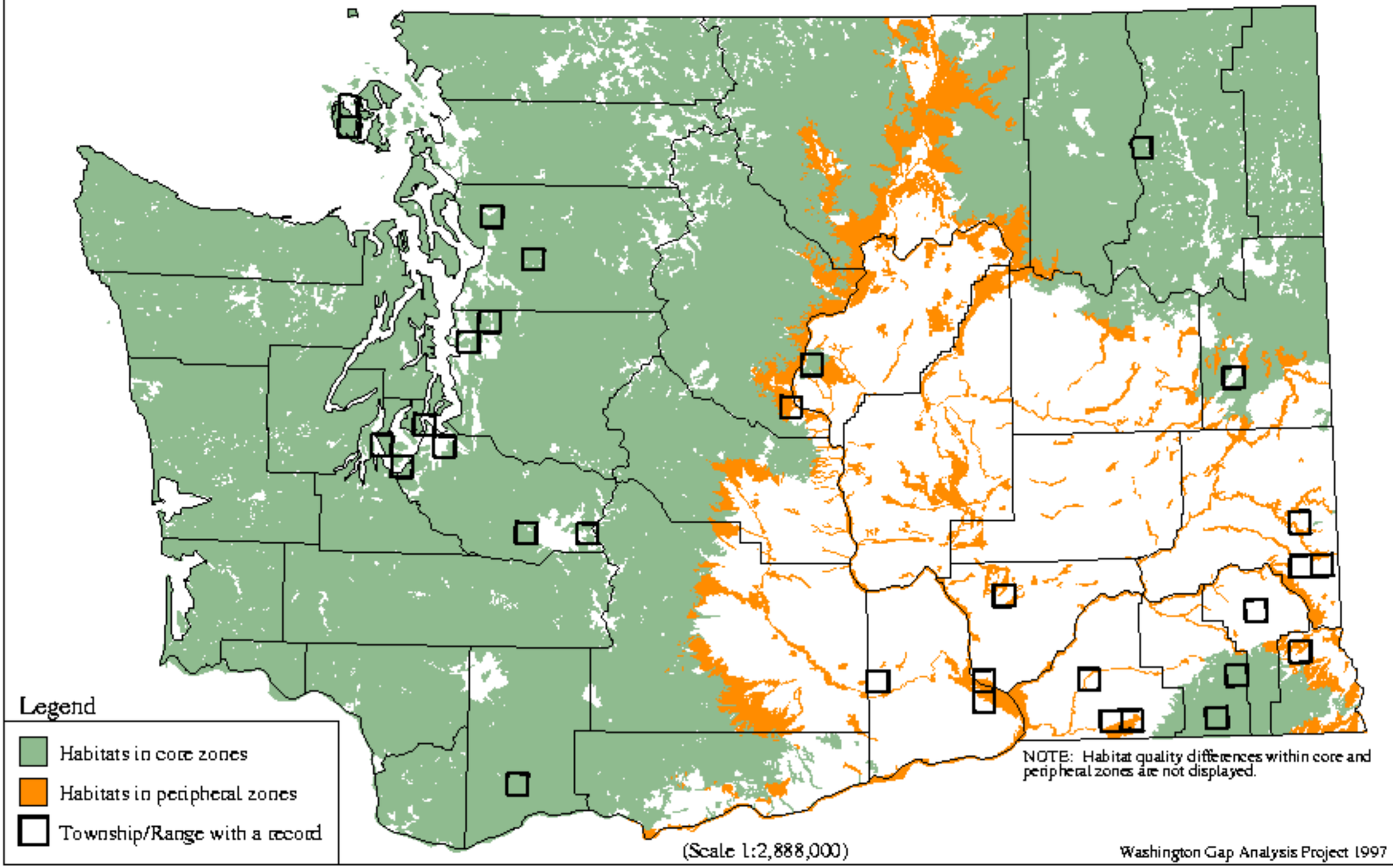
Myotis yumanensis - Yuma Myotis



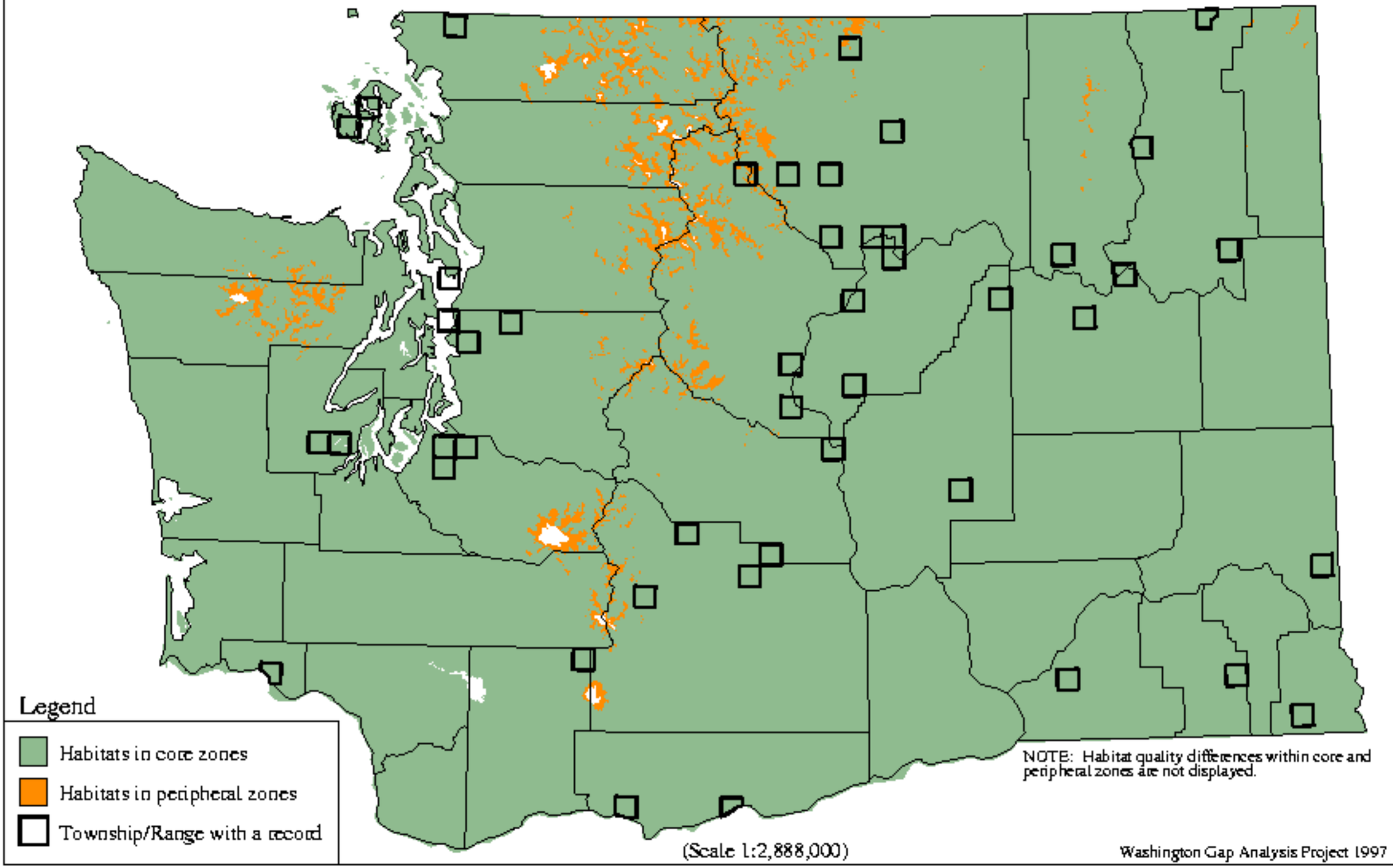
Lasiurus cinereus - Hoary Bat



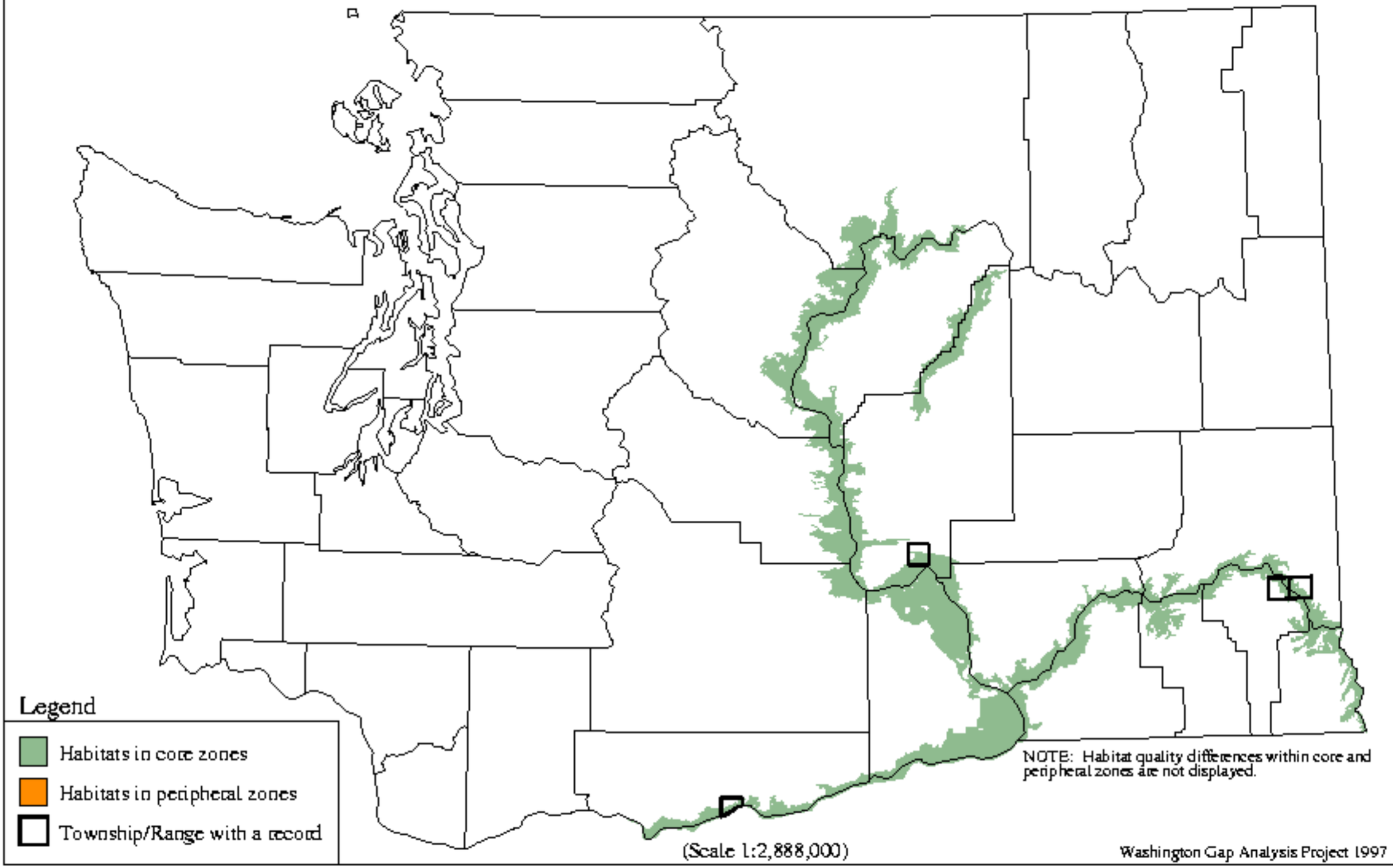
Lasionycteris noctivagans - Silver-haired Bat



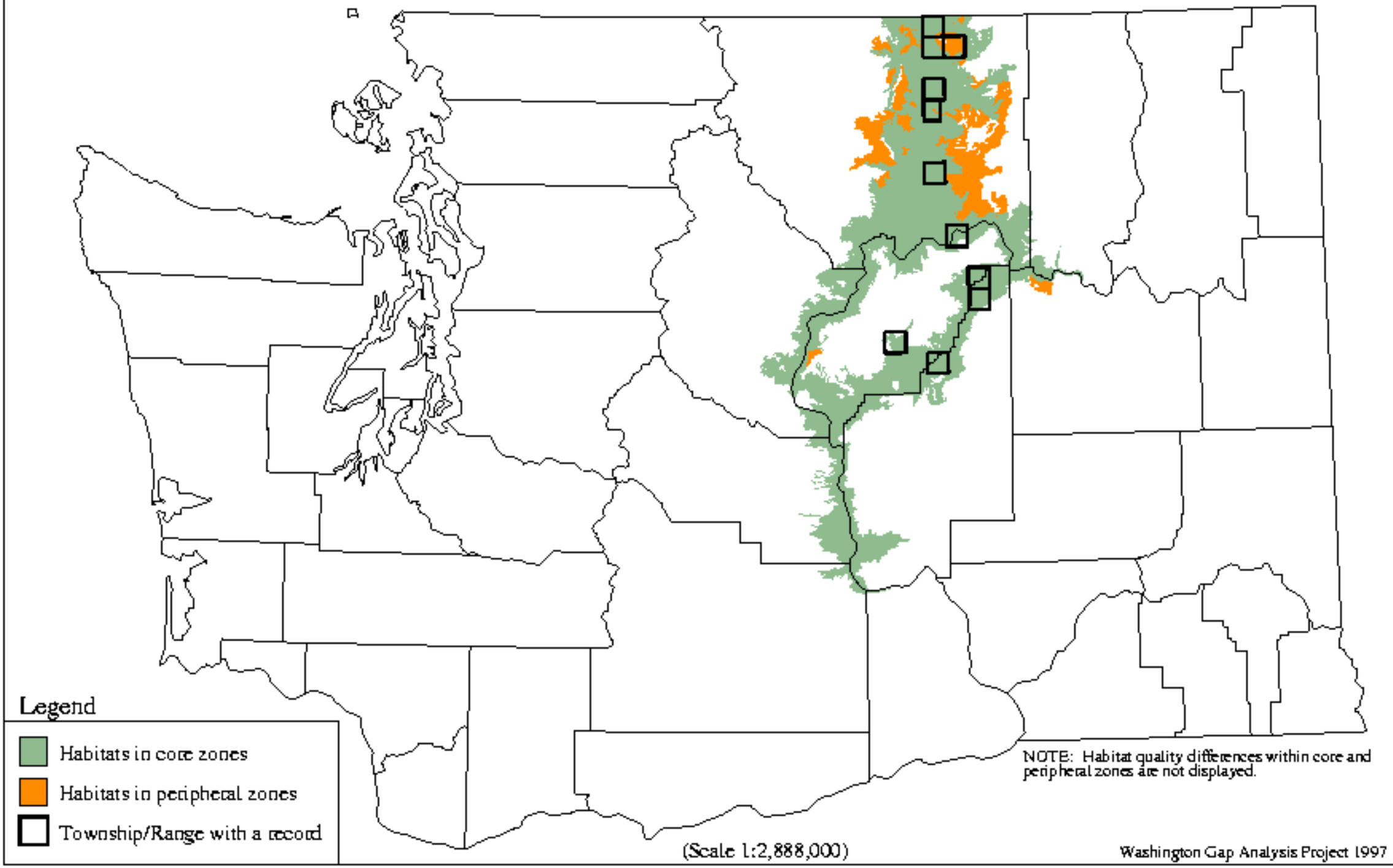
Eptesicus fuscus - Big Brown Bat



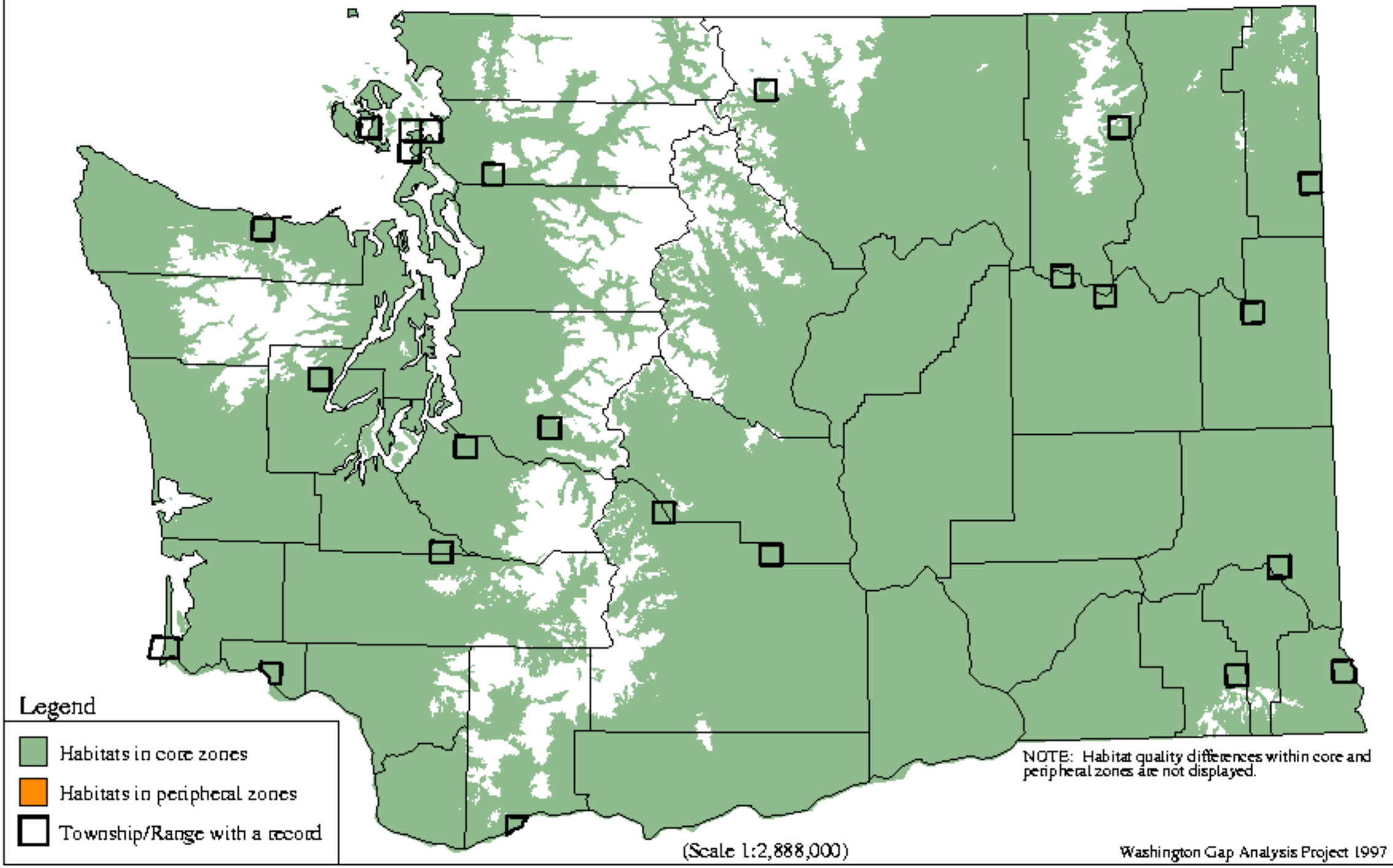
Pipistrellus hesperus - Western Pipistrelle



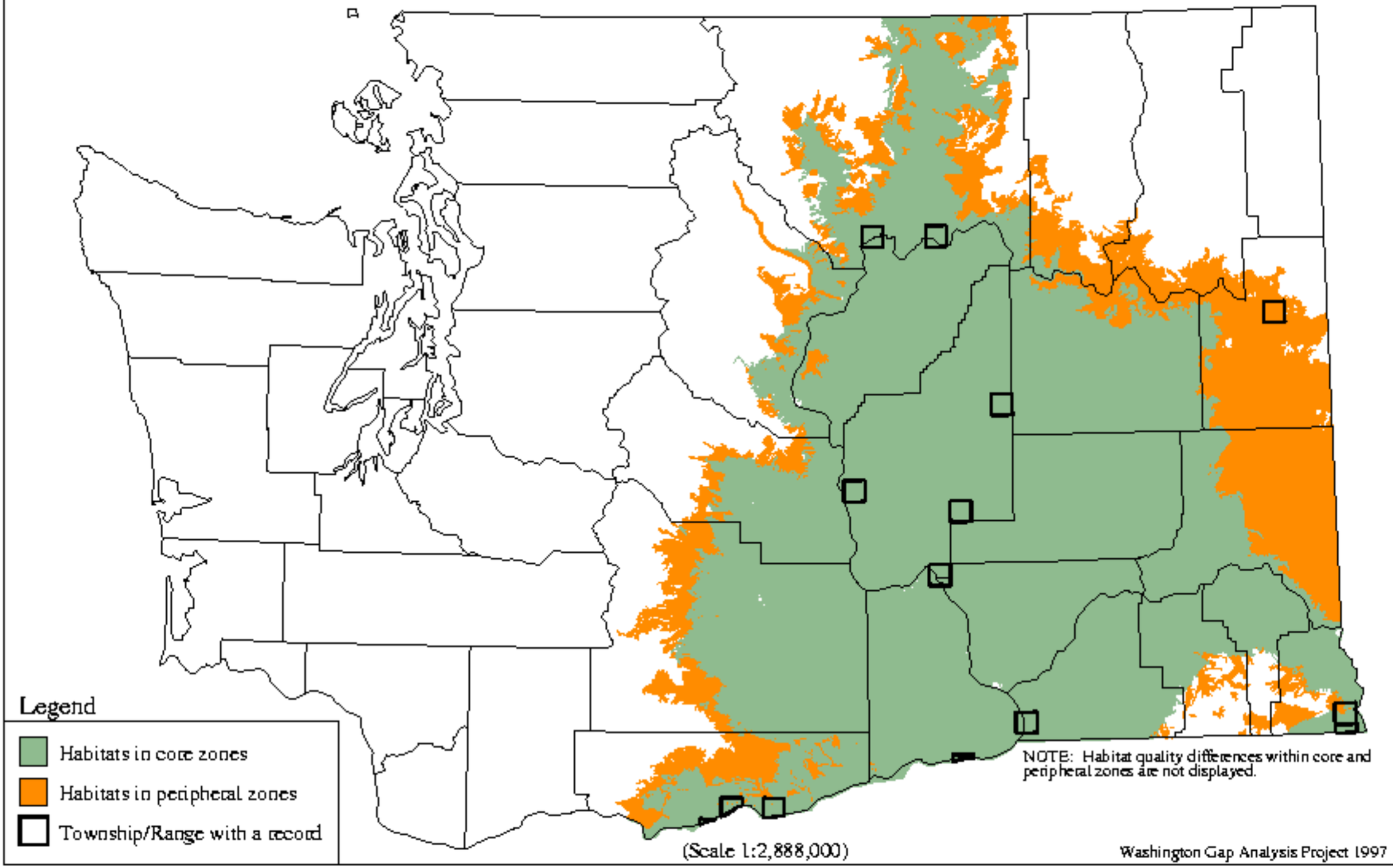
Euderma maculatum - Spotted Bat



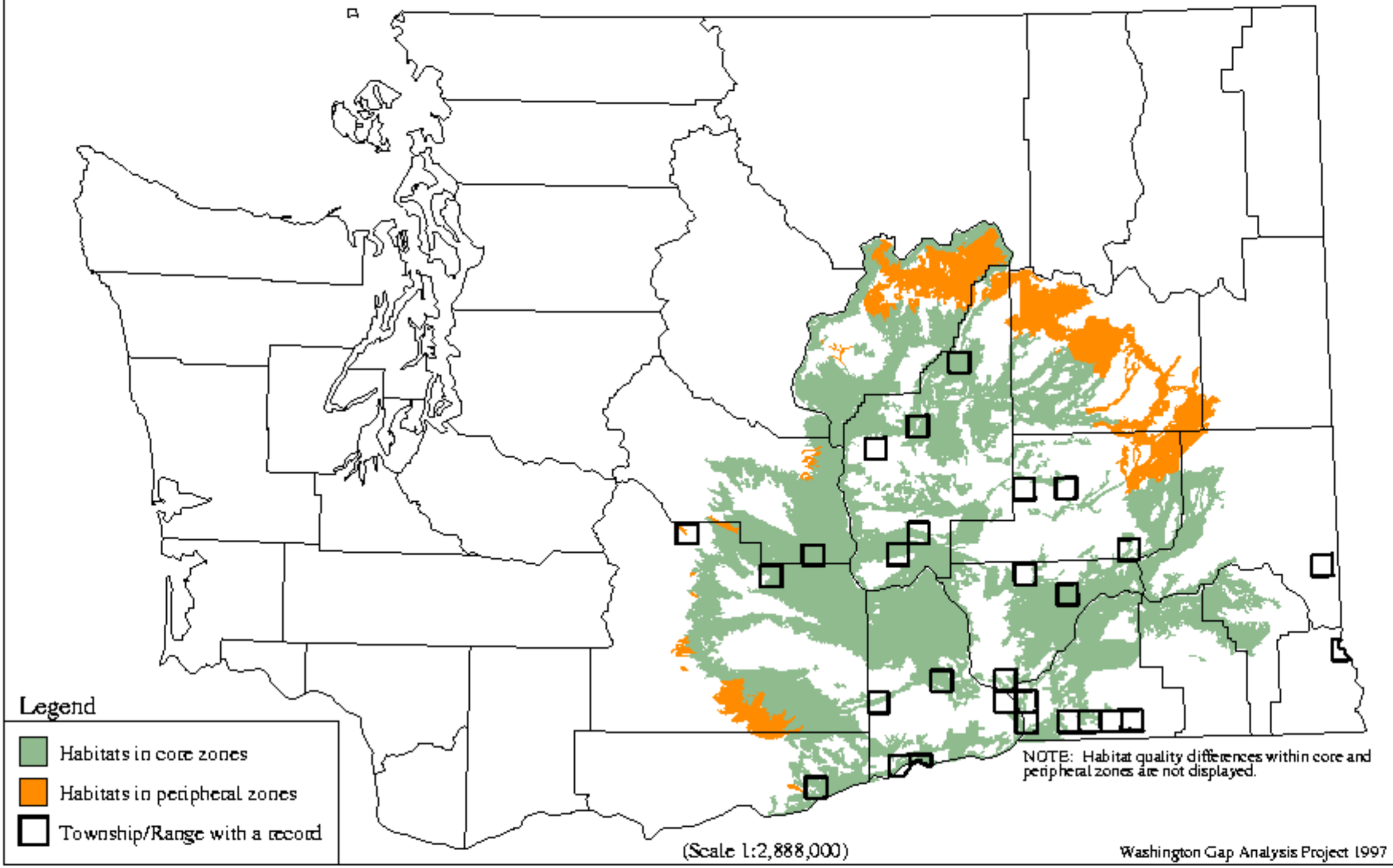
Plecotus townsendii - Townsend`s Big-eared Bat



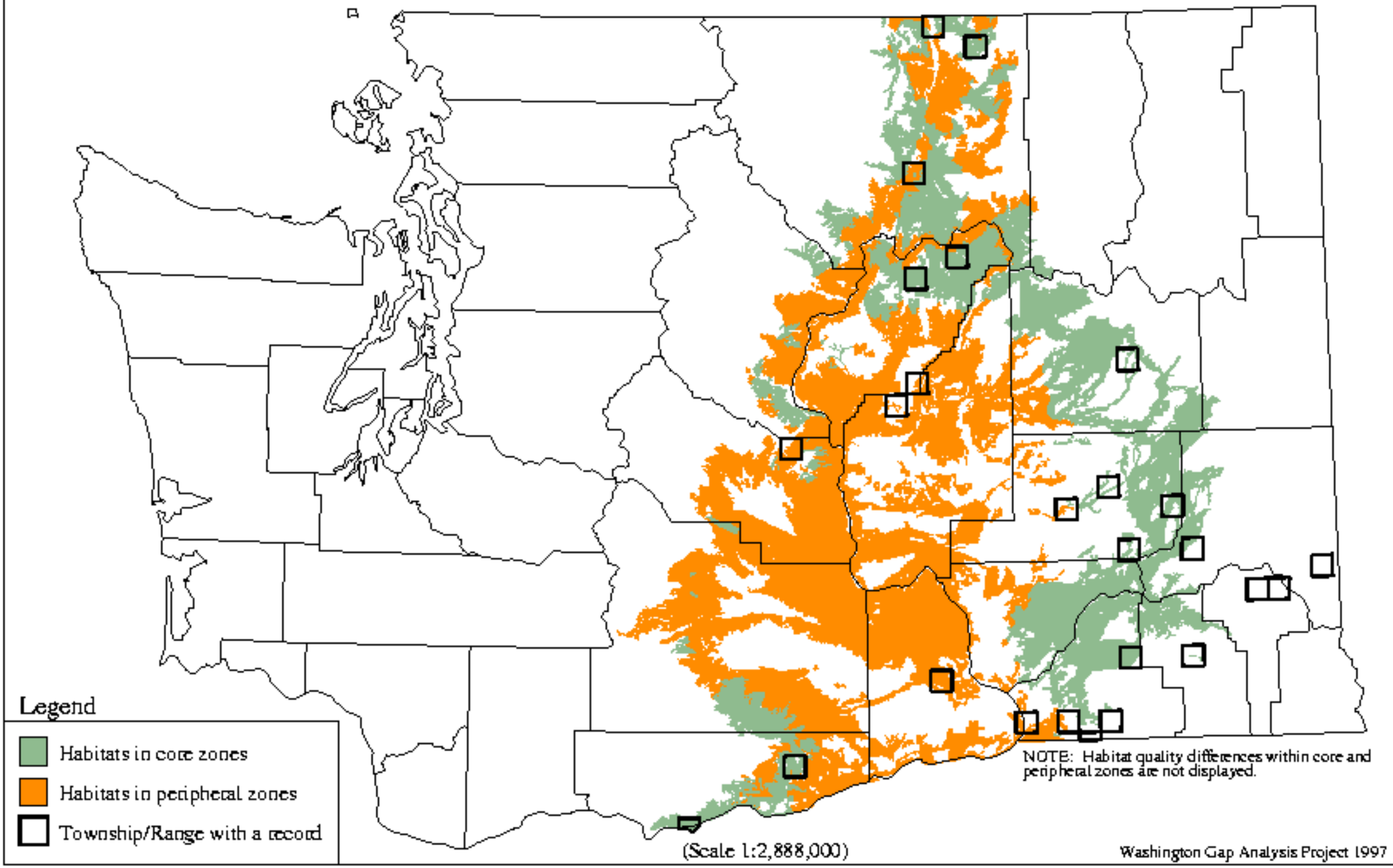
Antrozous pallidus - Pallid Bat



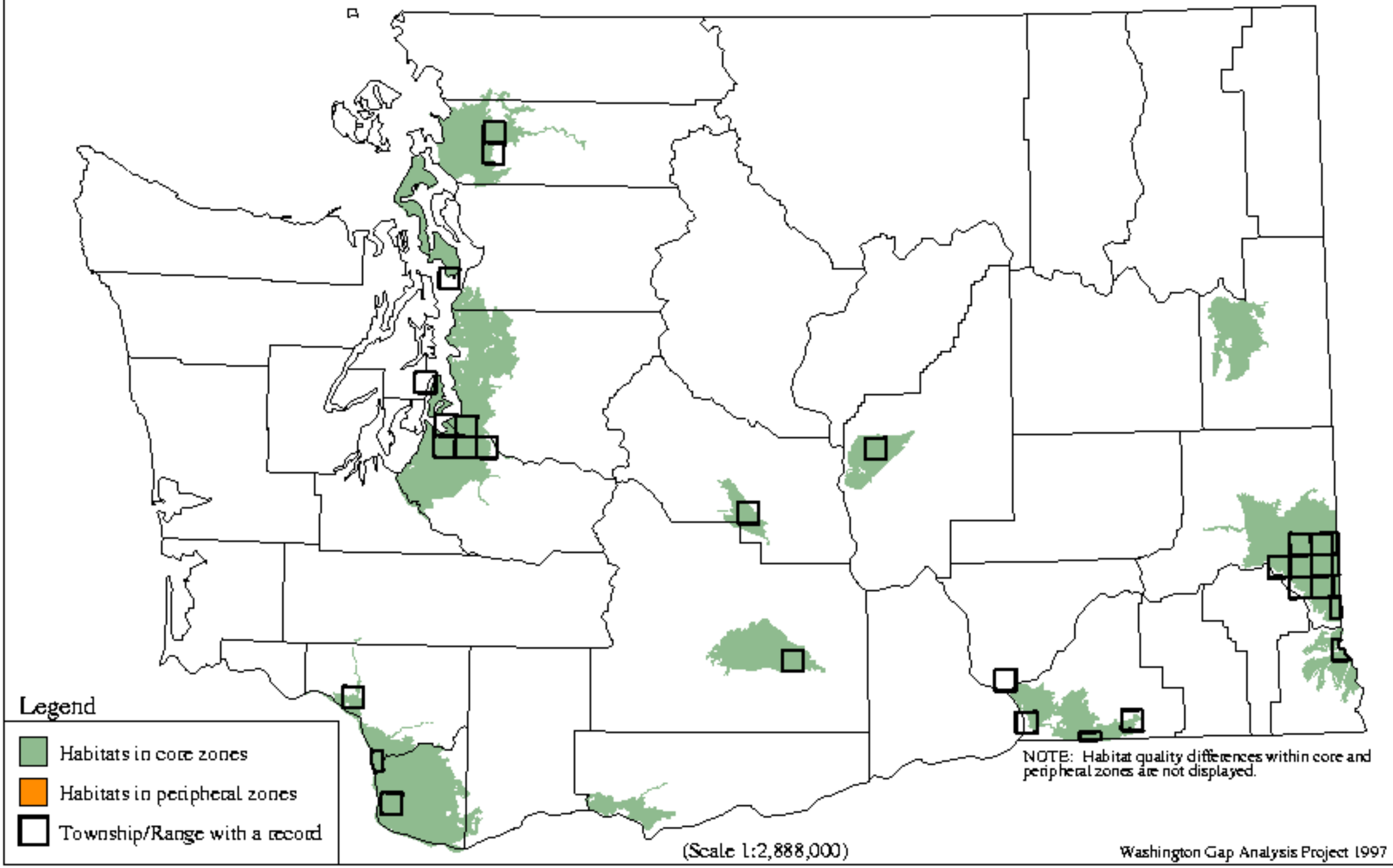
Lepus californicus - Black-tailed Jack Rabbit



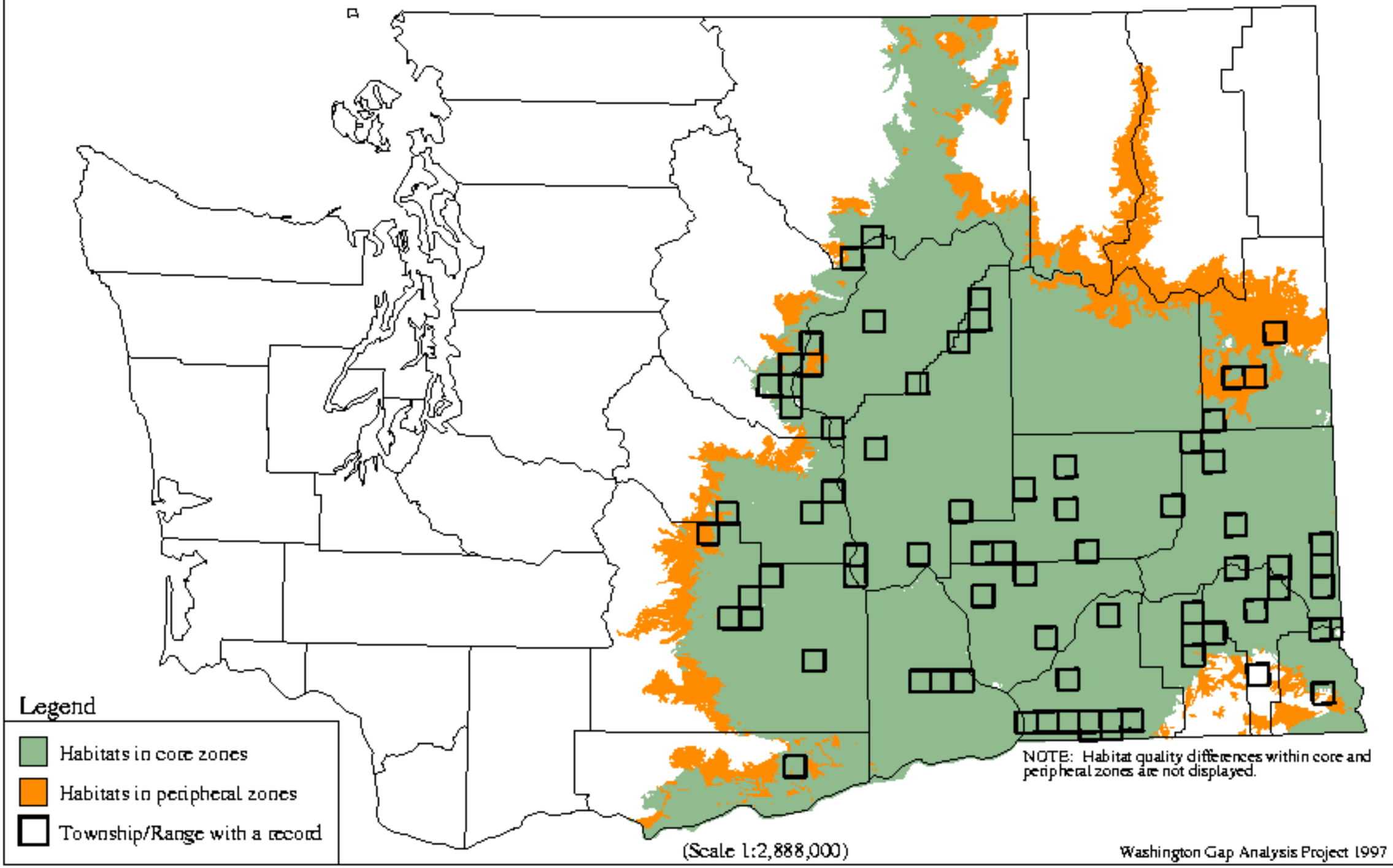
Lepus townsendii - White-tailed Jack Rabbit



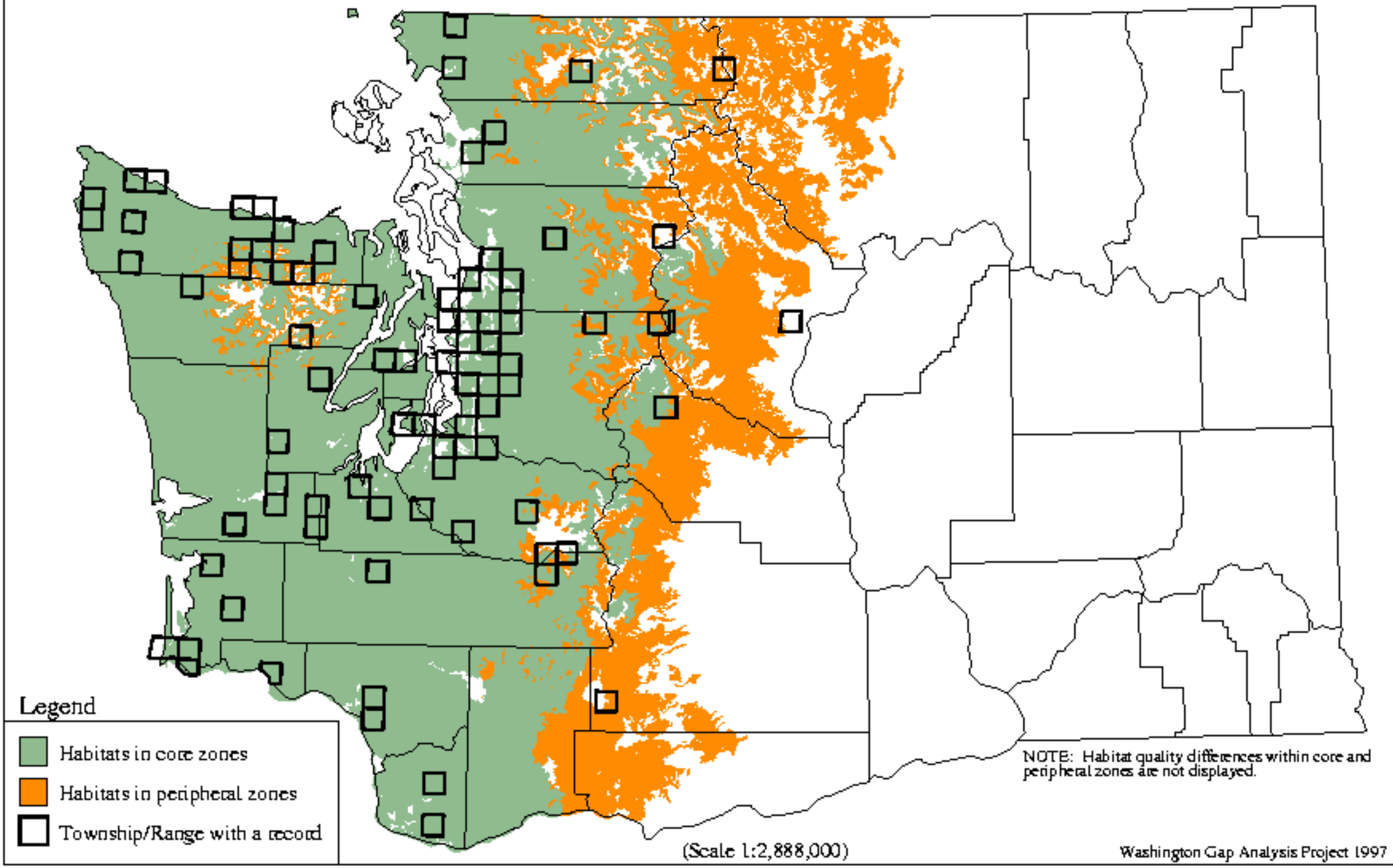
Sylvilagus floridanus - Eastern Cottontail



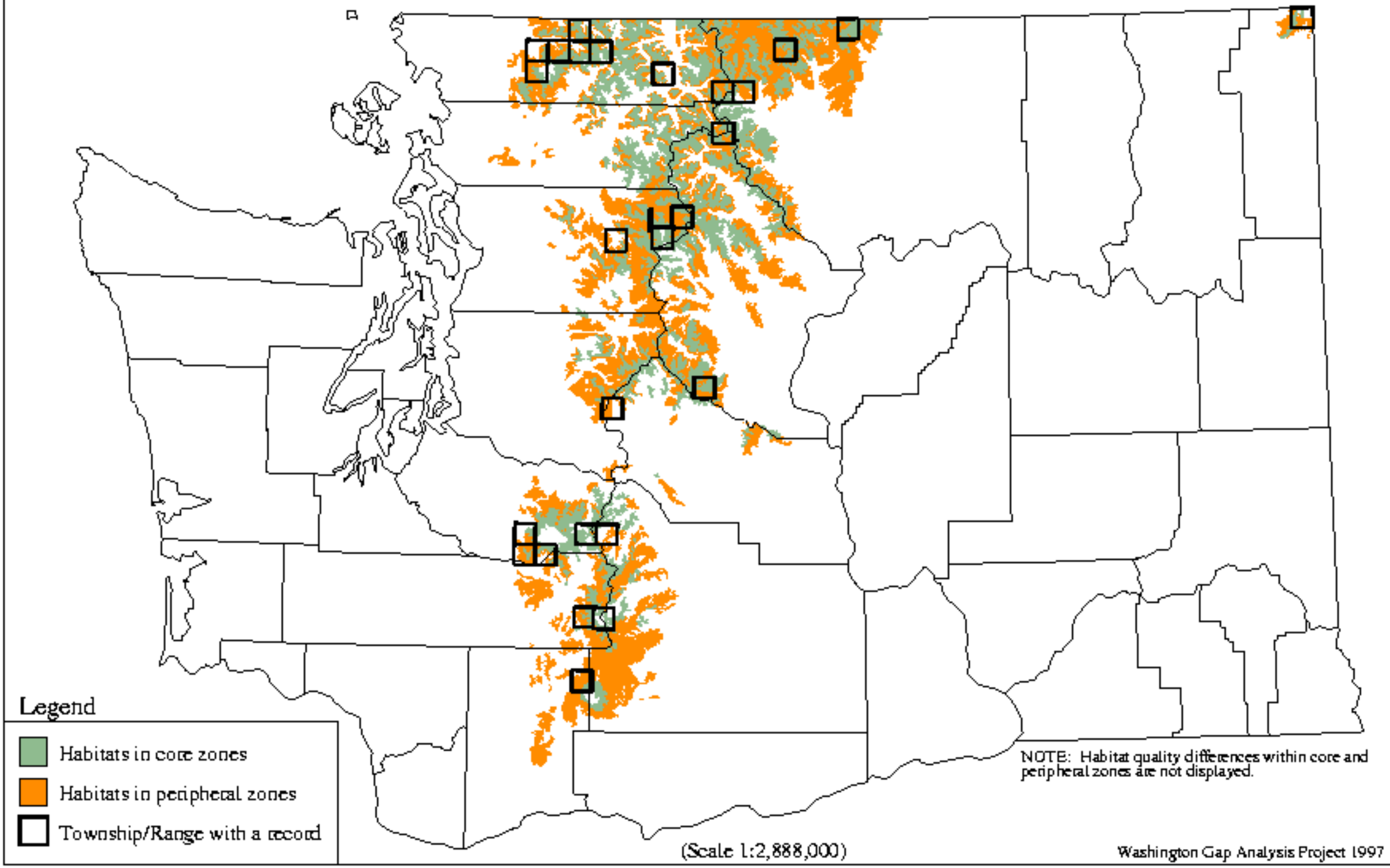
Sylvilagus nuttallii - Nuttall`s Cottontail



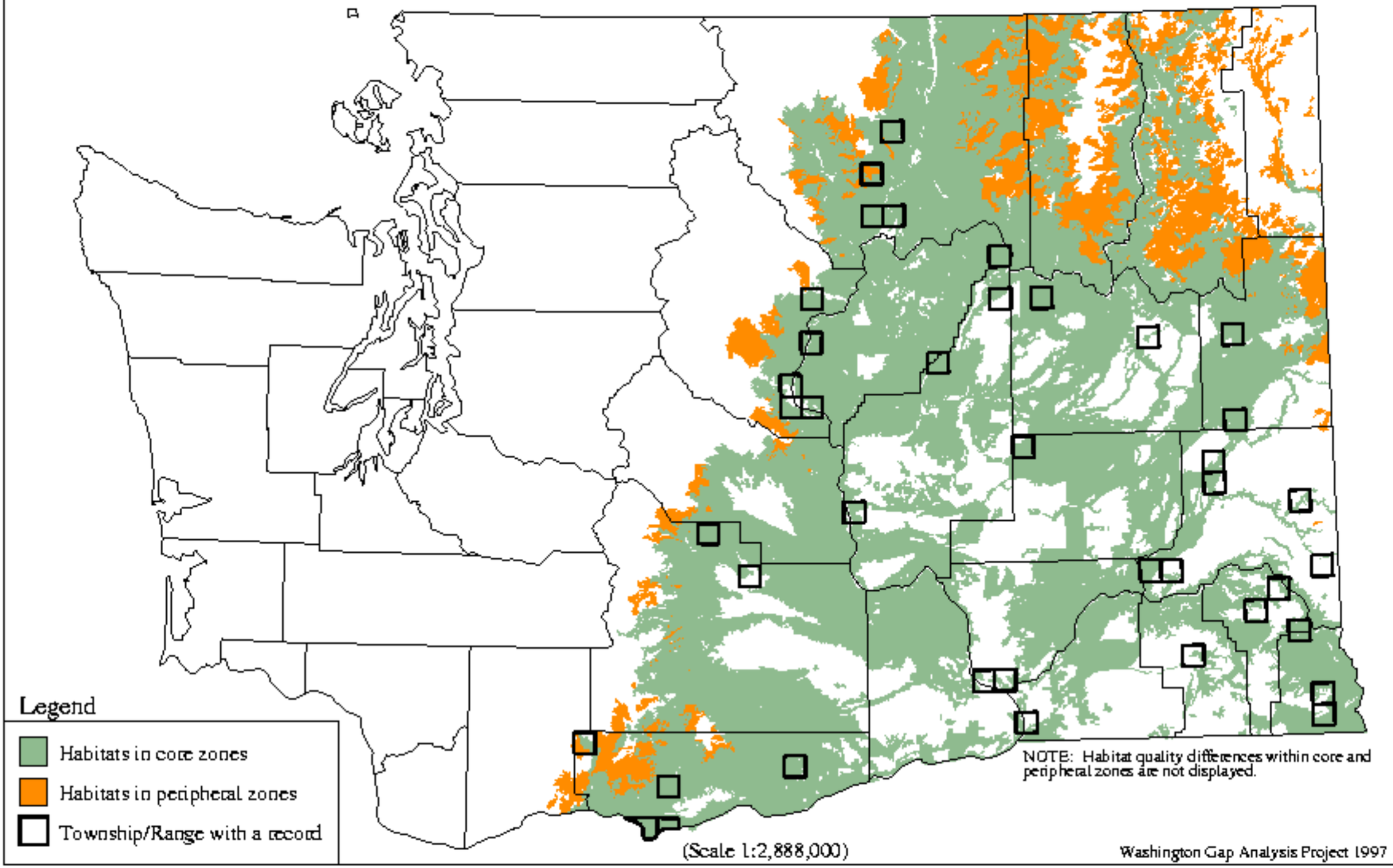
Aplodontia rufa - Mountain Beaver



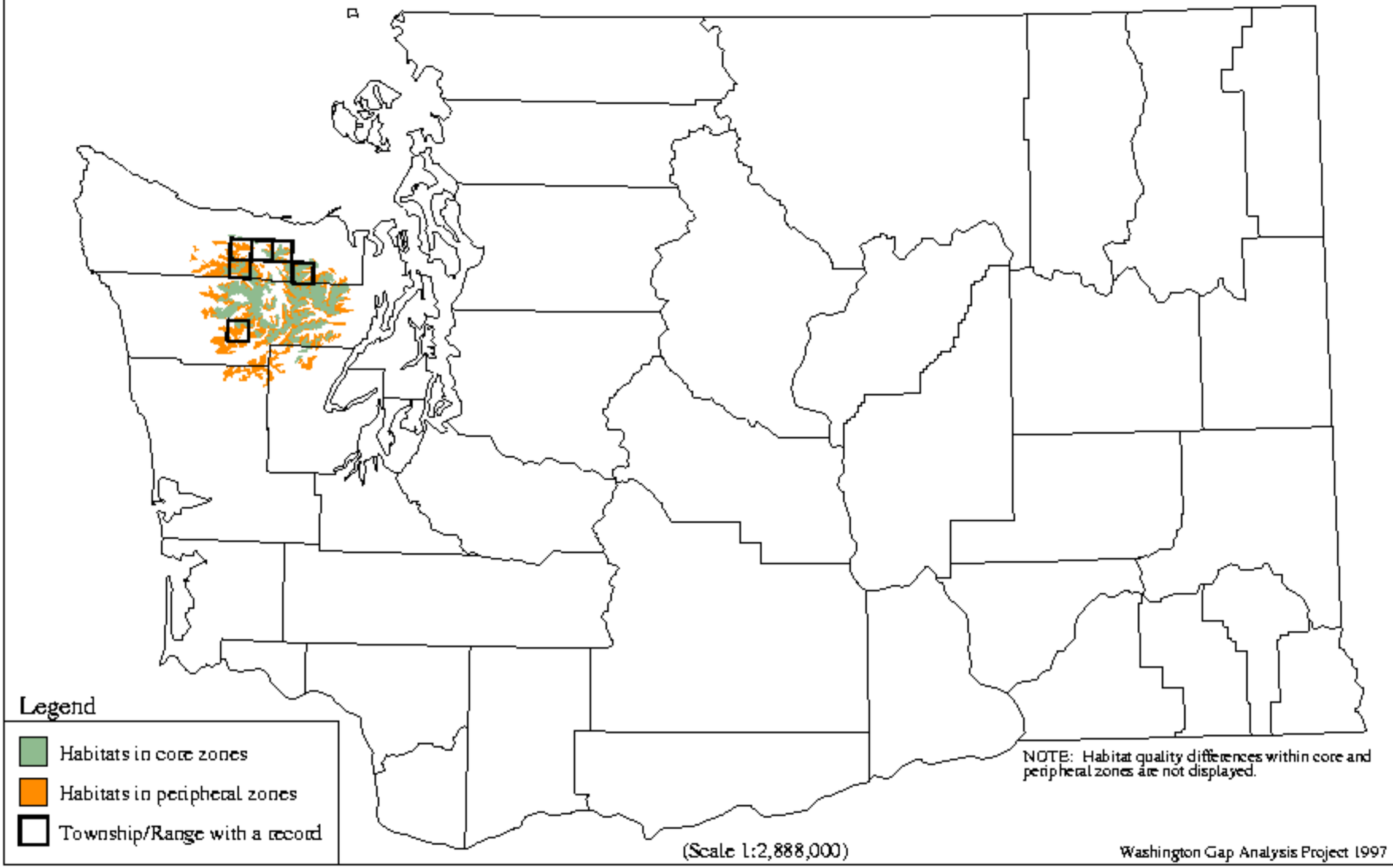
Marmota caligata - Hoary Marmot



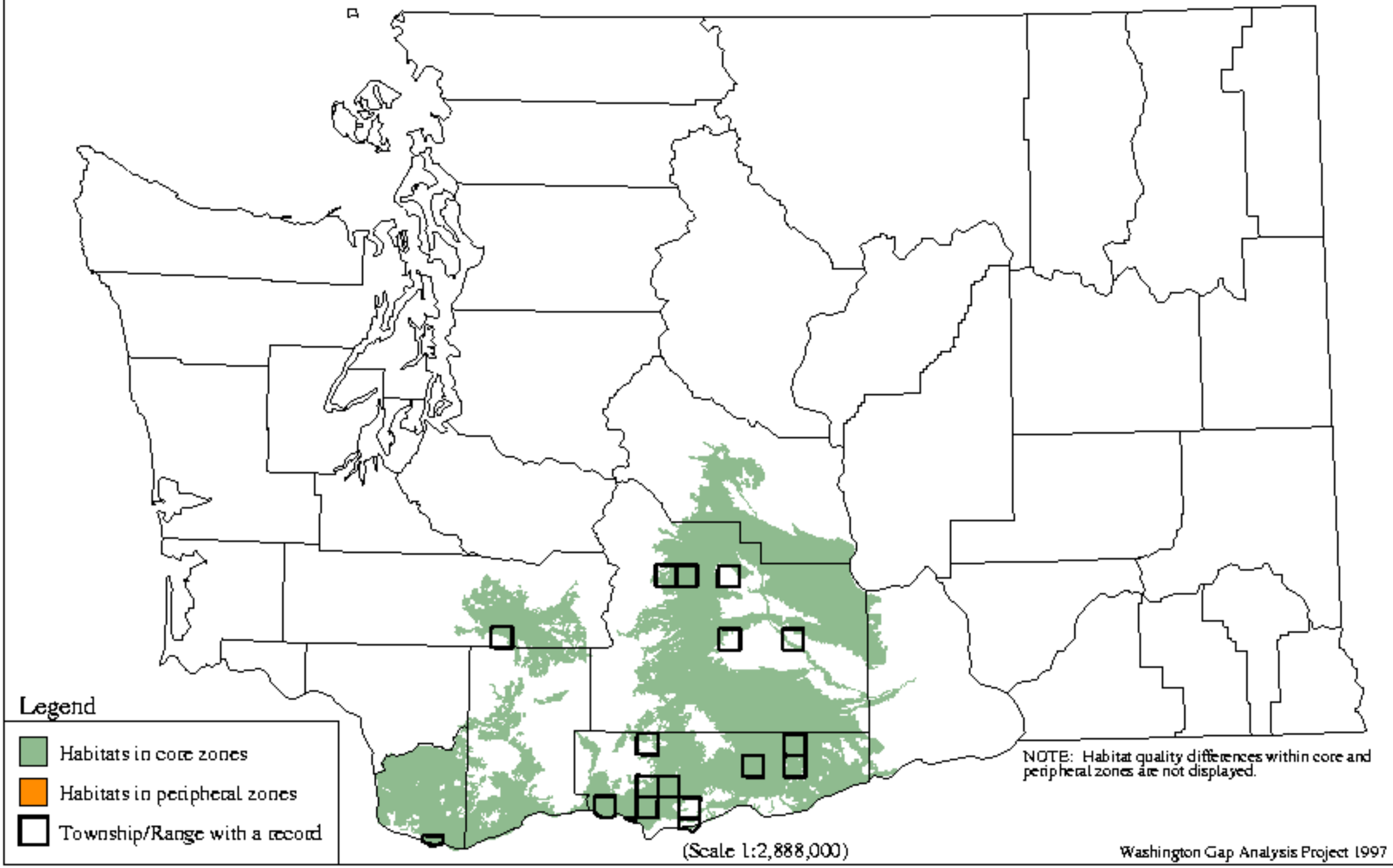
Marmota flaviventris - Yellow-bellied Marmot



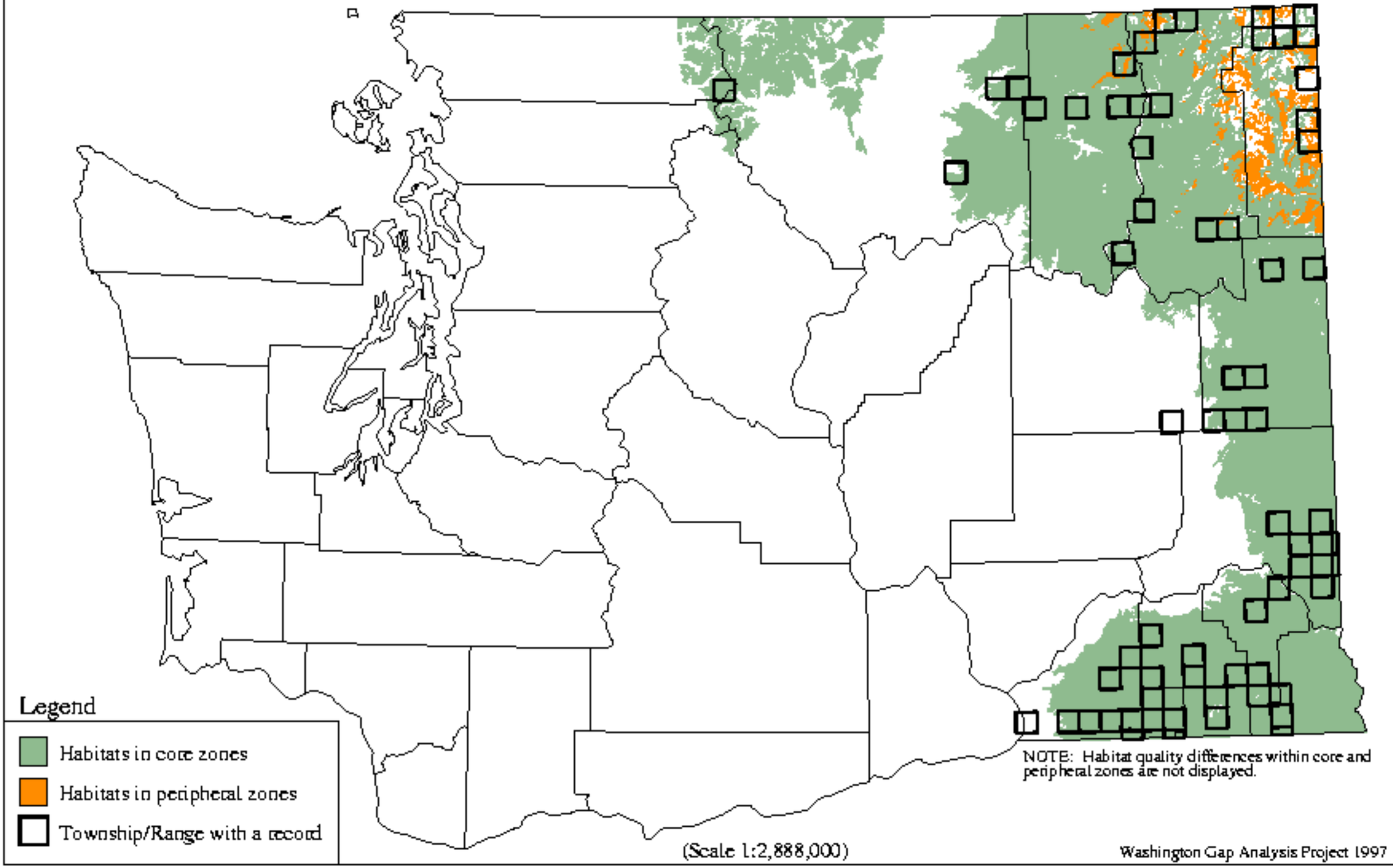
Marmota olympus - Olympic Marmot



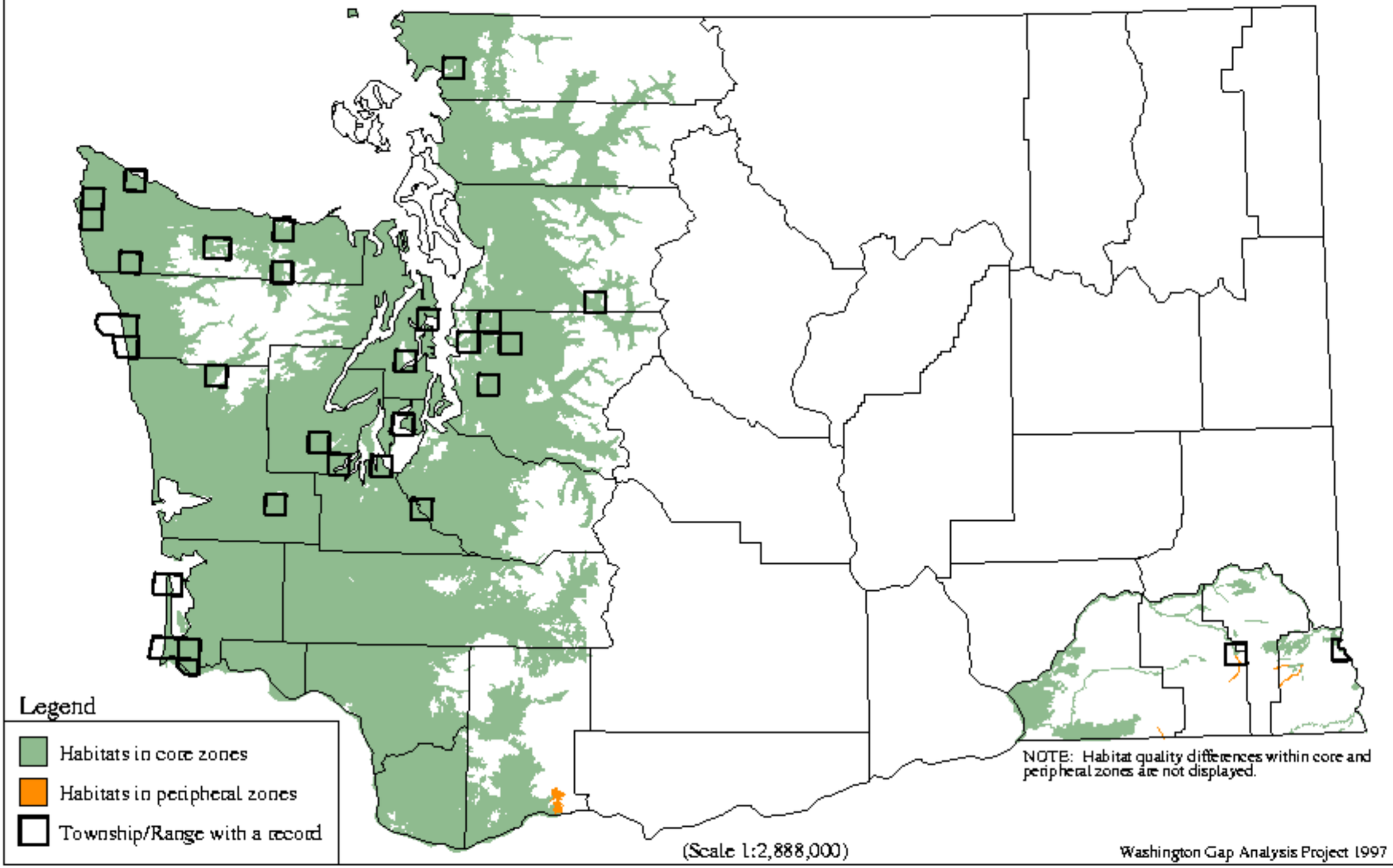
Spermophilus beecheyi - California Ground Squirrel



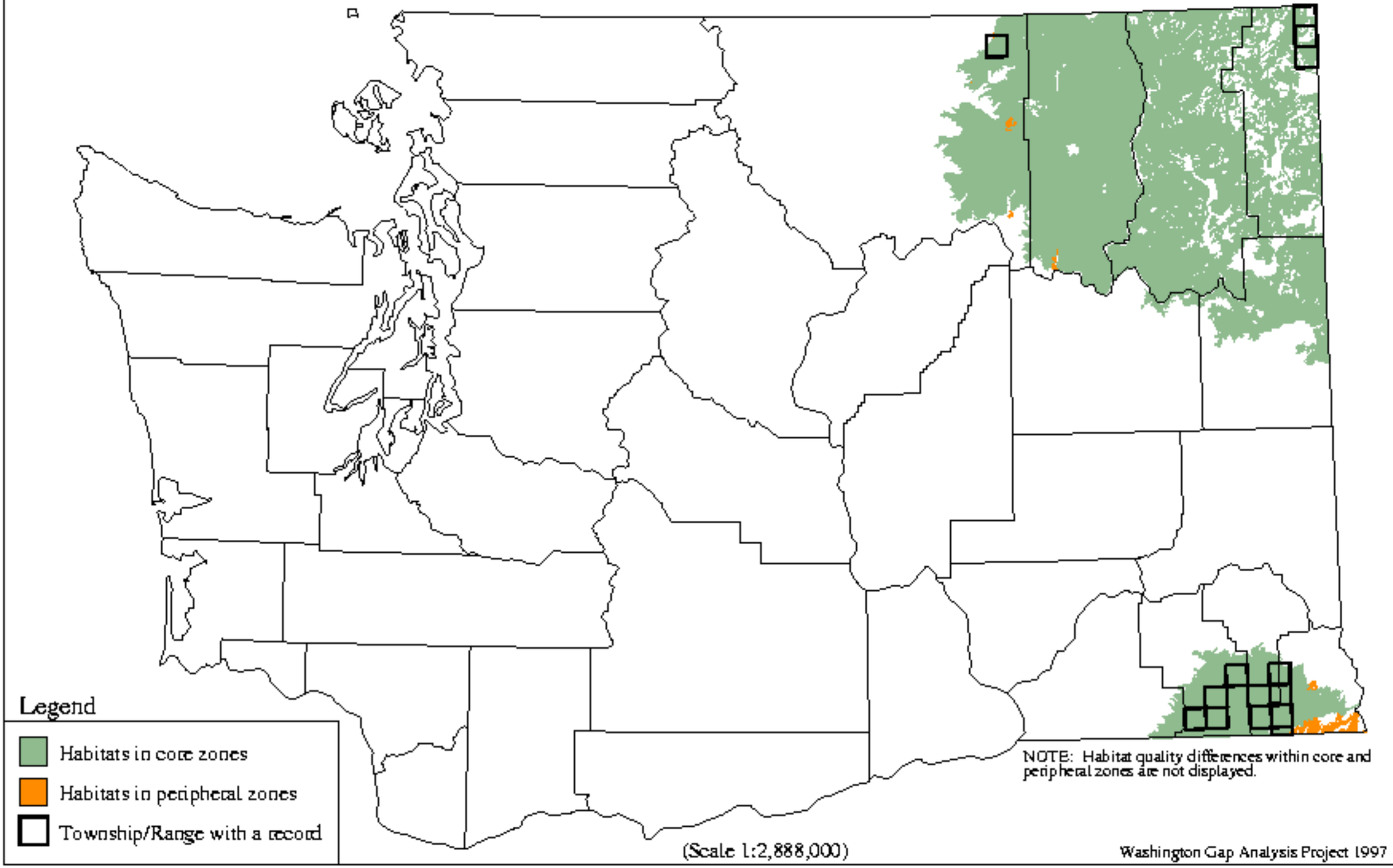
Spermophilus columbianus - Columbian Ground Squirrel



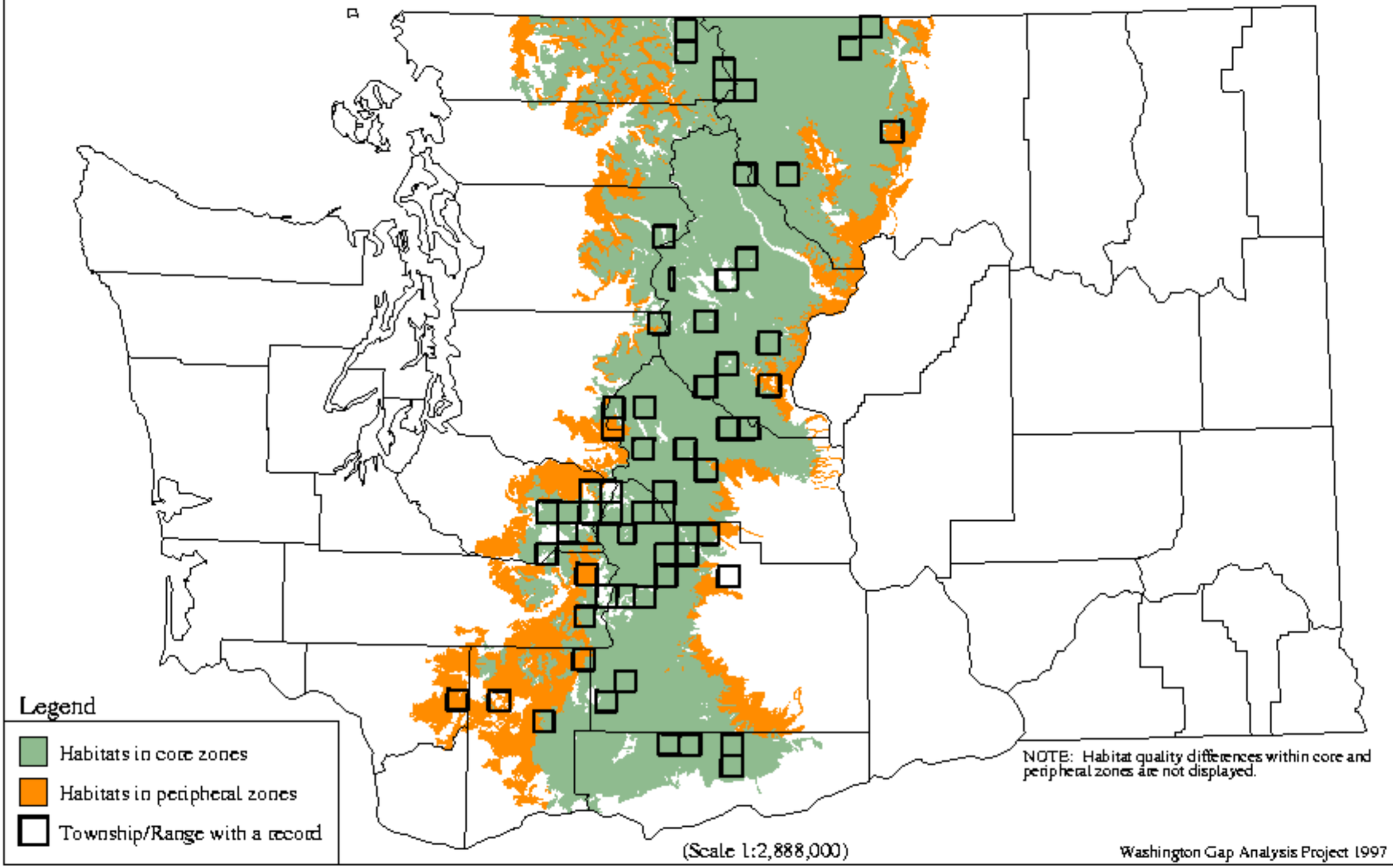
Spilogale gracilis - Spotted Skunk



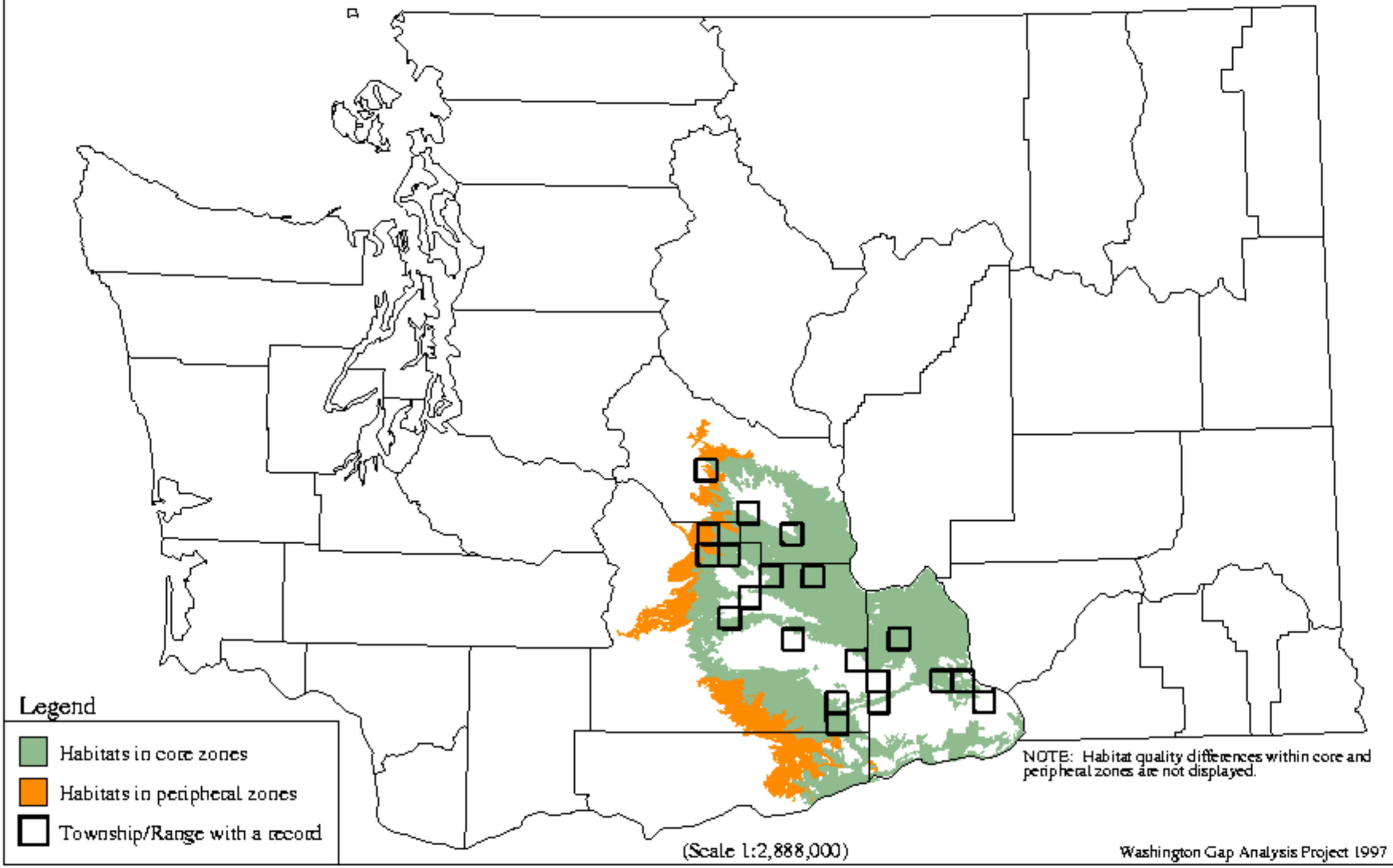
Spermophilus lateralis - Golden-mantled Ground Squirrel



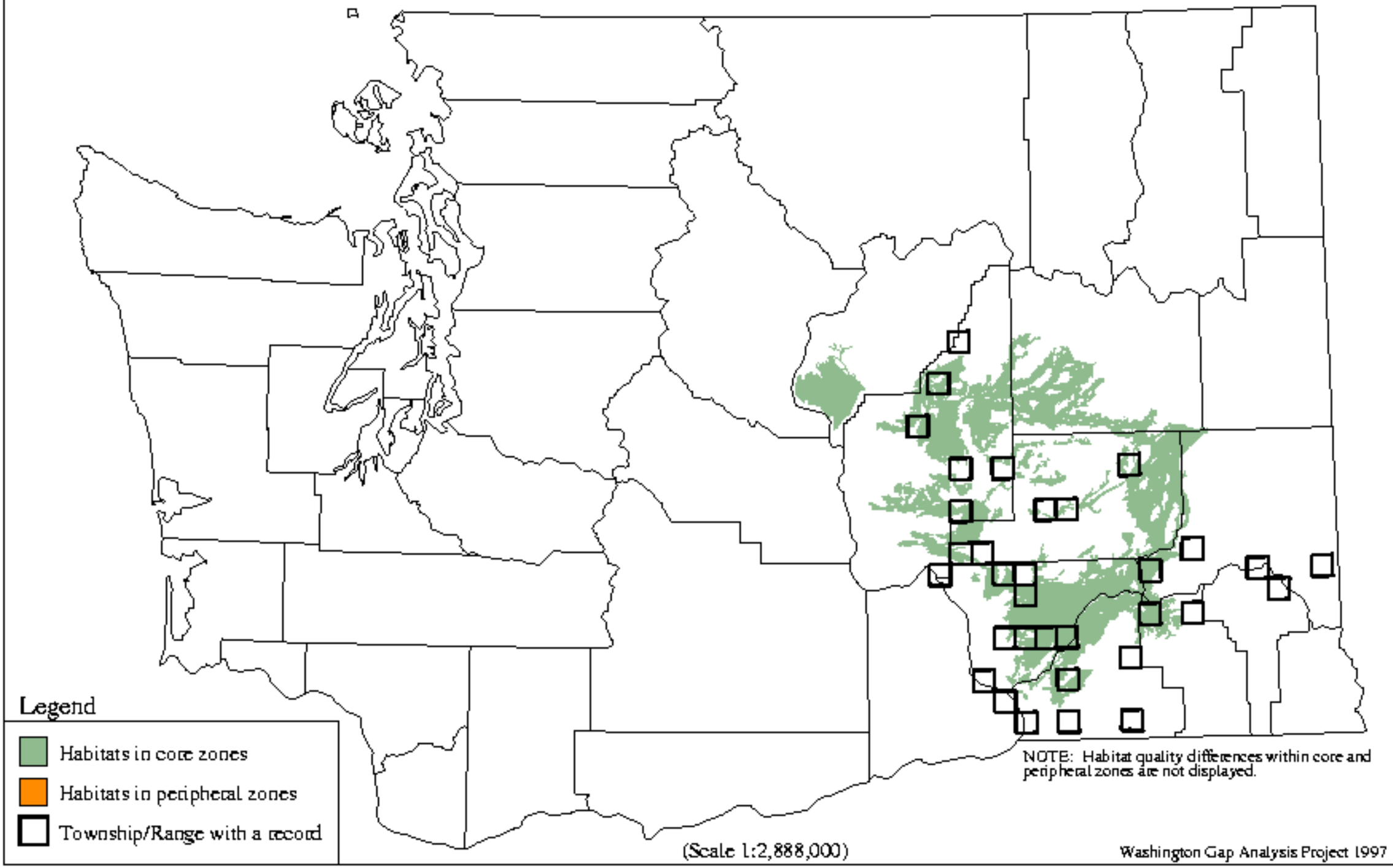
Spermophilus saturatus - Cascade Golden-mantled Ground Squirrel



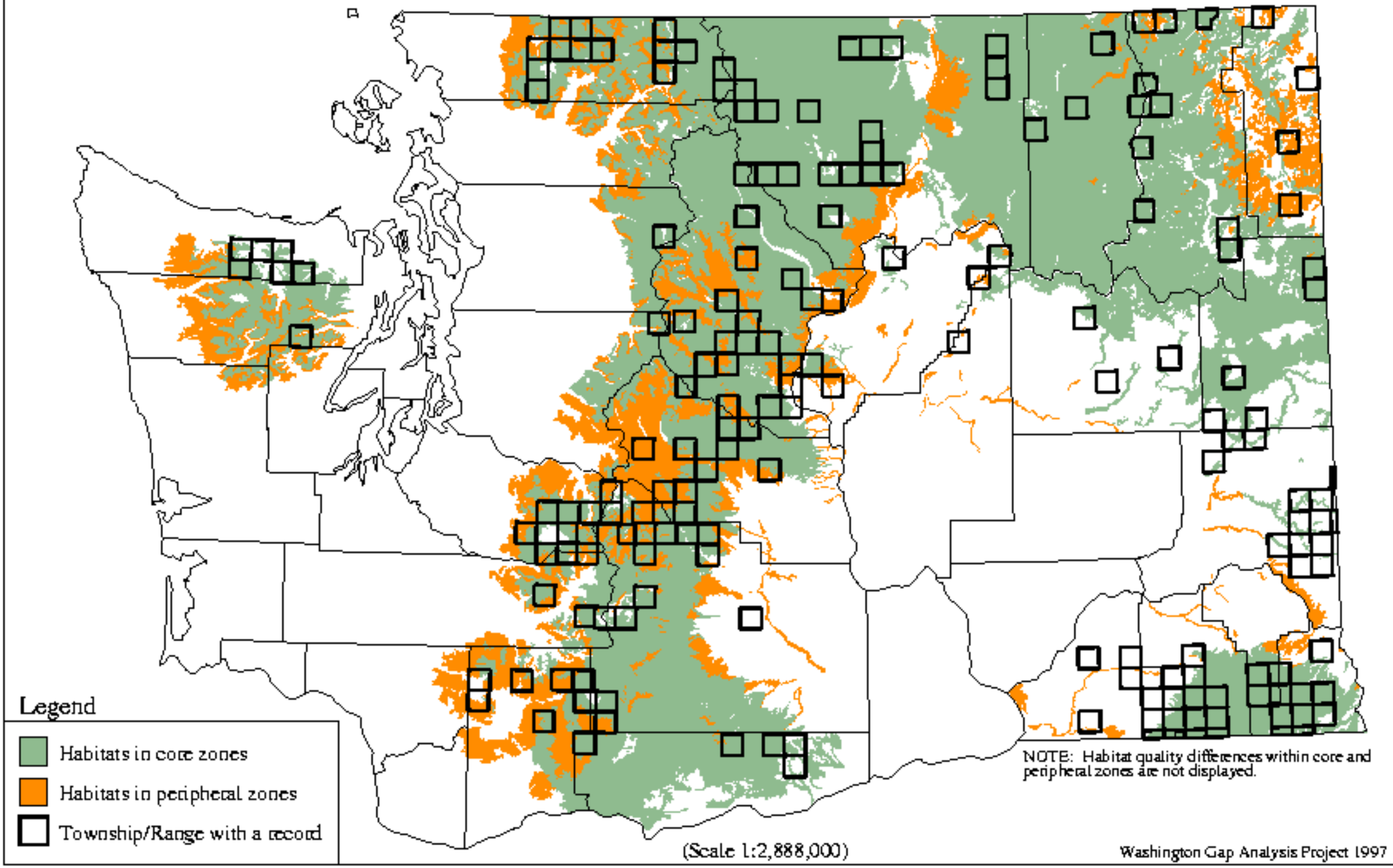
Spermophilus townsendii - Townsend`s Ground Squirrel



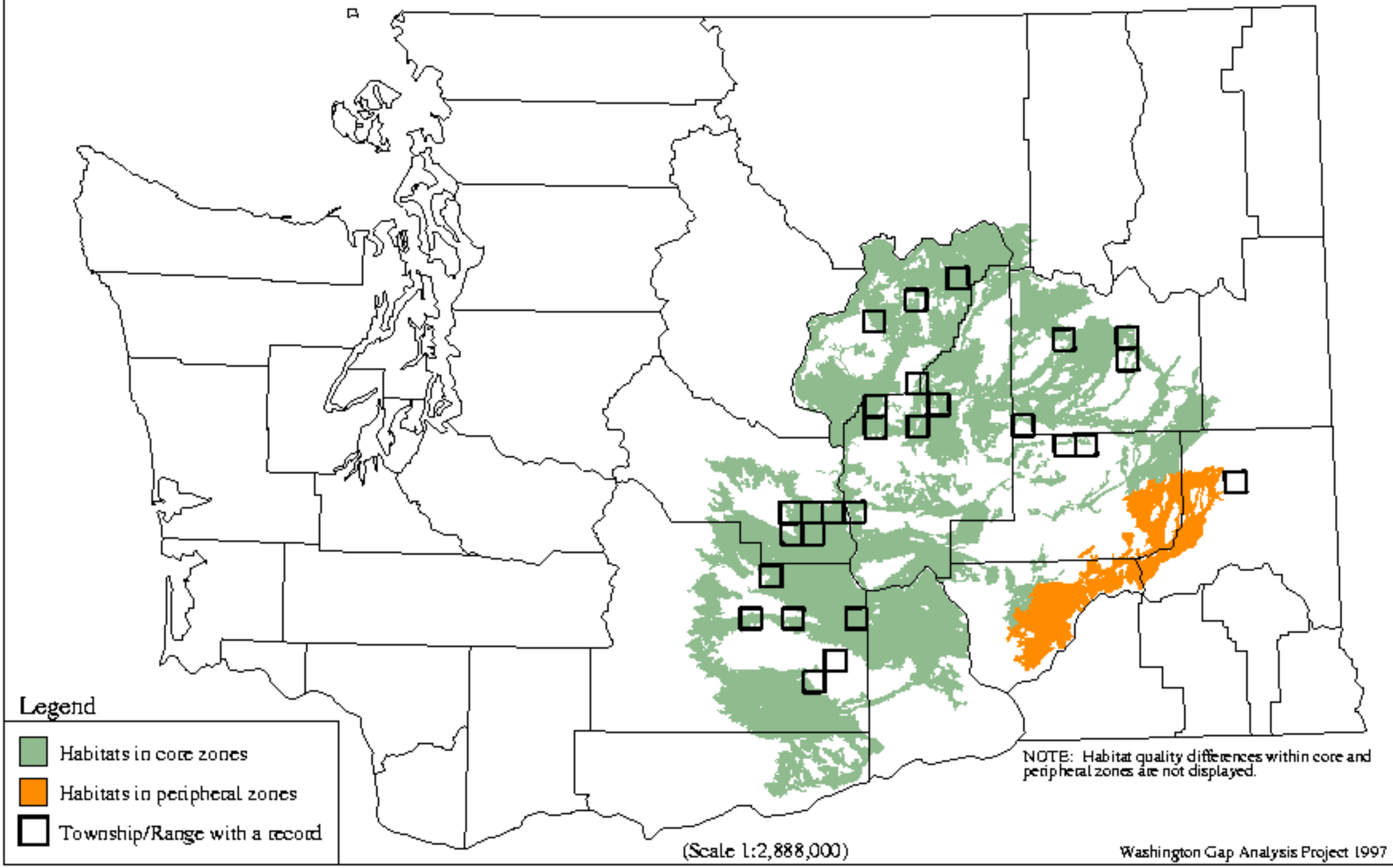
Spermophilus washingtoni - Washington Ground Squirrel



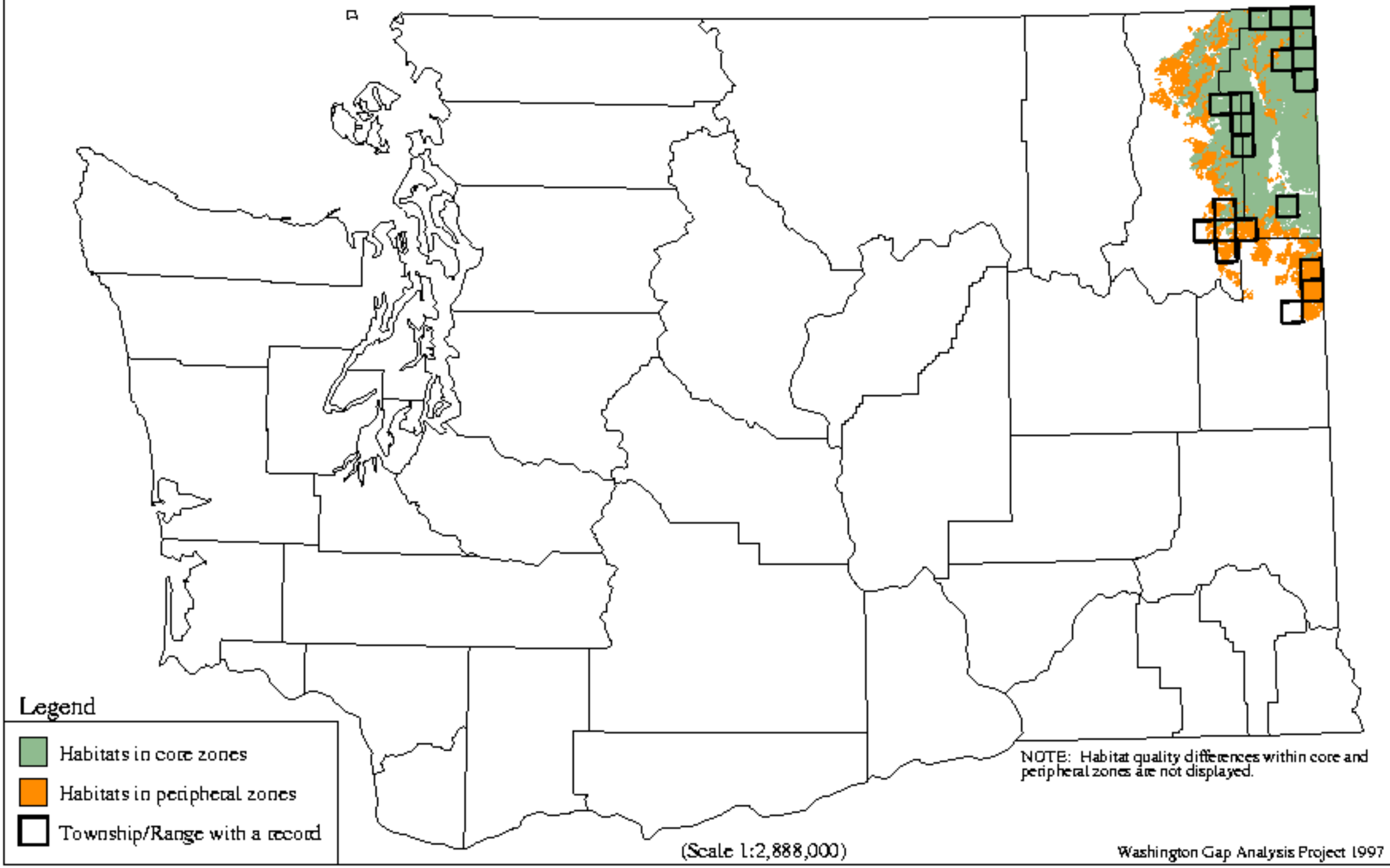
Tamias amoenus - Yellow-pine Chipmunk



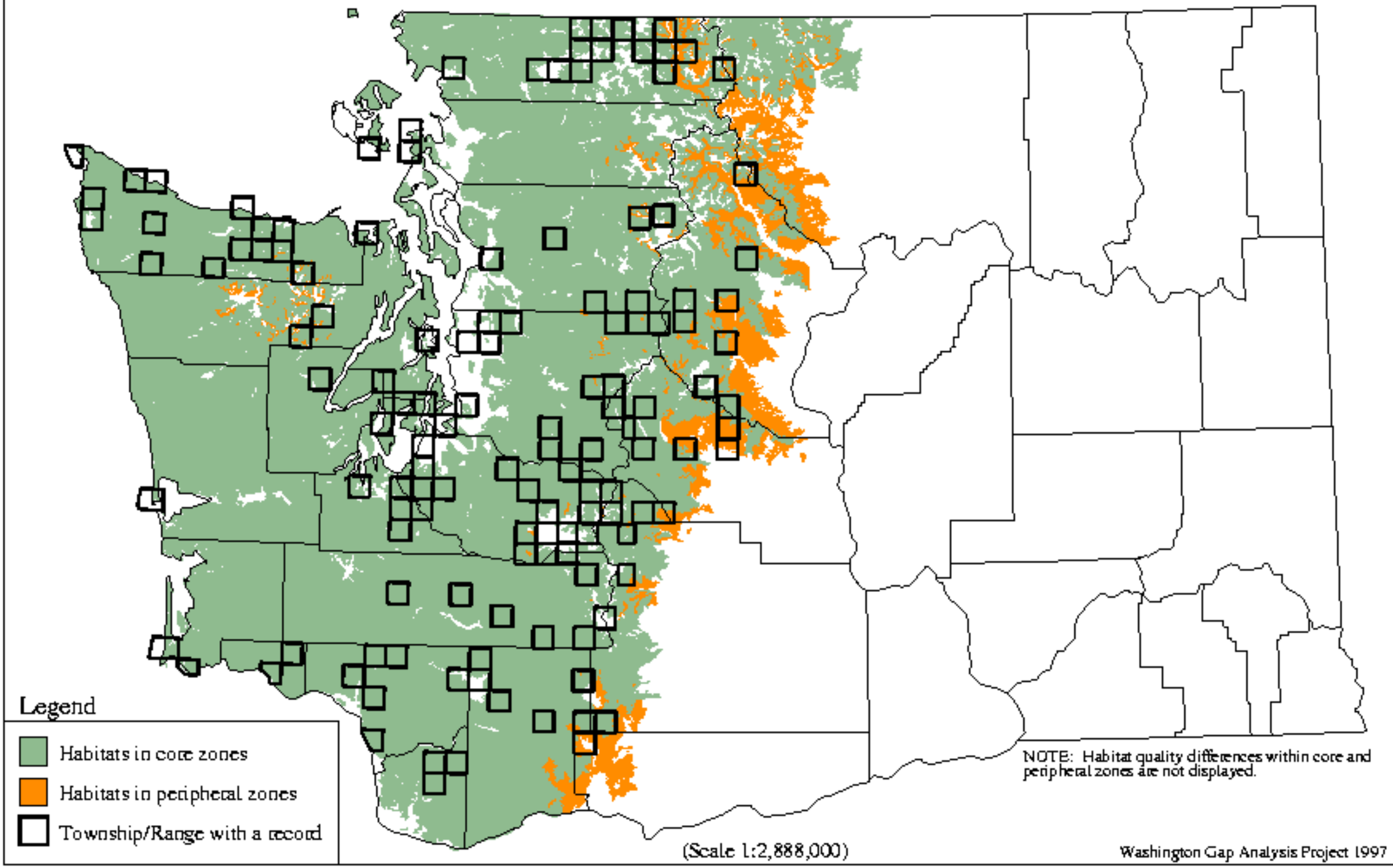
Tamias minimus - Least Chipmunk



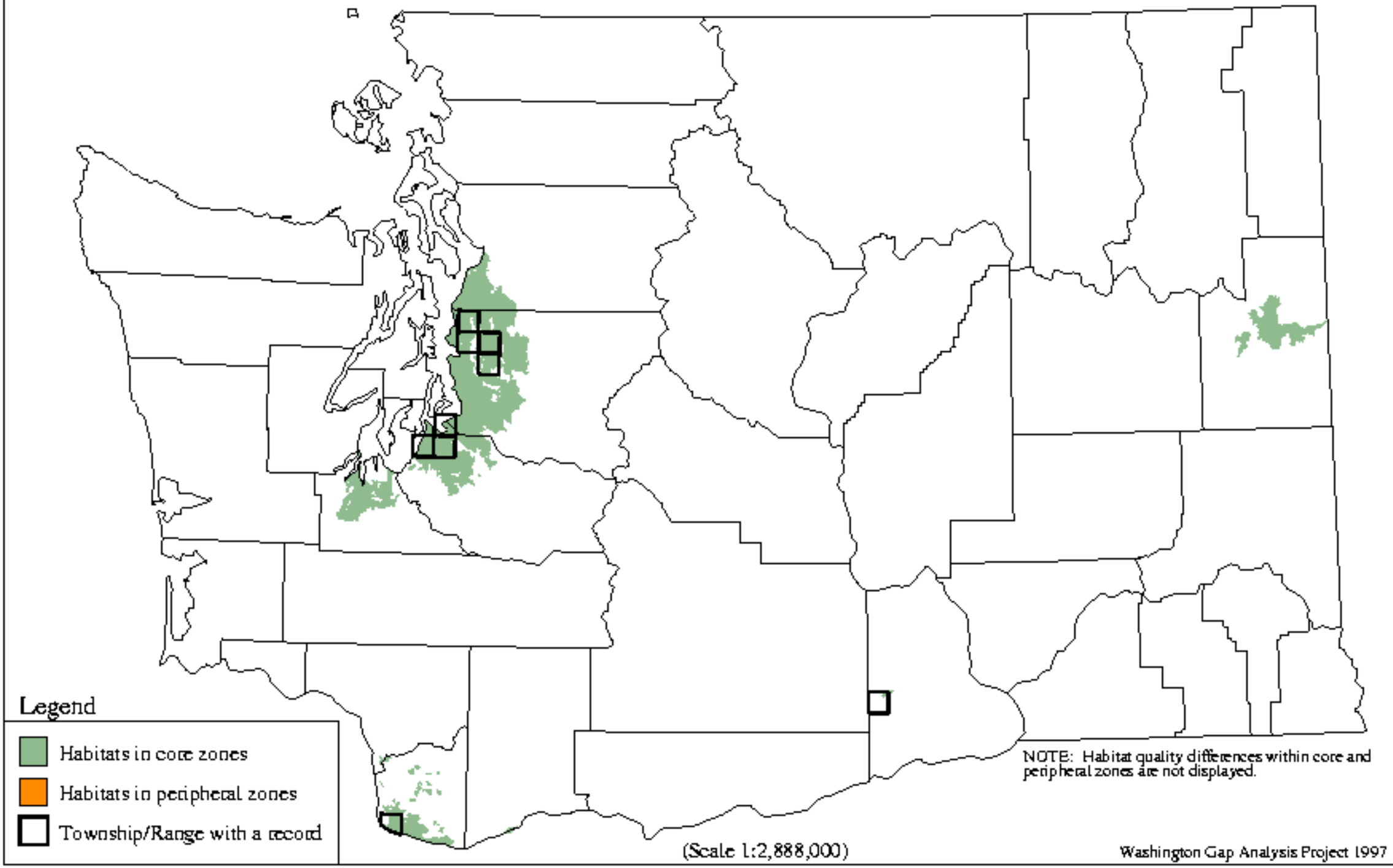
Tamias ruficaudus - Red-tailed Chipmunk



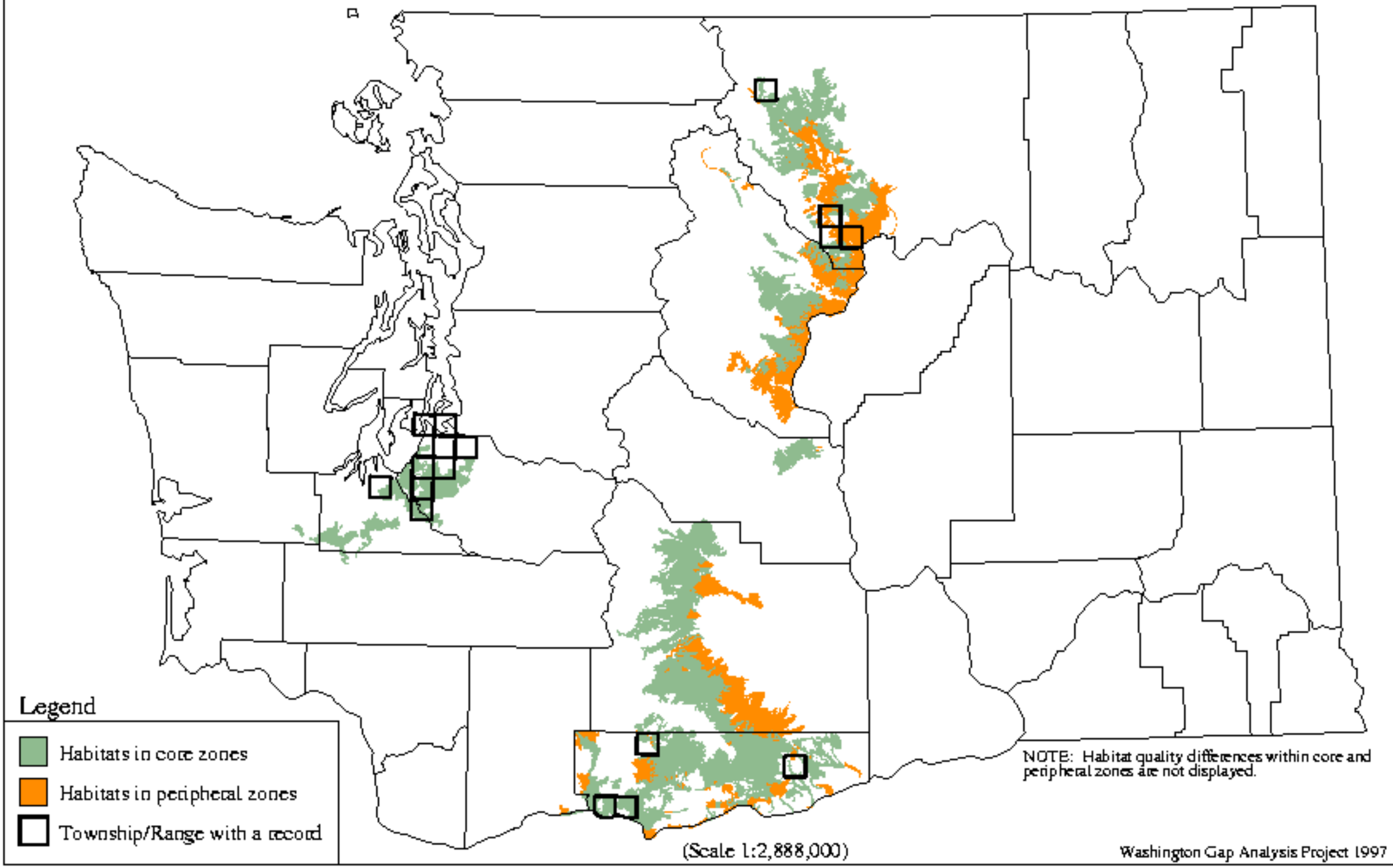
Tamias townsendii - Townsend`s Chipmunk



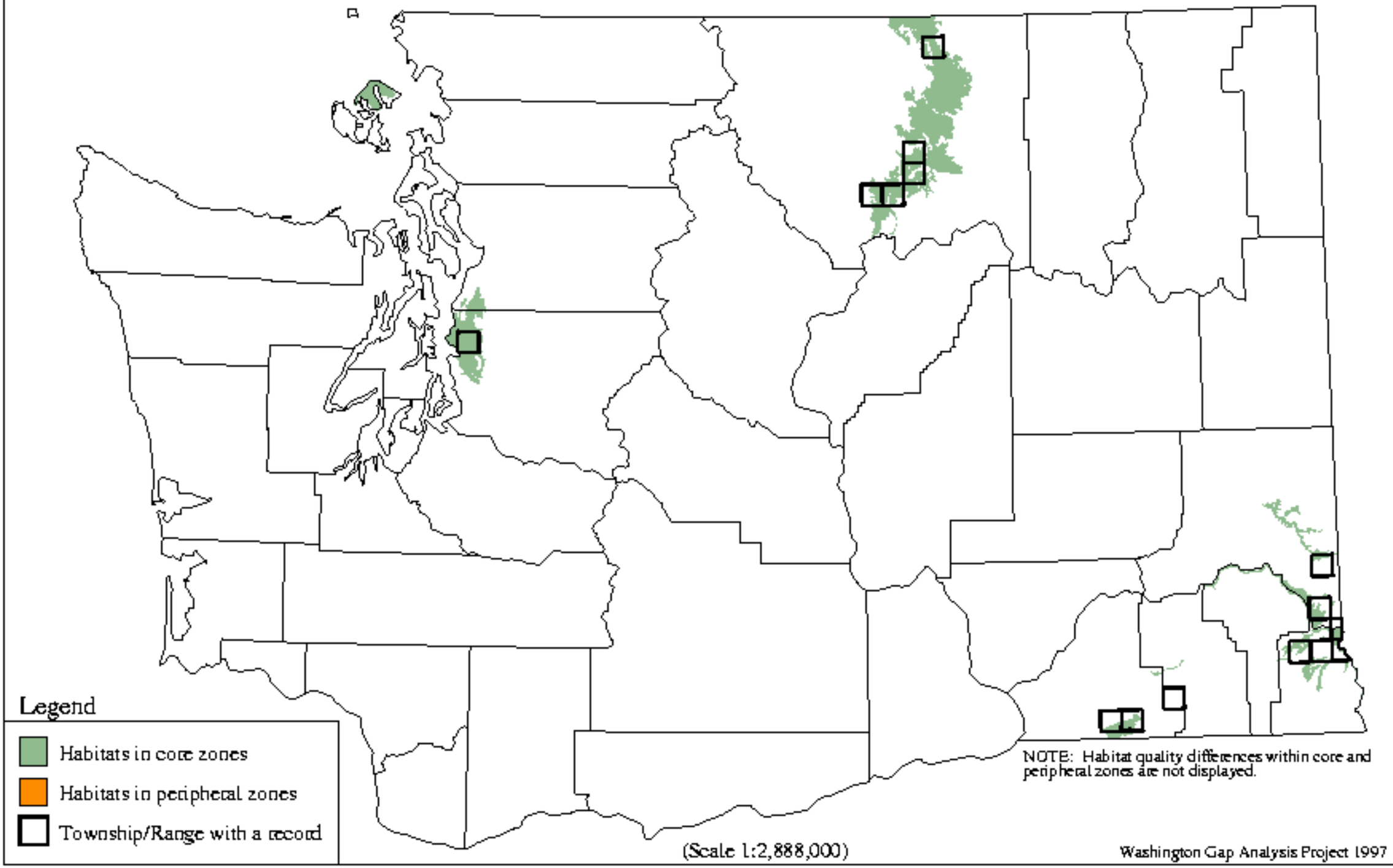
Sciurus carolinensis - Eastern Gray Squirrel



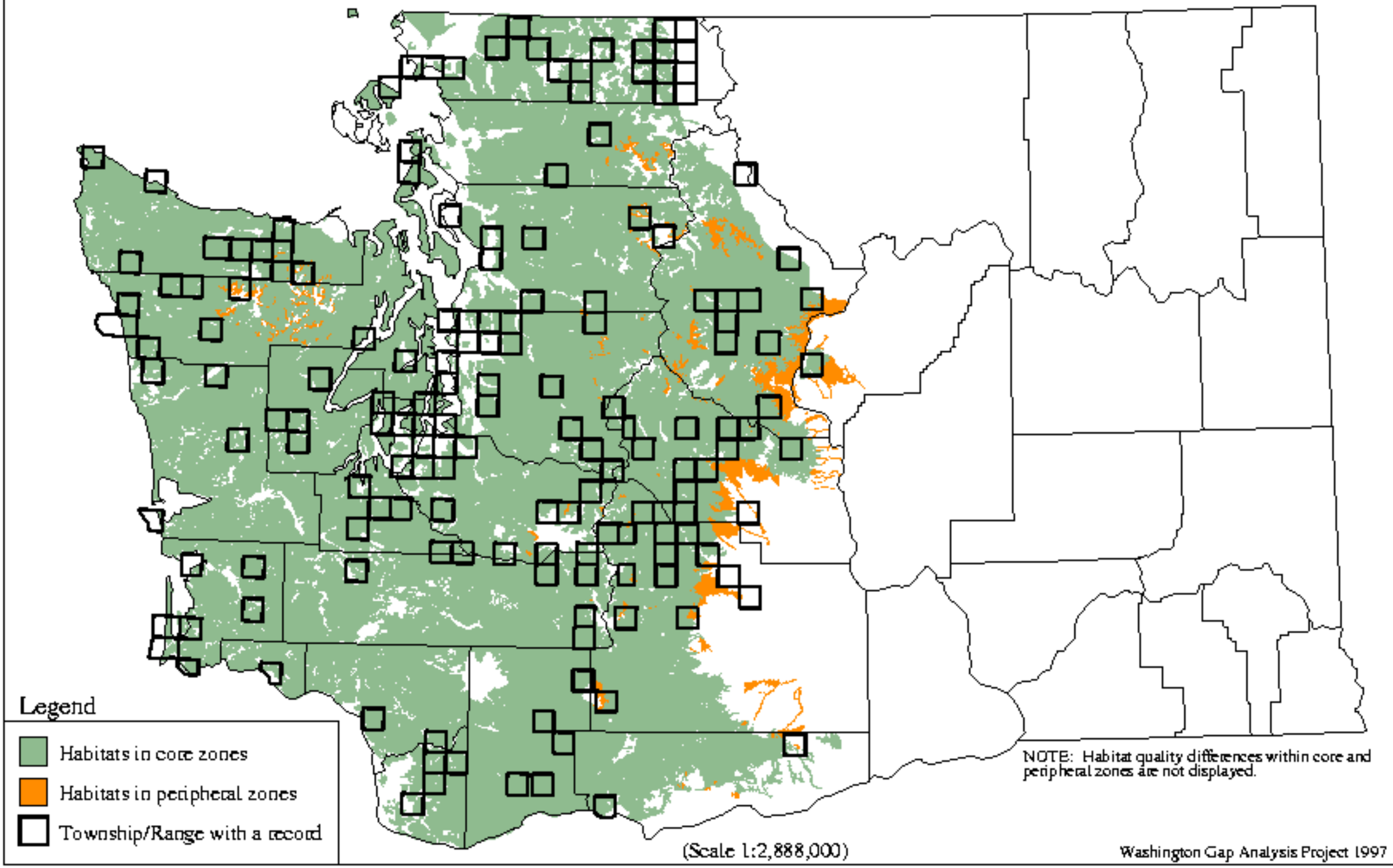
Sciurus griseus - Western Gray Squirrel



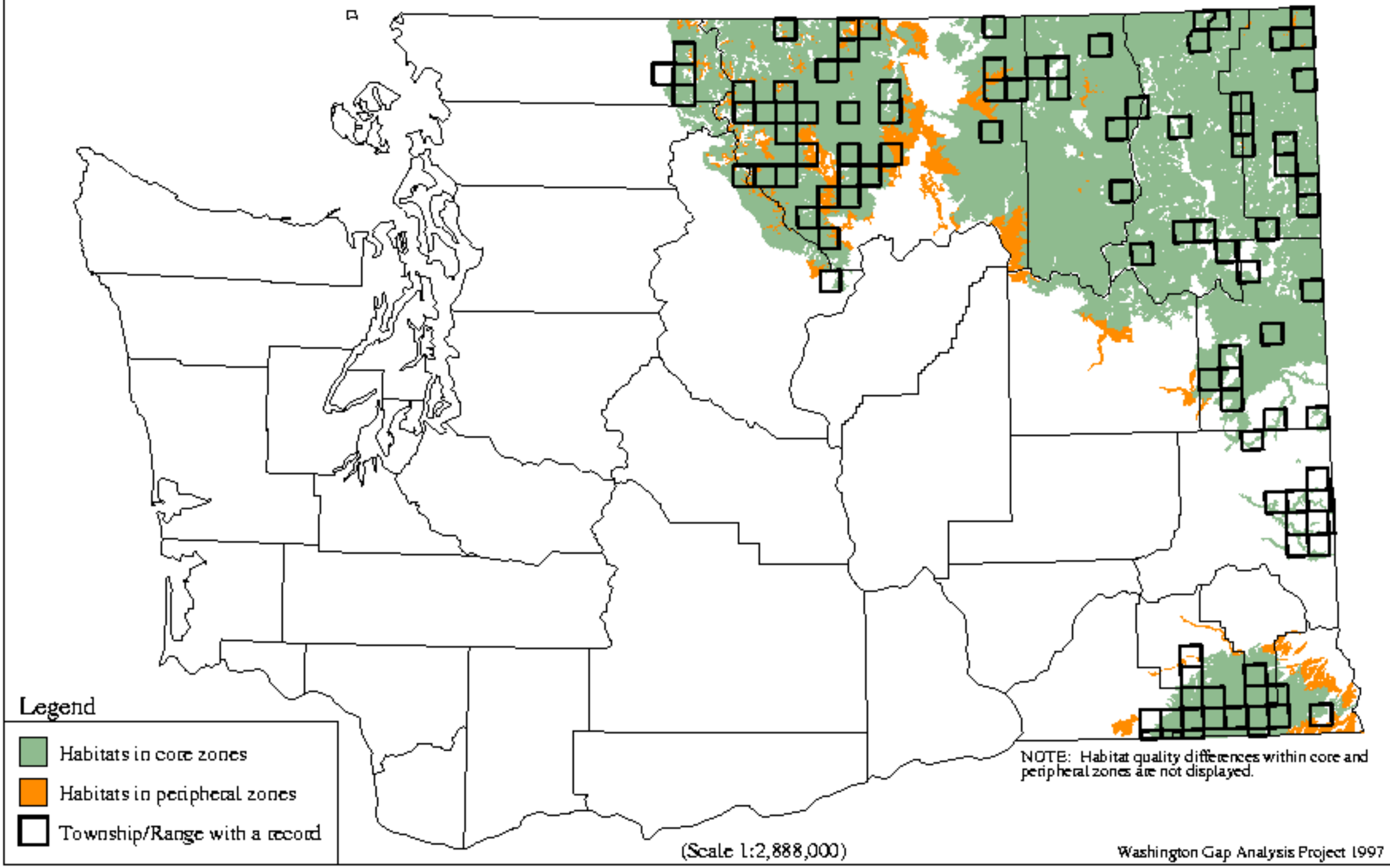
Sciurus niger - Fox Squirrel



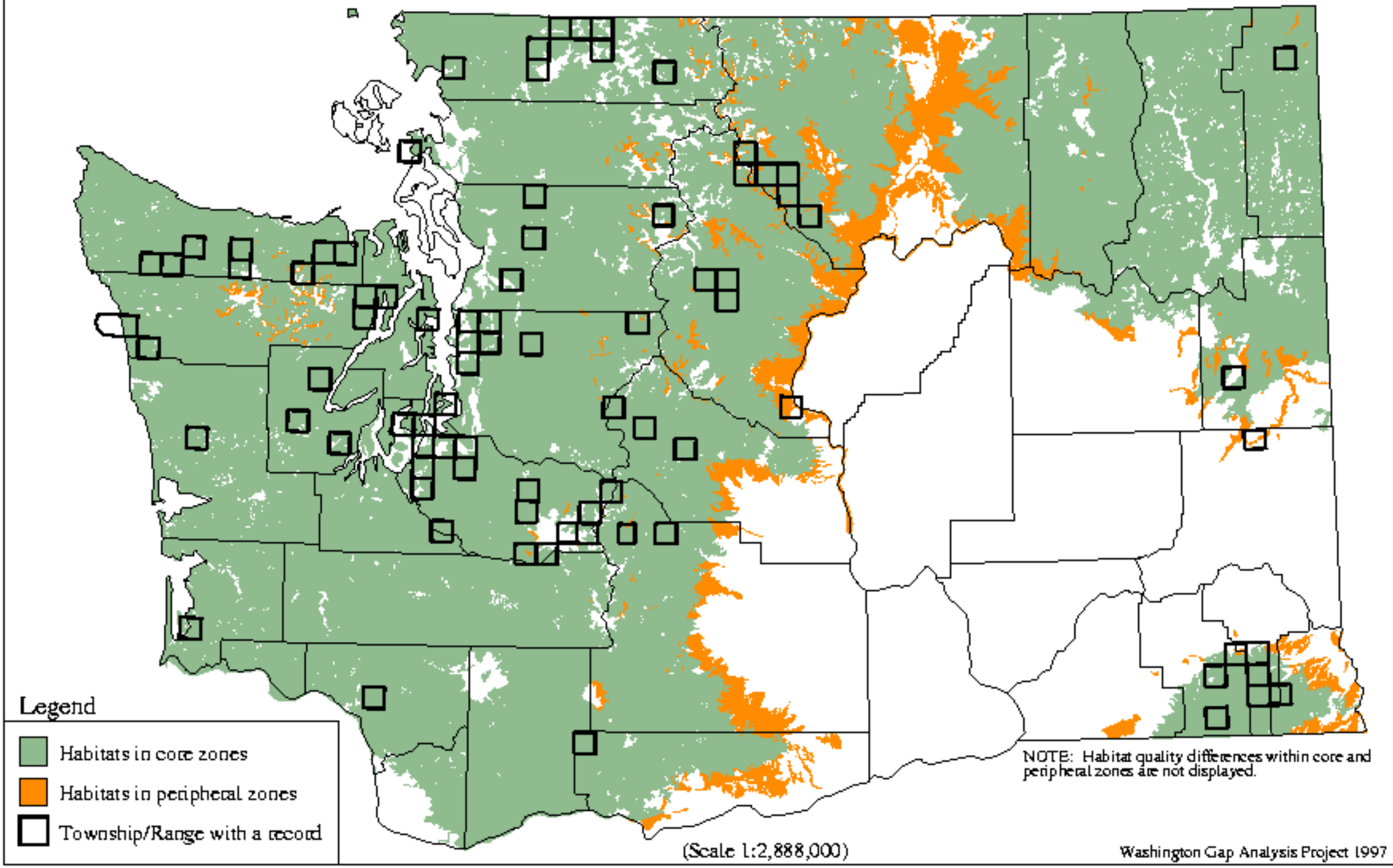
Tamiasciurus douglasii - Douglas` Squirrel



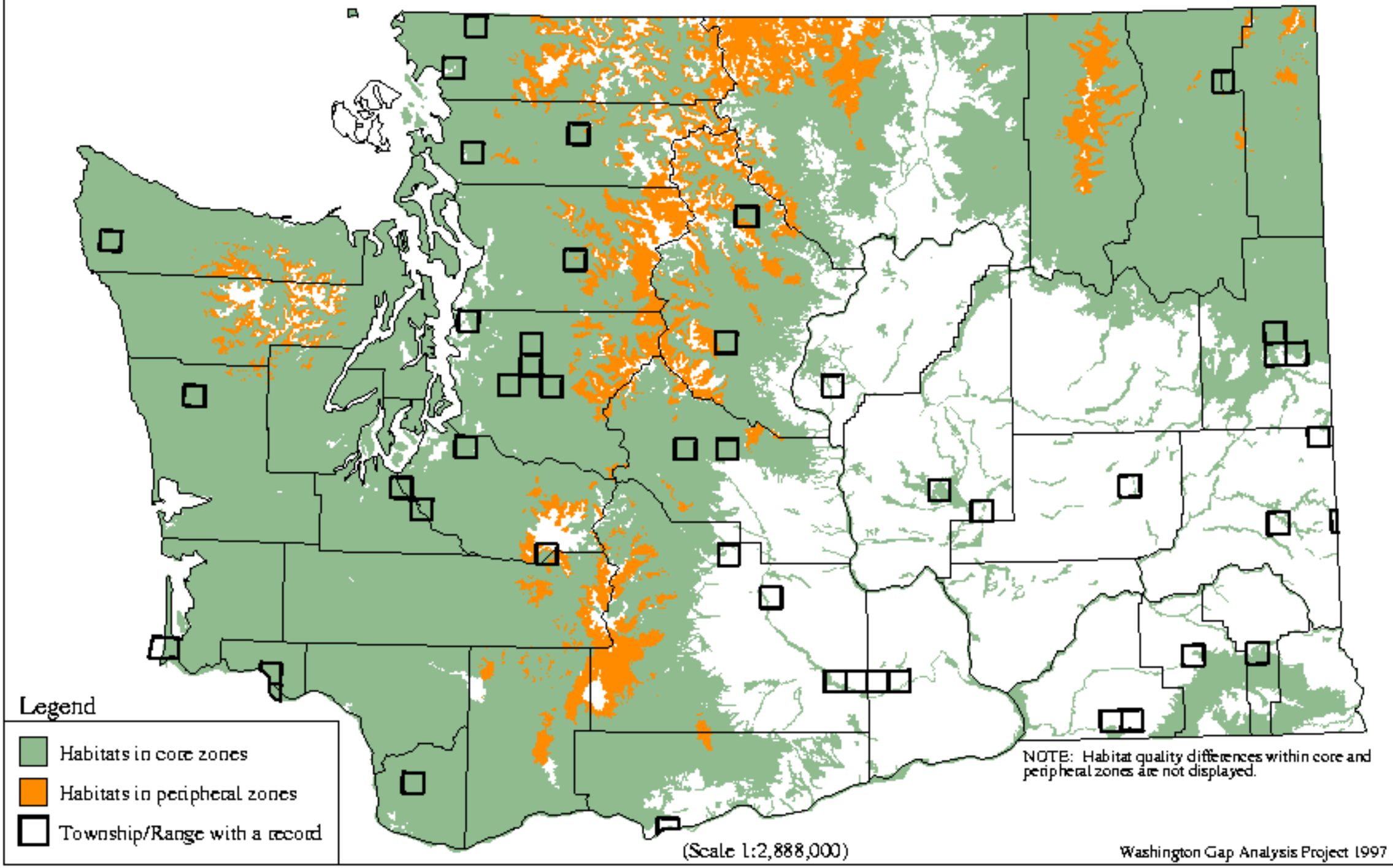
Tamiasciurus hudsonicus - Red Squirrel



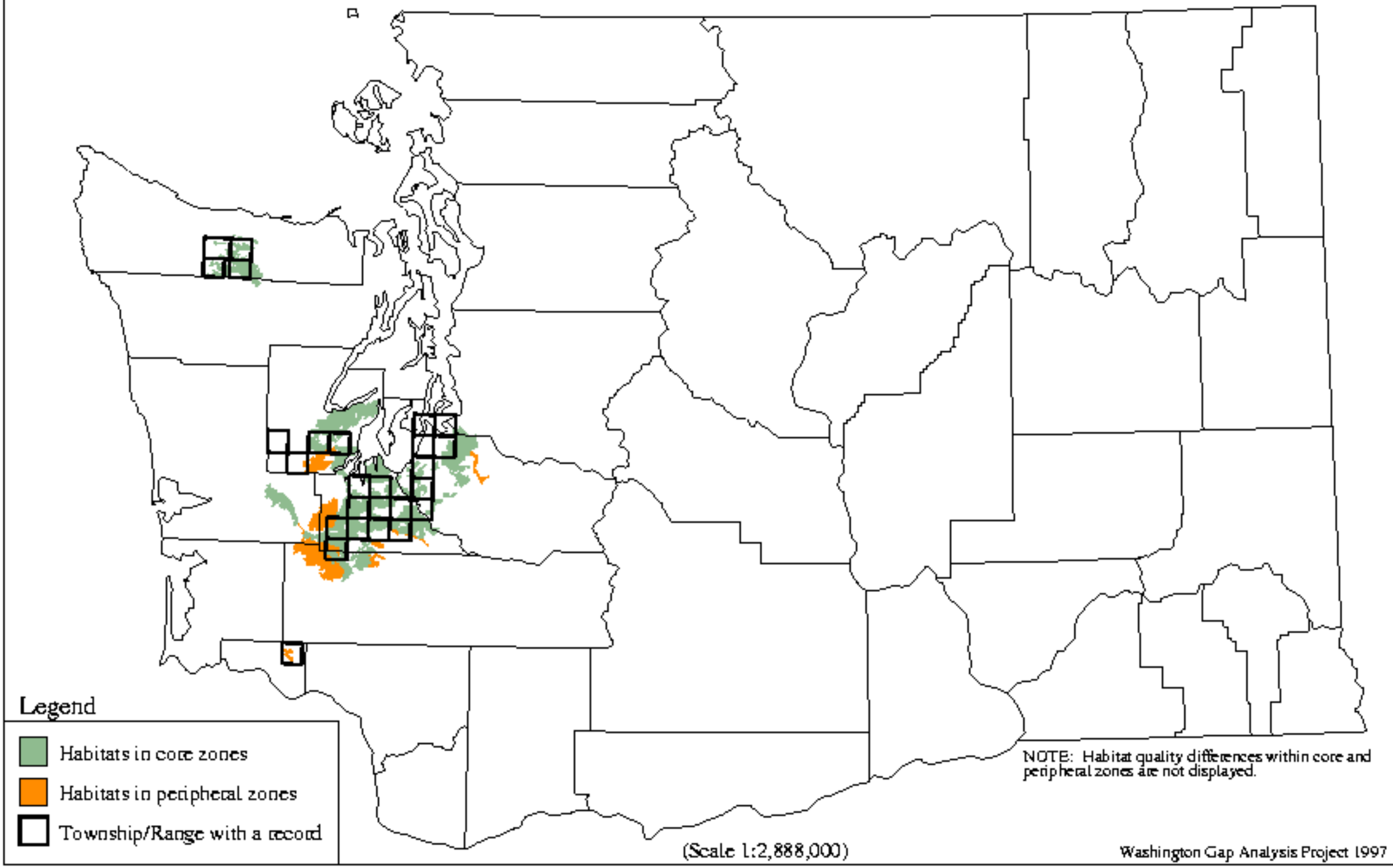
Glaucomys sabrinus - Northern Flying Squirrel



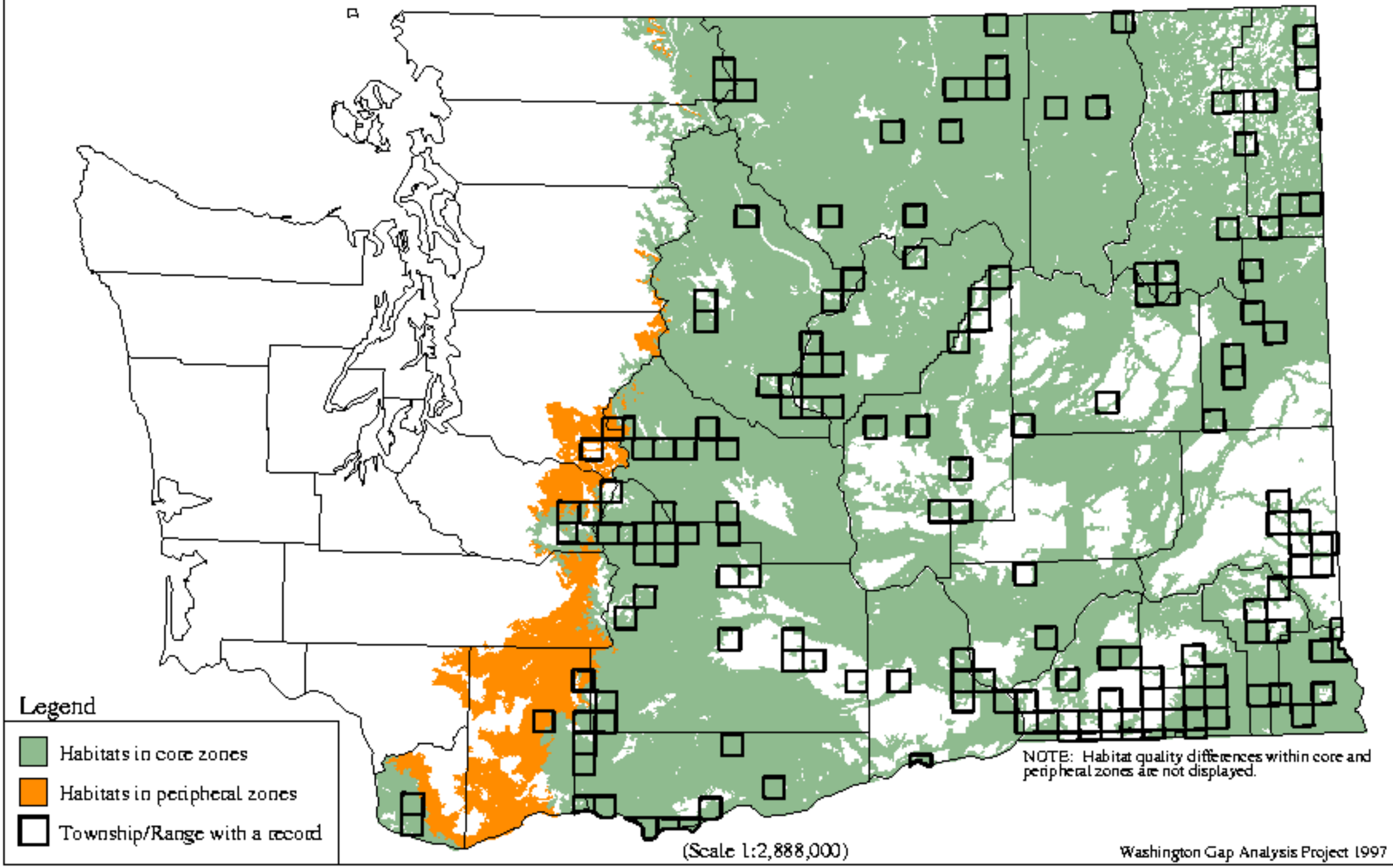
Castor canadensis - **Beaver**



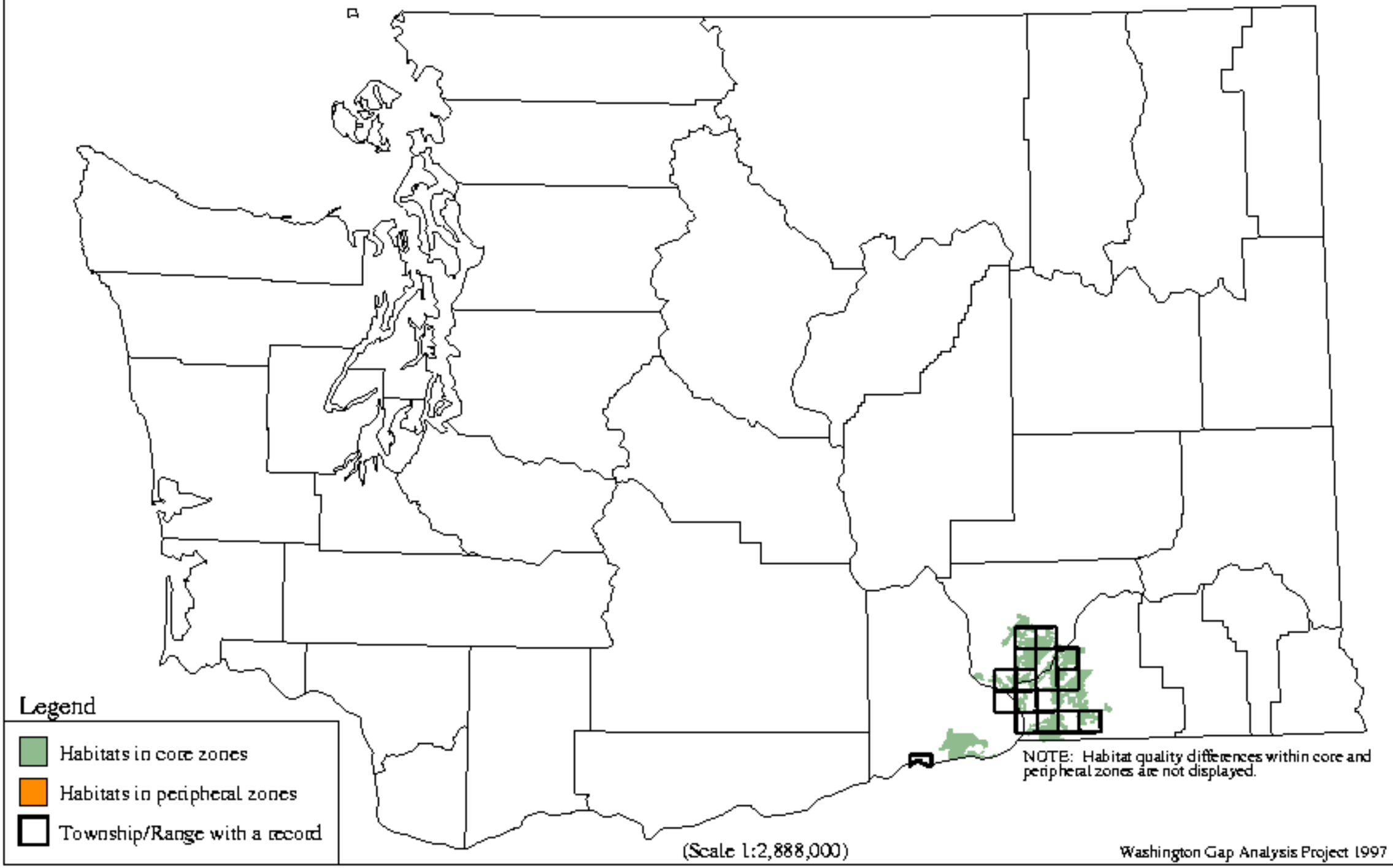
Thomomys mazama - Mazama Pocket Gopher



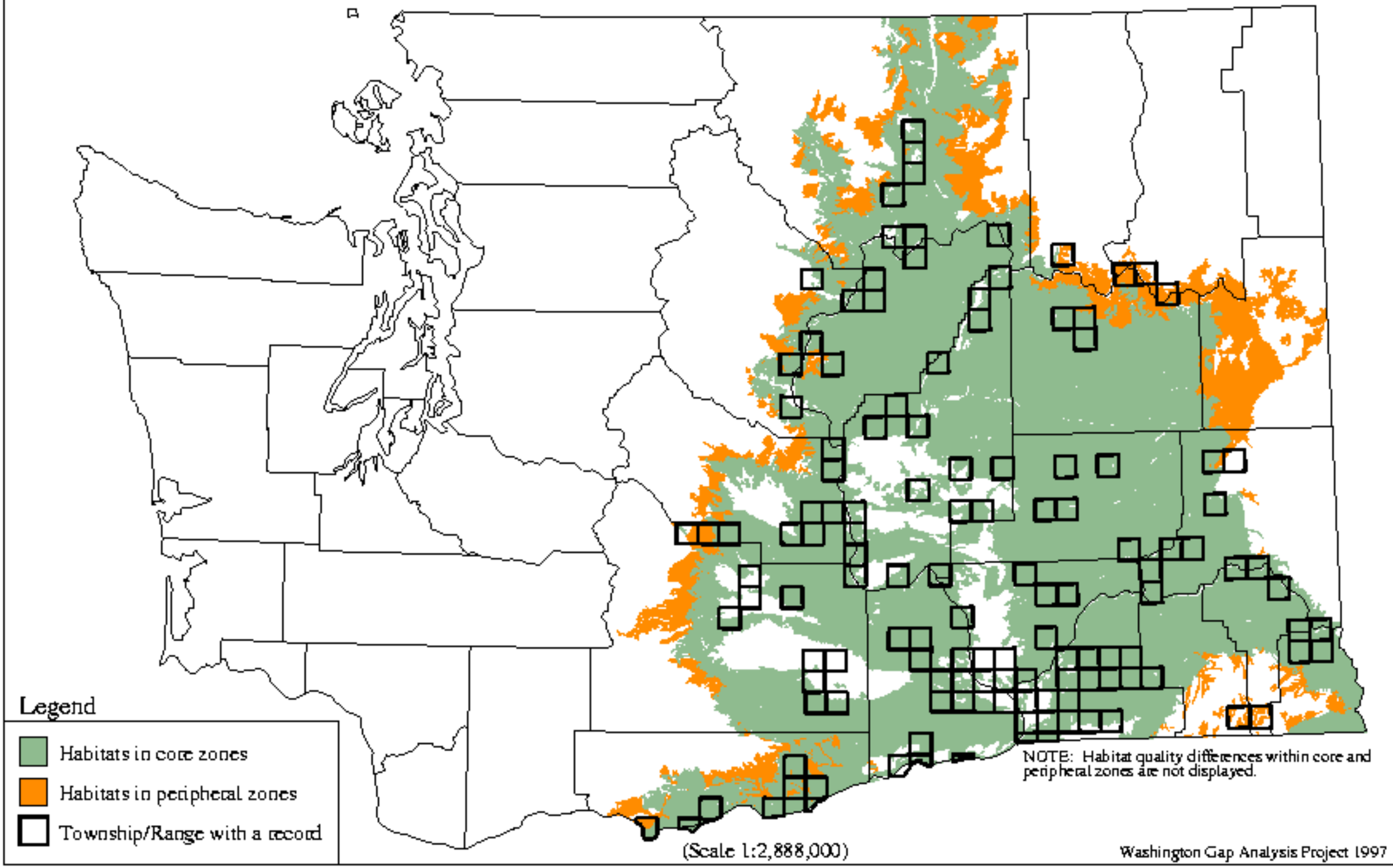
Thomomys talpoides - Northern Pocket Gopher



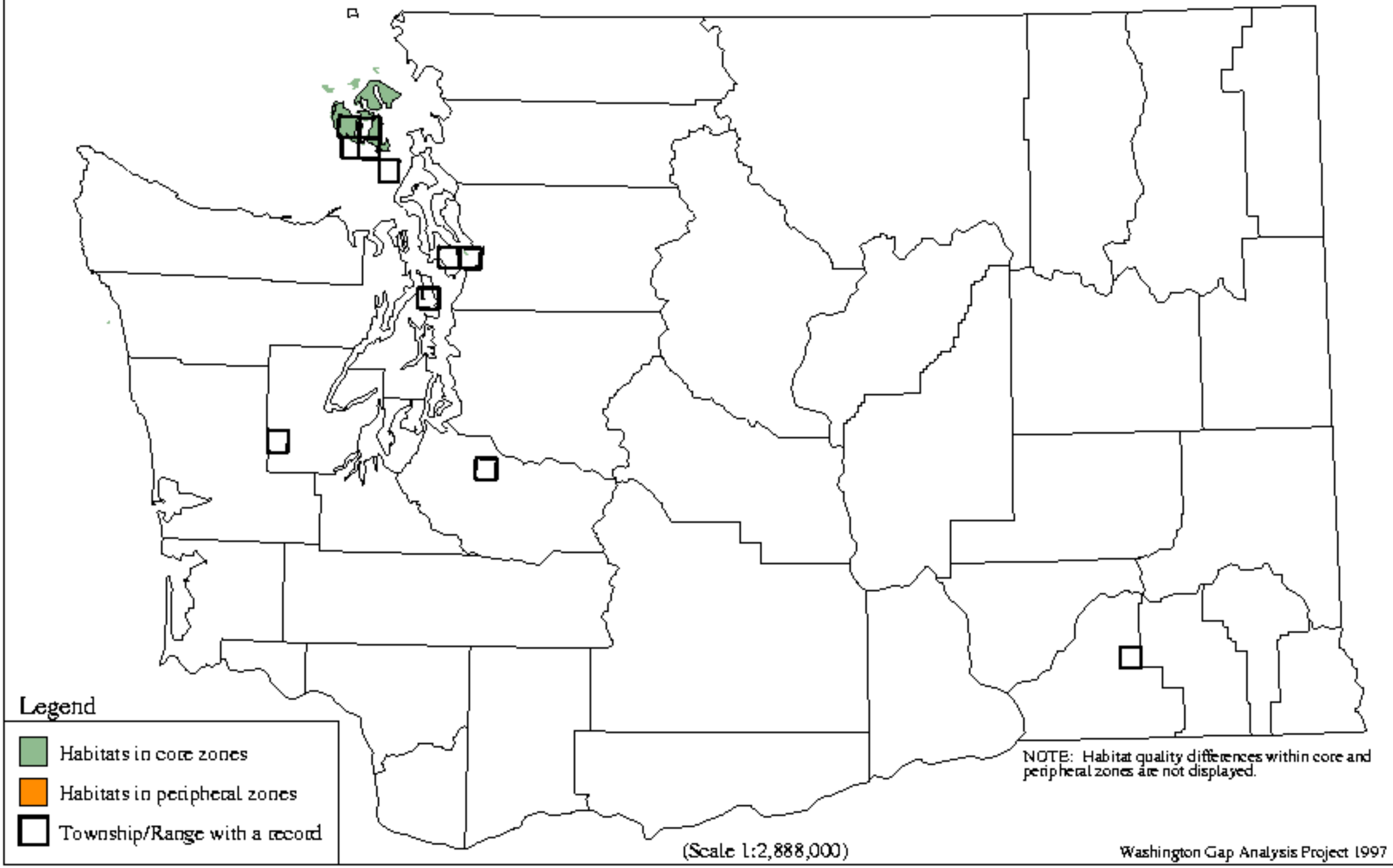
Dipodomys ordii - Ord`s Kangaroo Rat



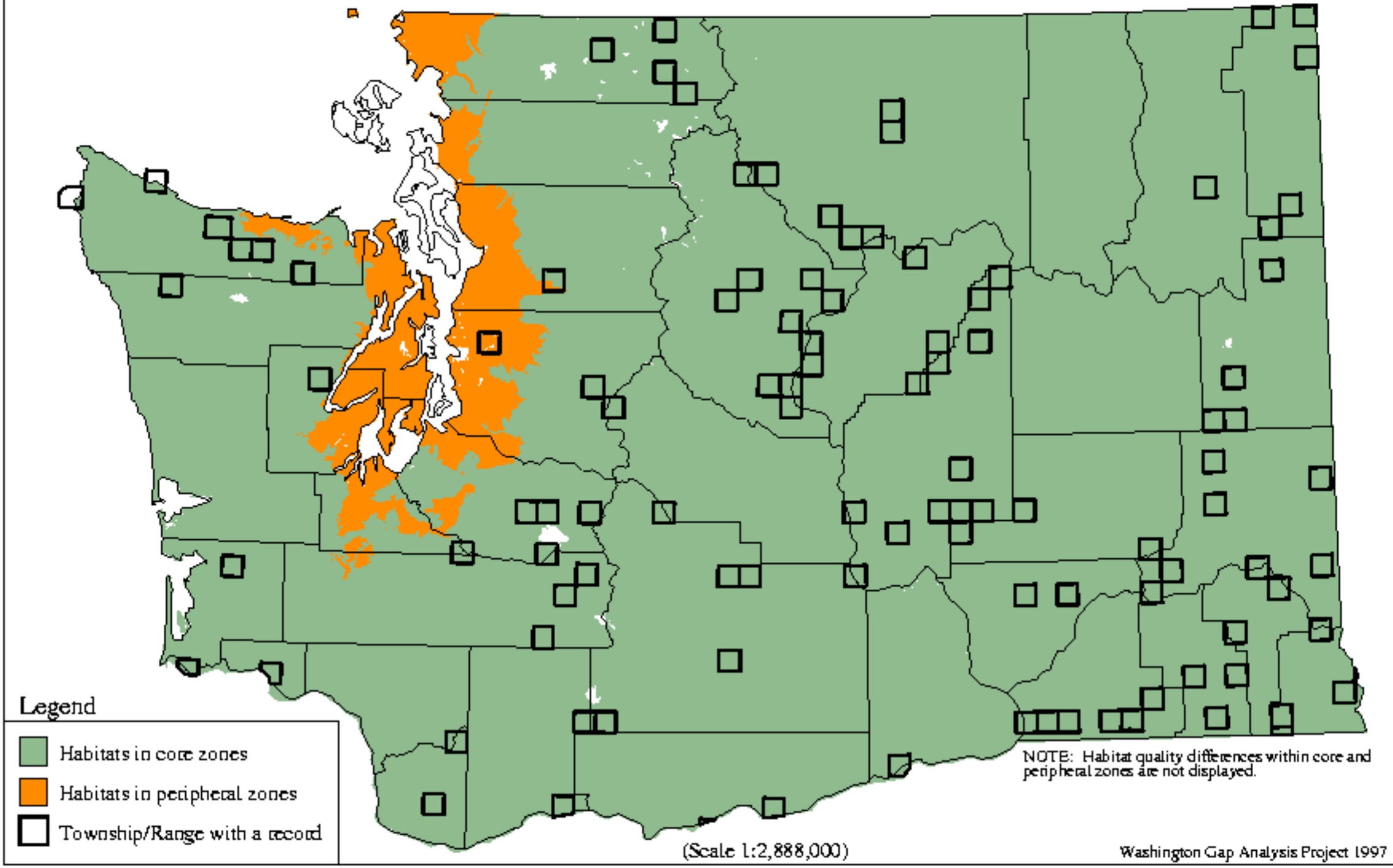
Perognathus parvus - Great Basin Pocket Mouse



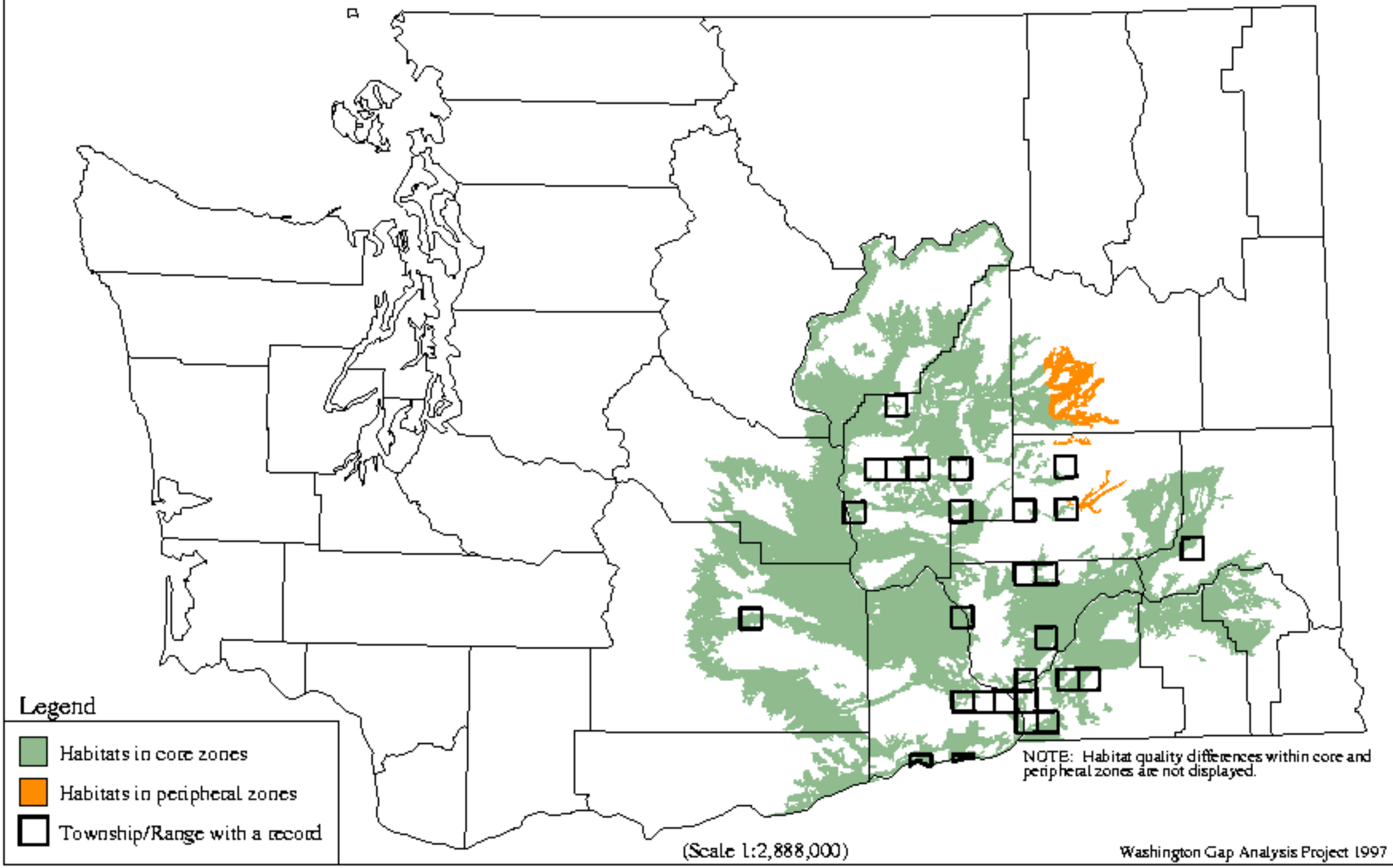
Oryctolagus cuniculus - European Rabbit



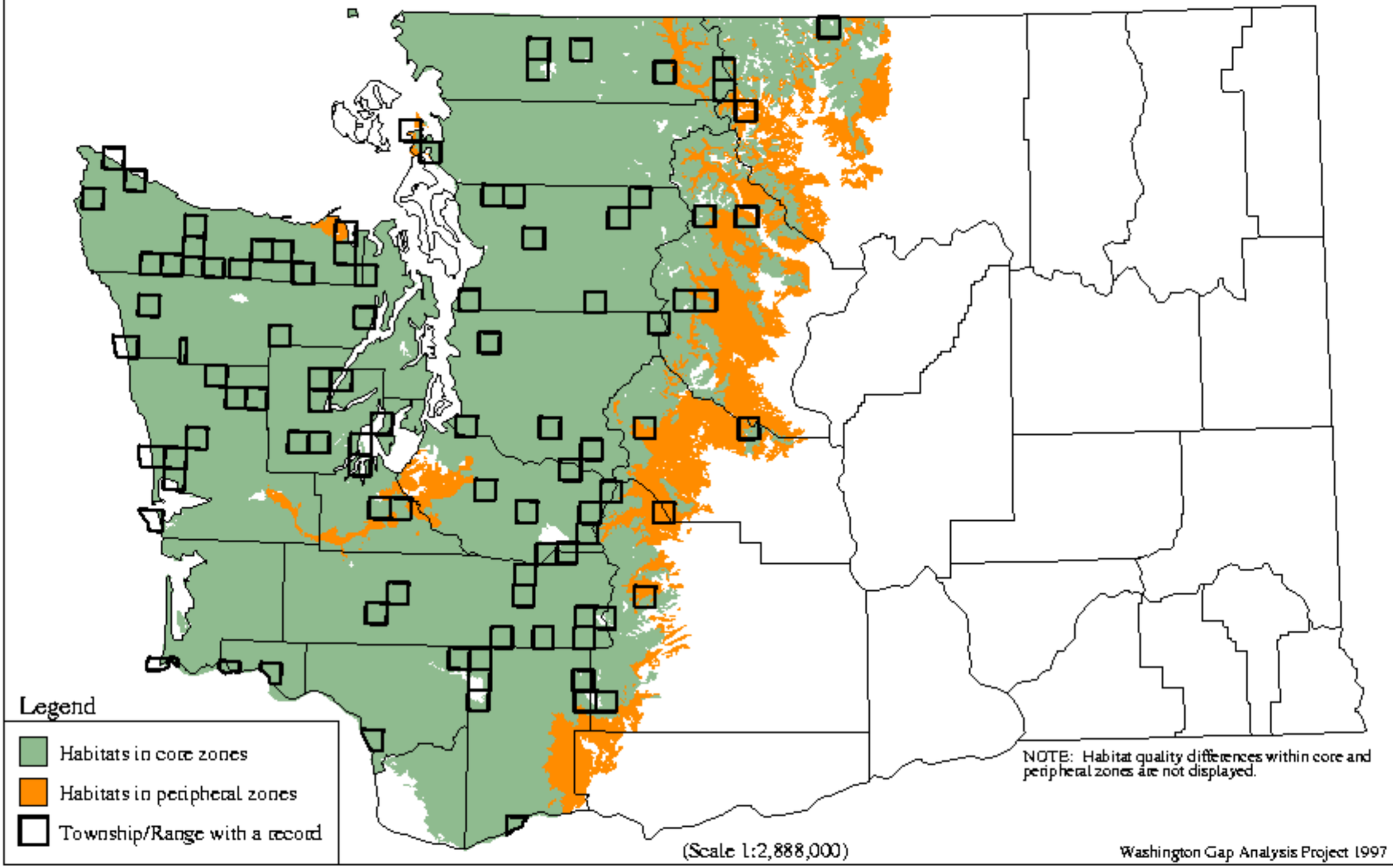
Neotoma cinerea - Bushy-tailed Woodrat



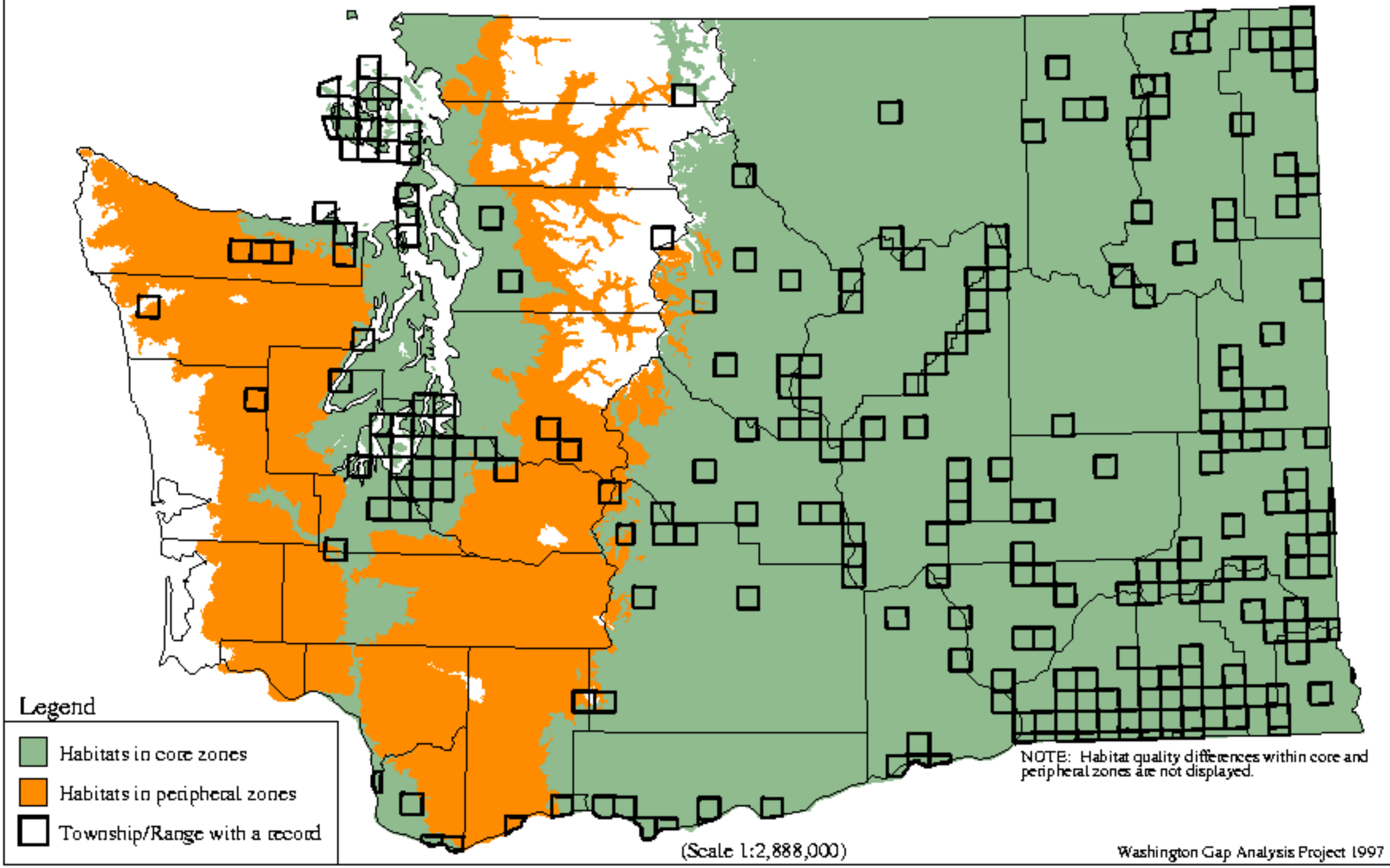
Onychomys leucogaster - Northern Grasshopper Mouse



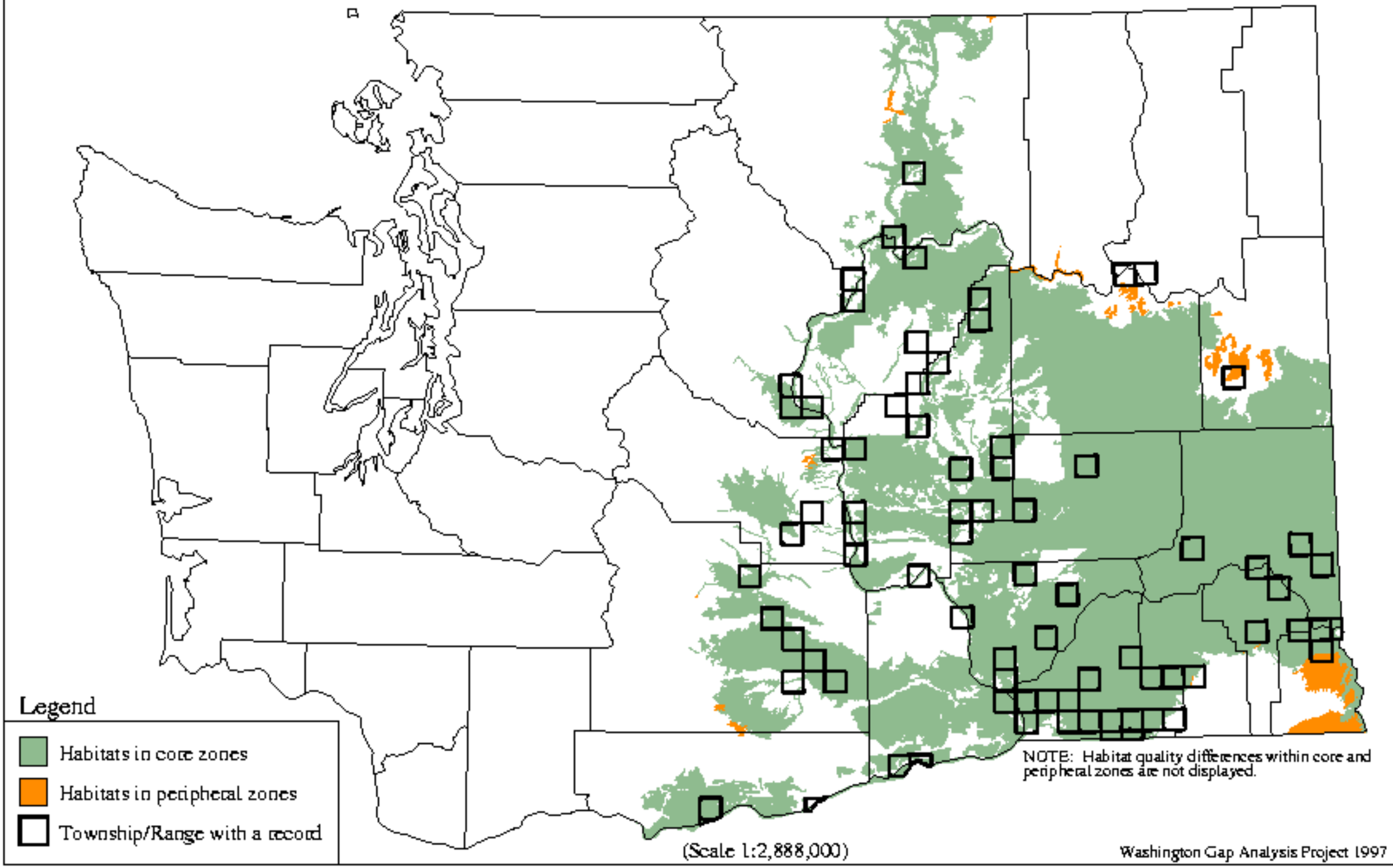
Peromyscus keeni - Forest Deer Mouse



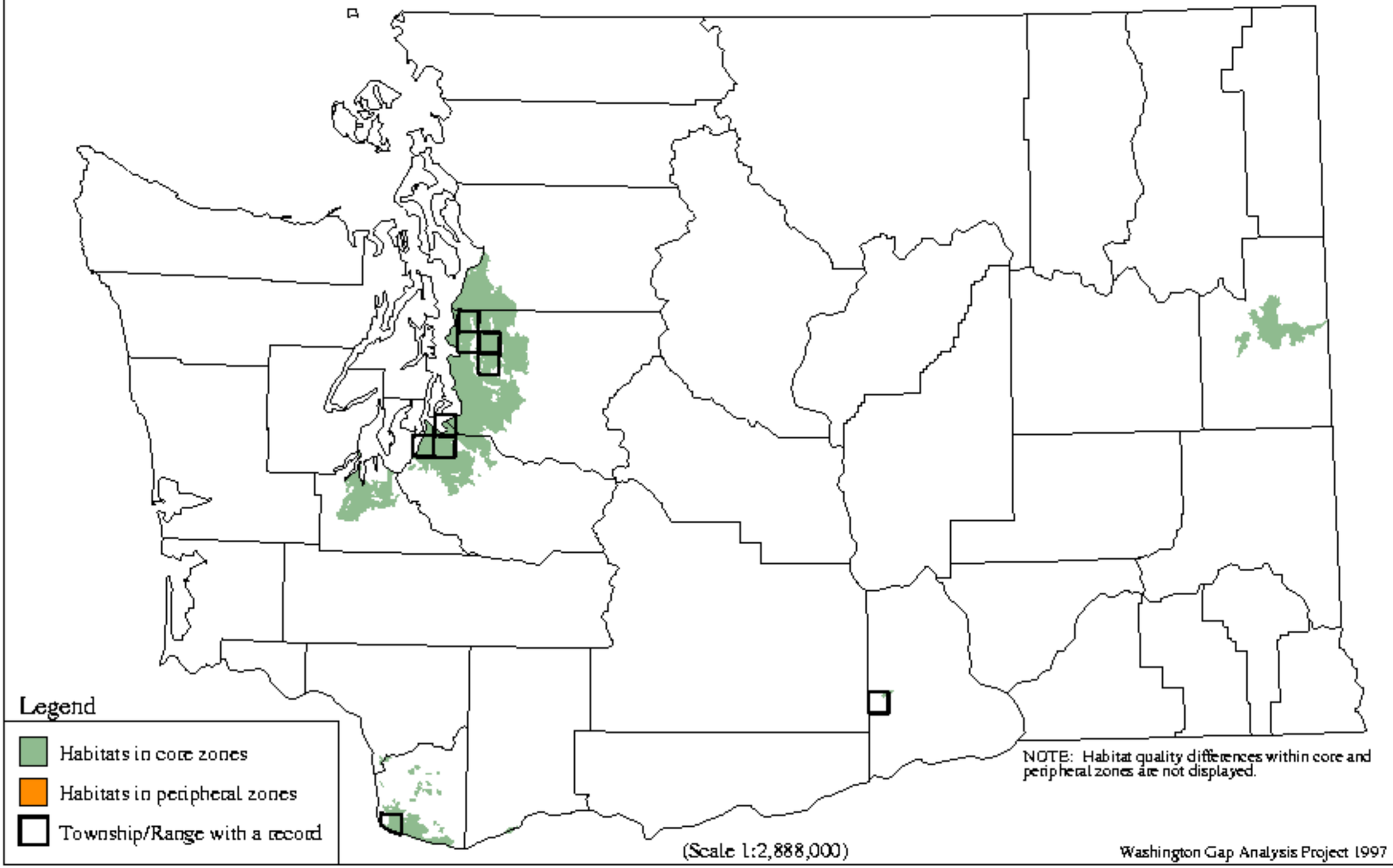
Peromyscus maniculatus - Deer Mouse



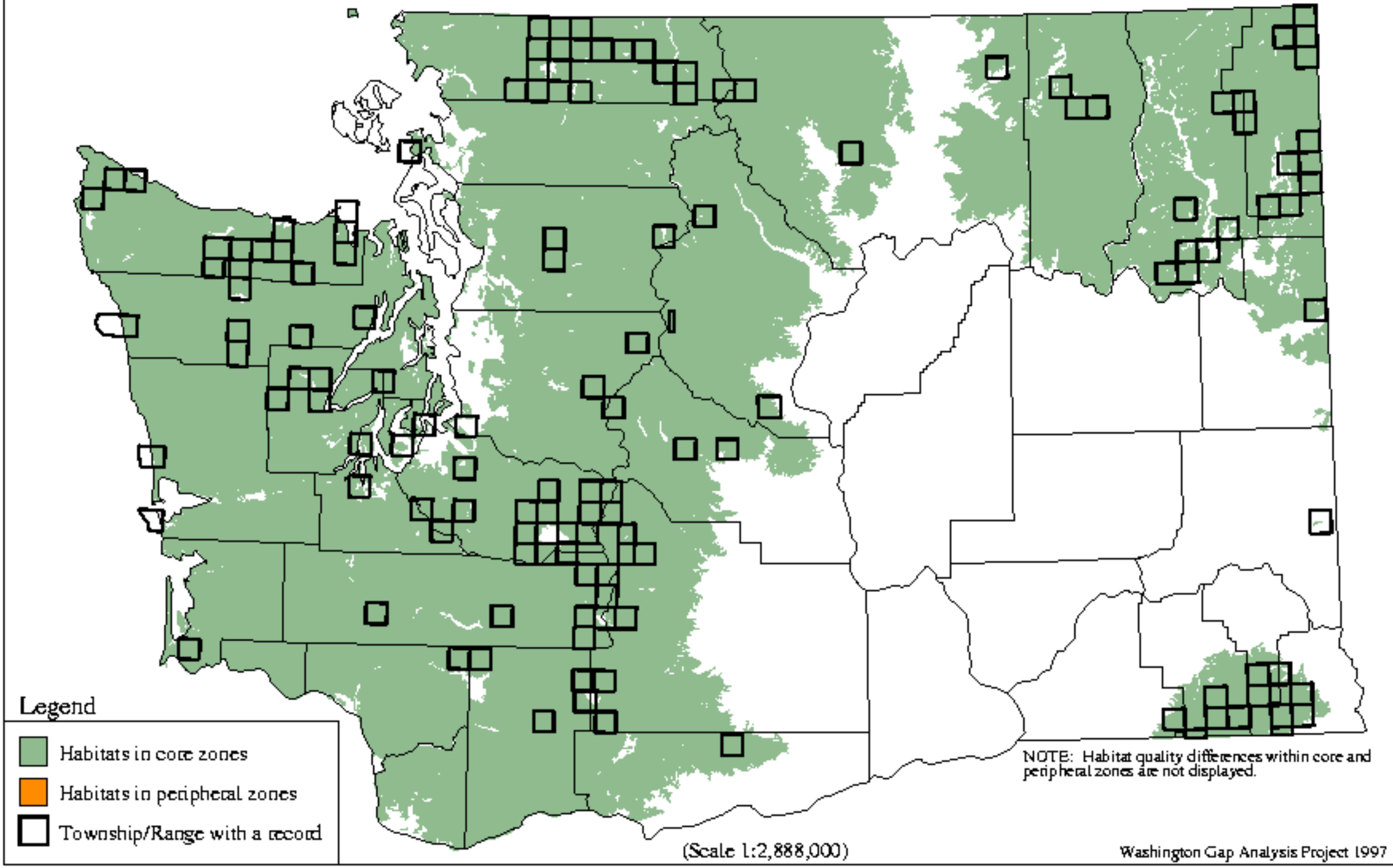
Reithrodontomys megalotis - Western Harvest Mouse



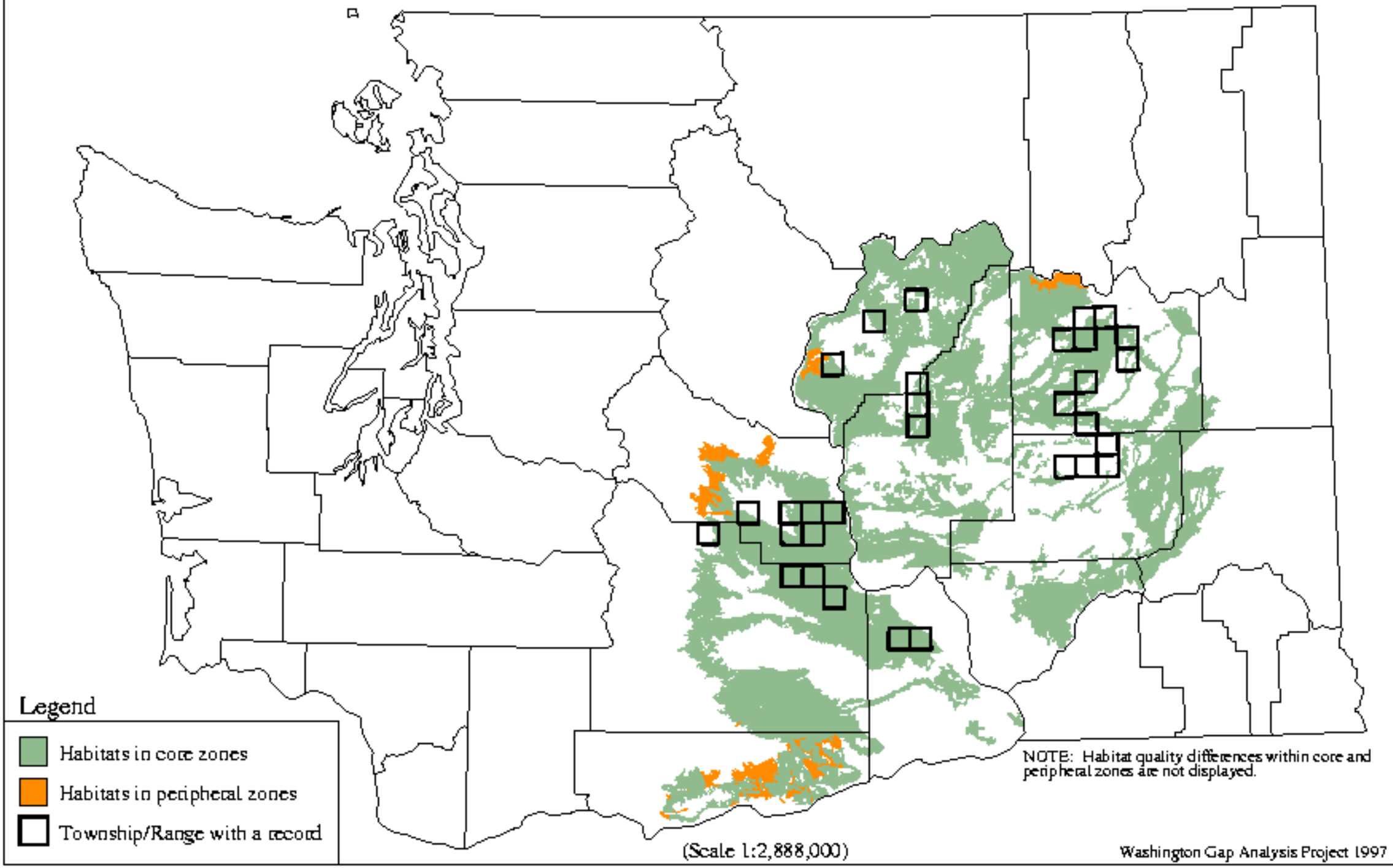
Sciurus carolinensis - Eastern Gray Squirrel



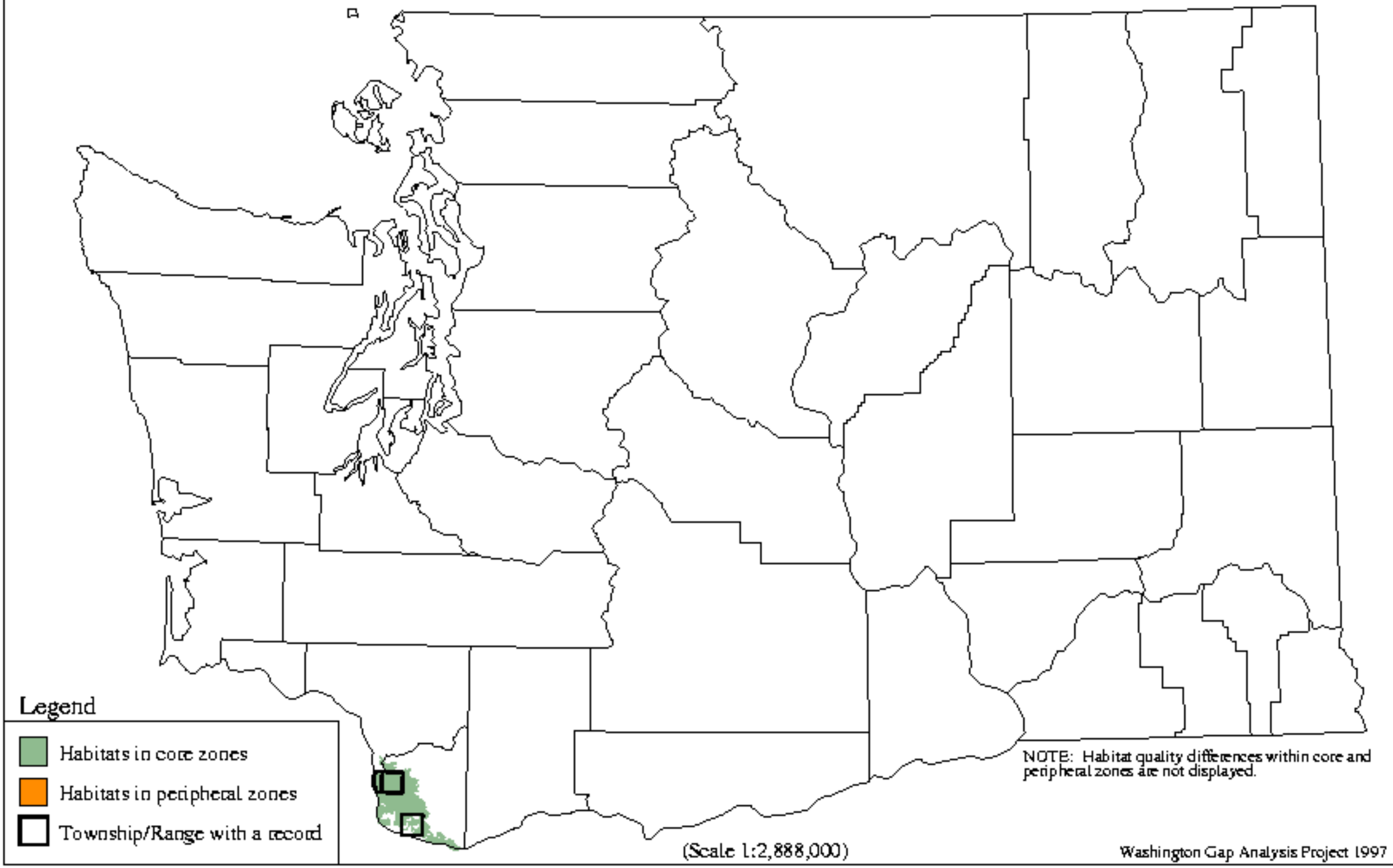
Clethrionomys gapperi - Gapper`s Red-backed Vole



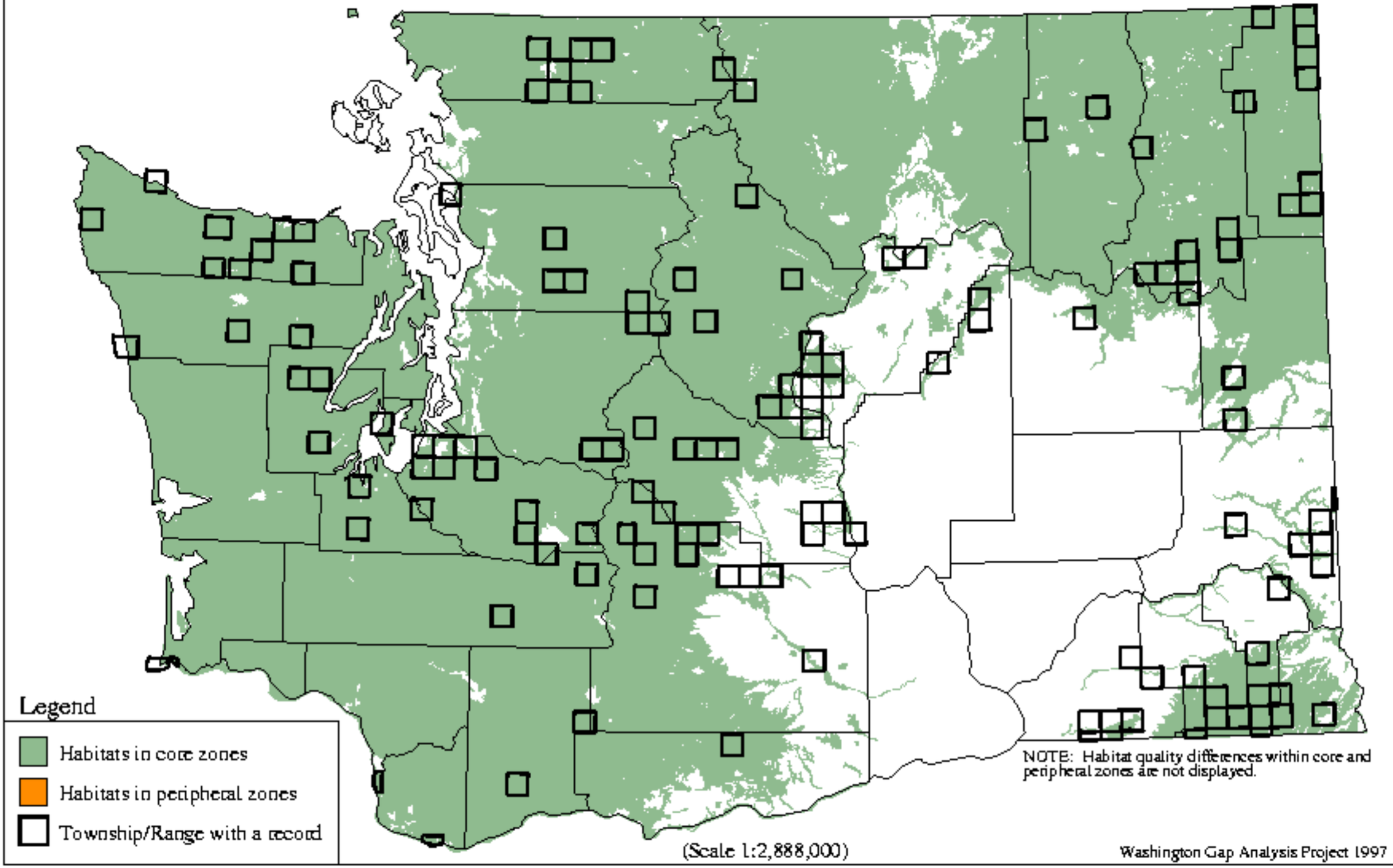
Lemmiscus curtatus - Sagebrush Vole



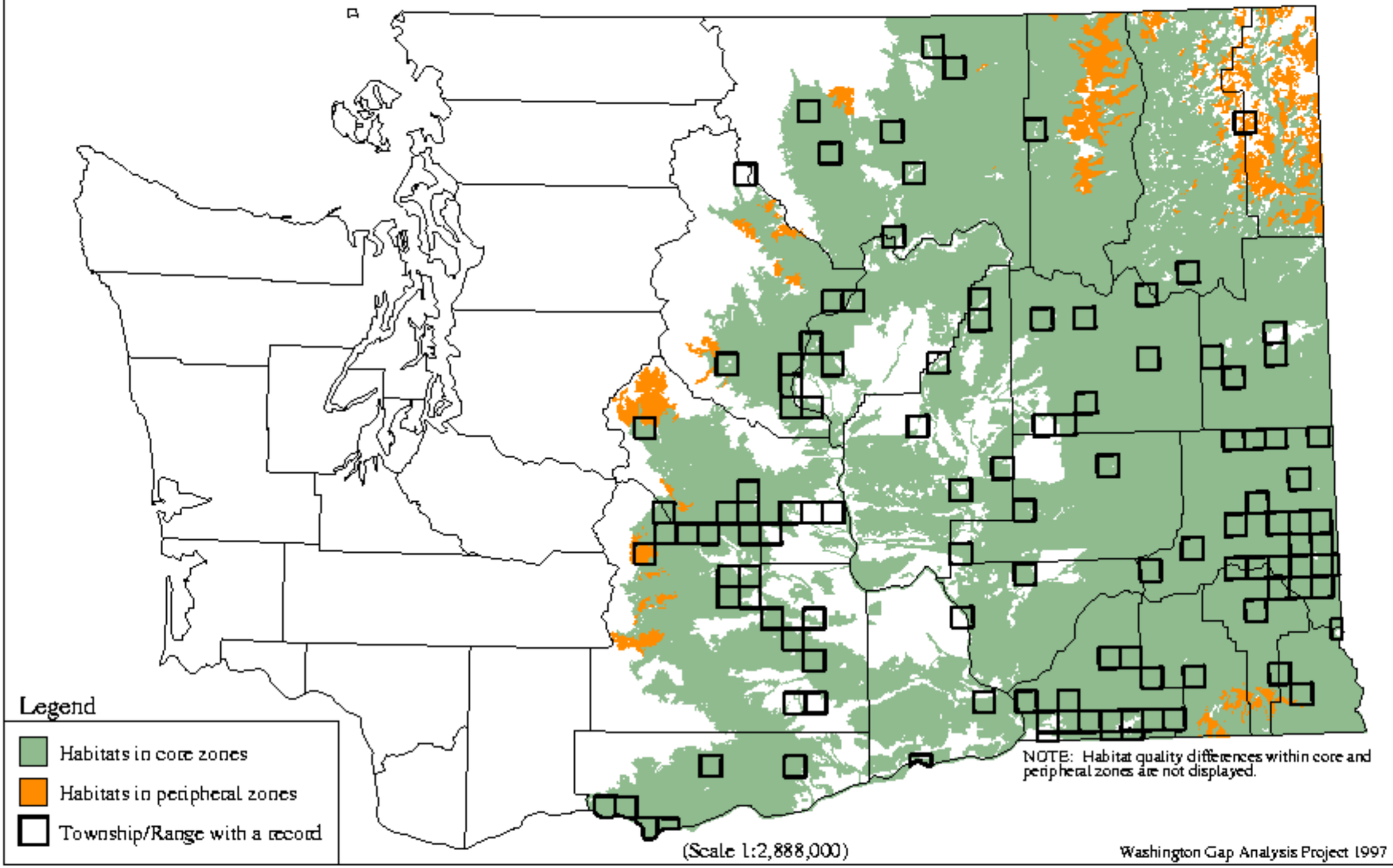
Microtus canicaudus - Gray-tailed Vole



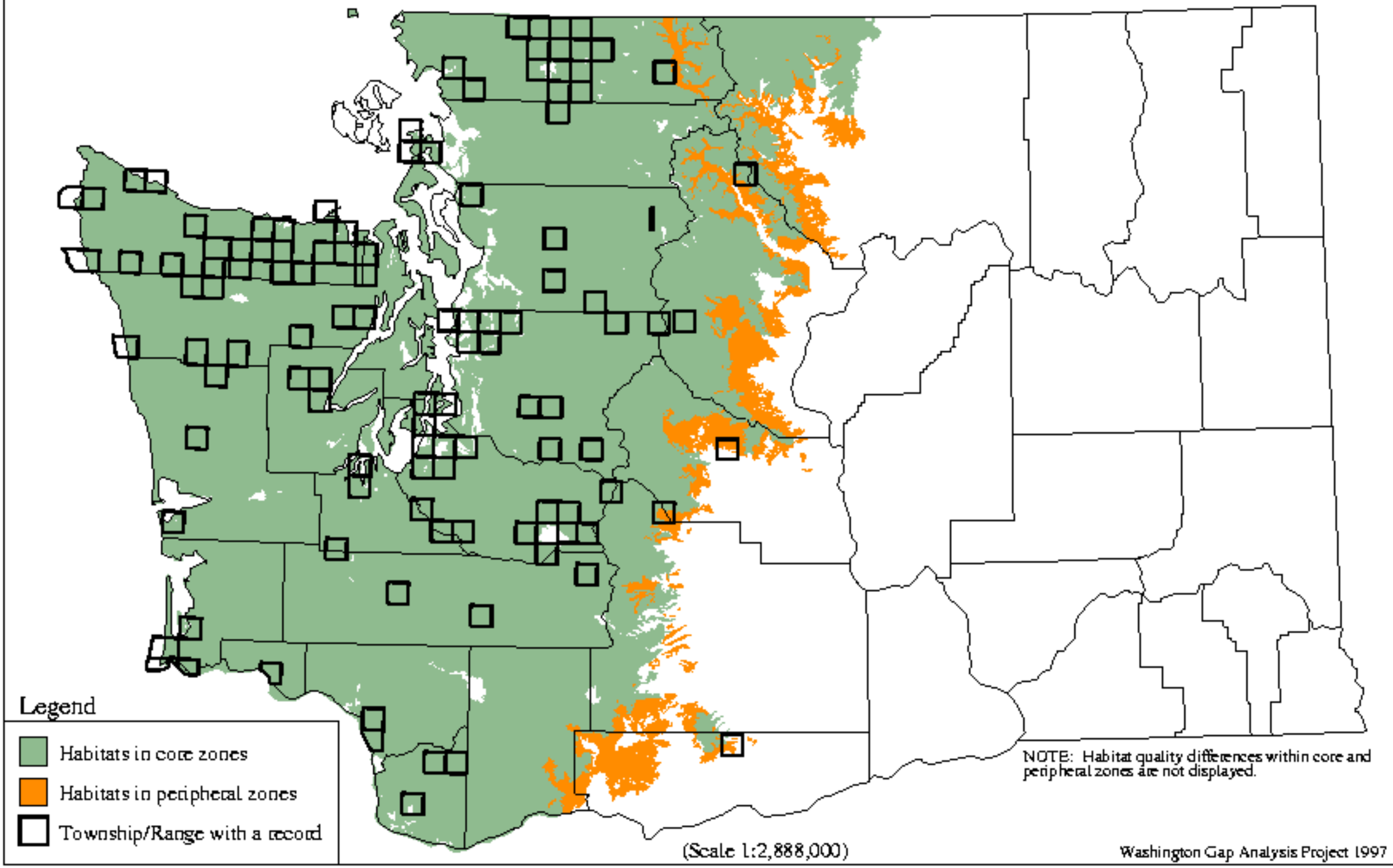
Microtus longicaudus - Long-tailed Vole



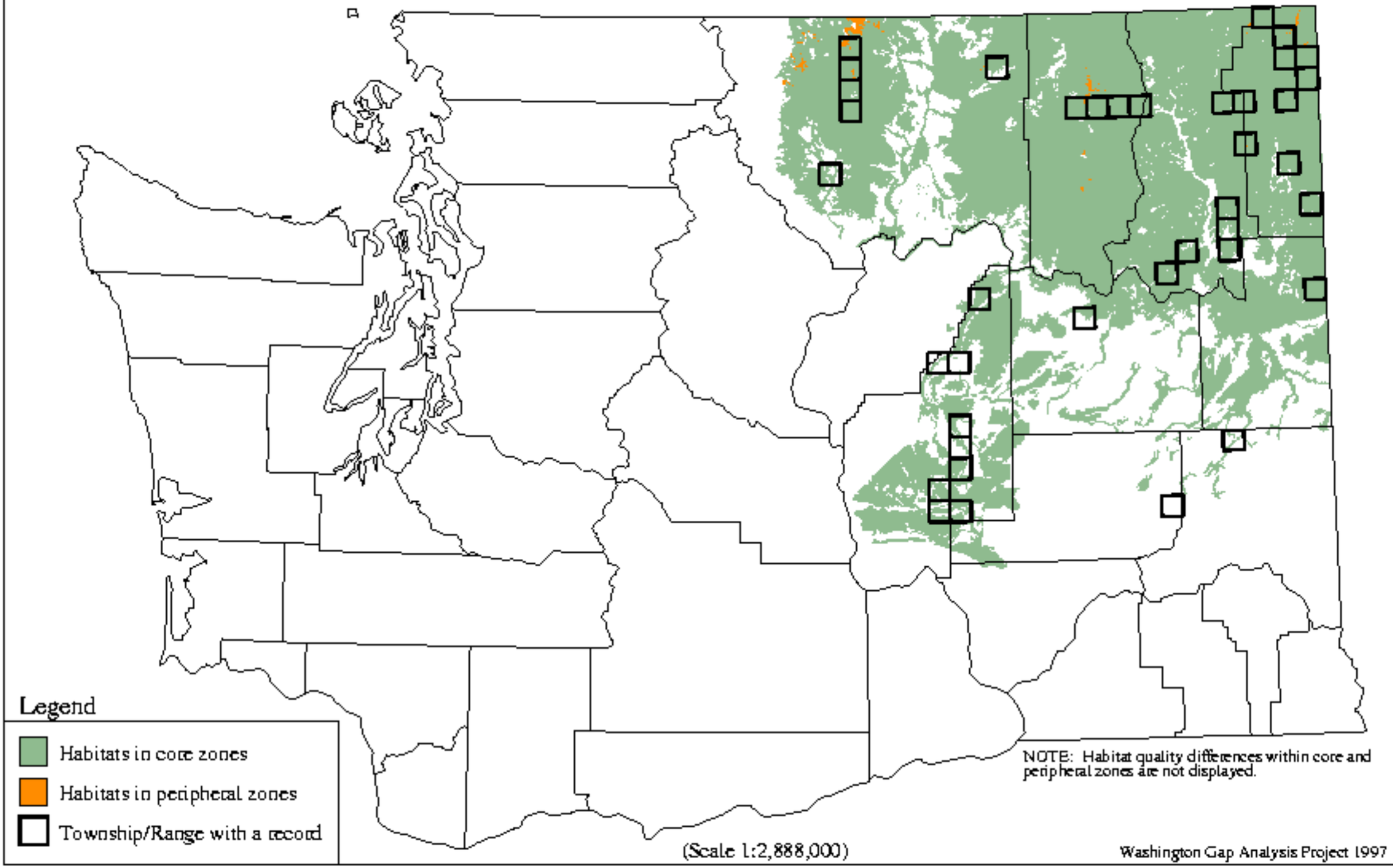
Microtus montanus - Montane Vole



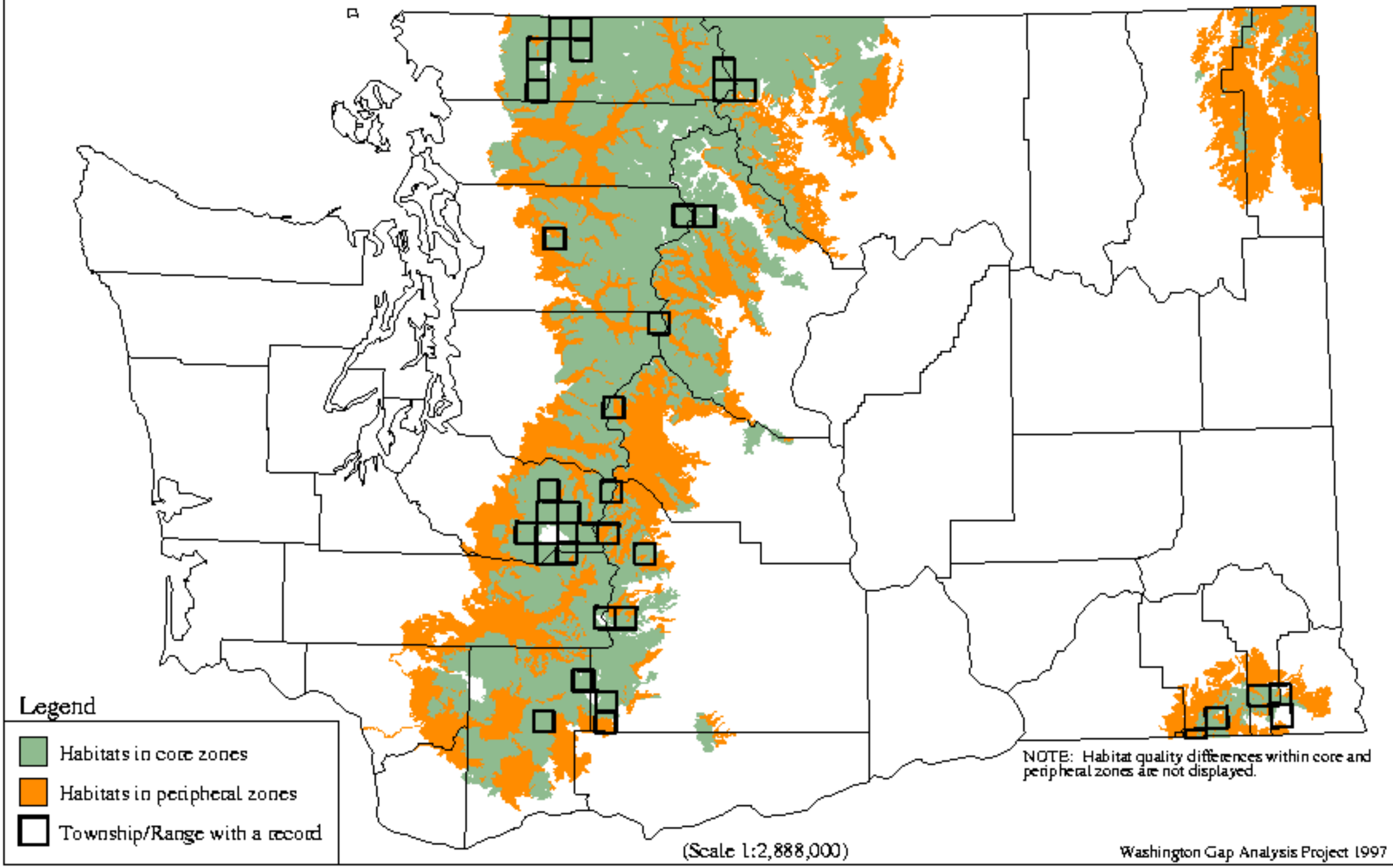
Microtus oregoni - Creeping Vole



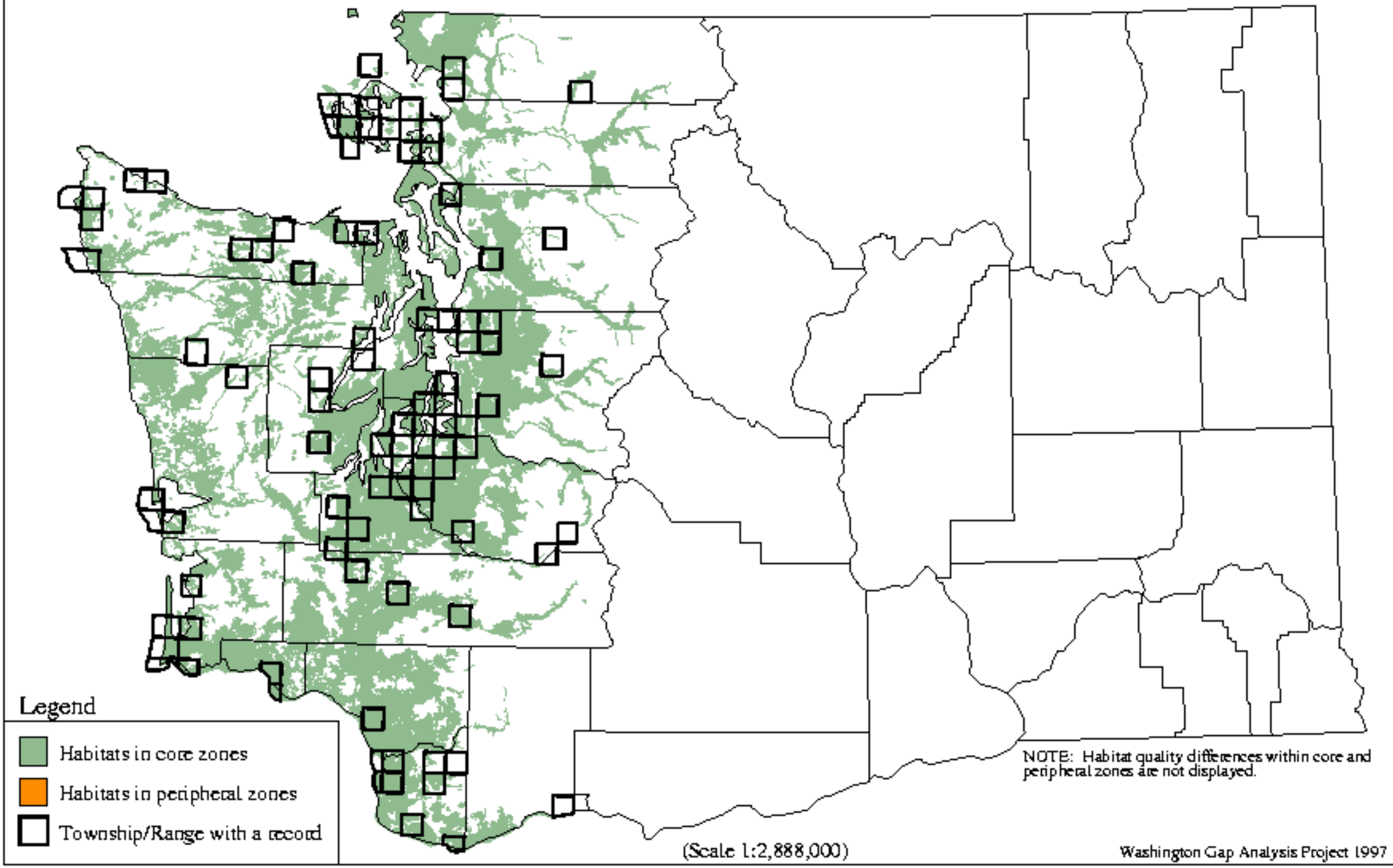
Microtus pennsylvanicus - Meadow Vole



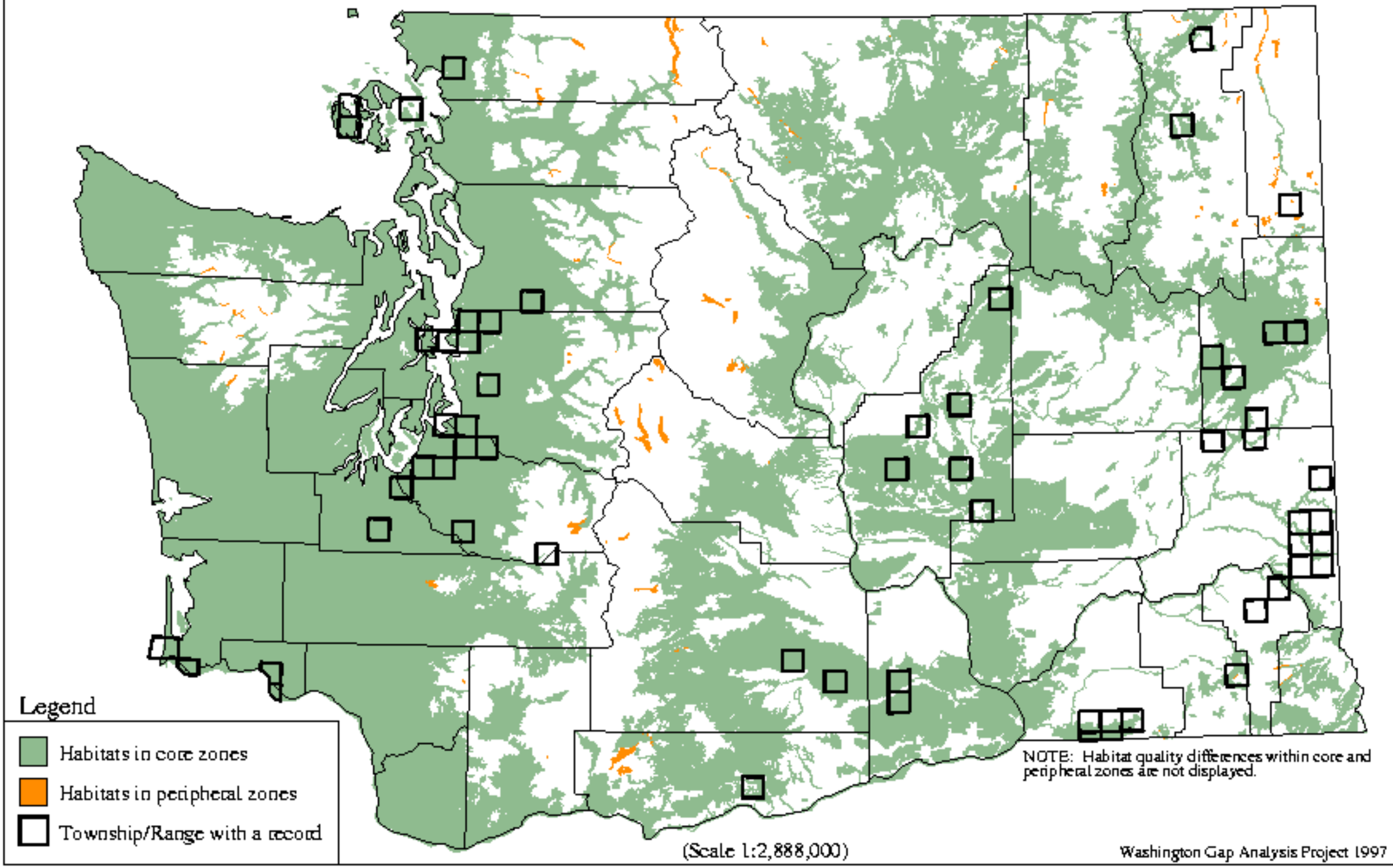
Microtus richardsoni - Richardson`s Vole



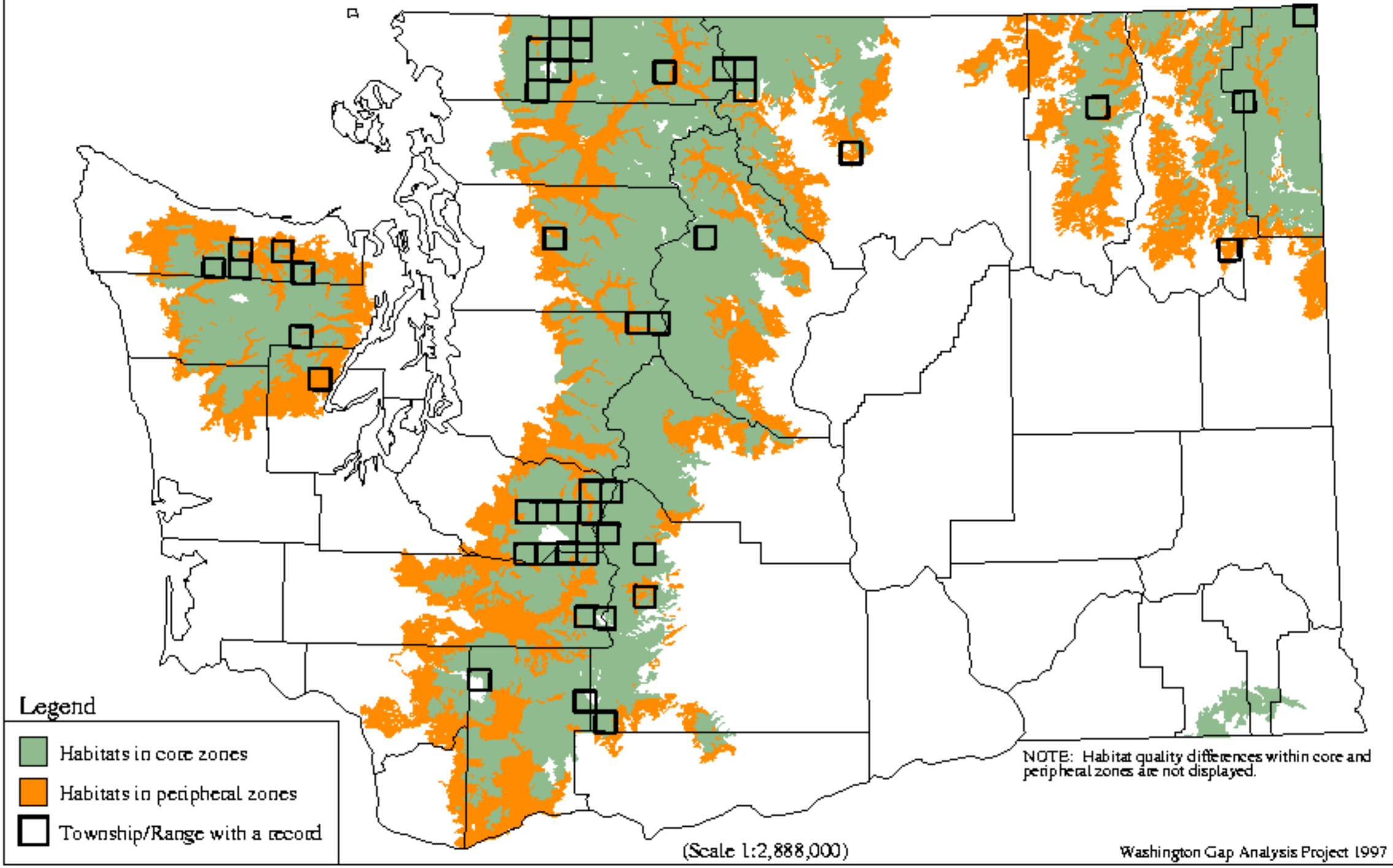
Microtus townsendii - Townsend`s Vole



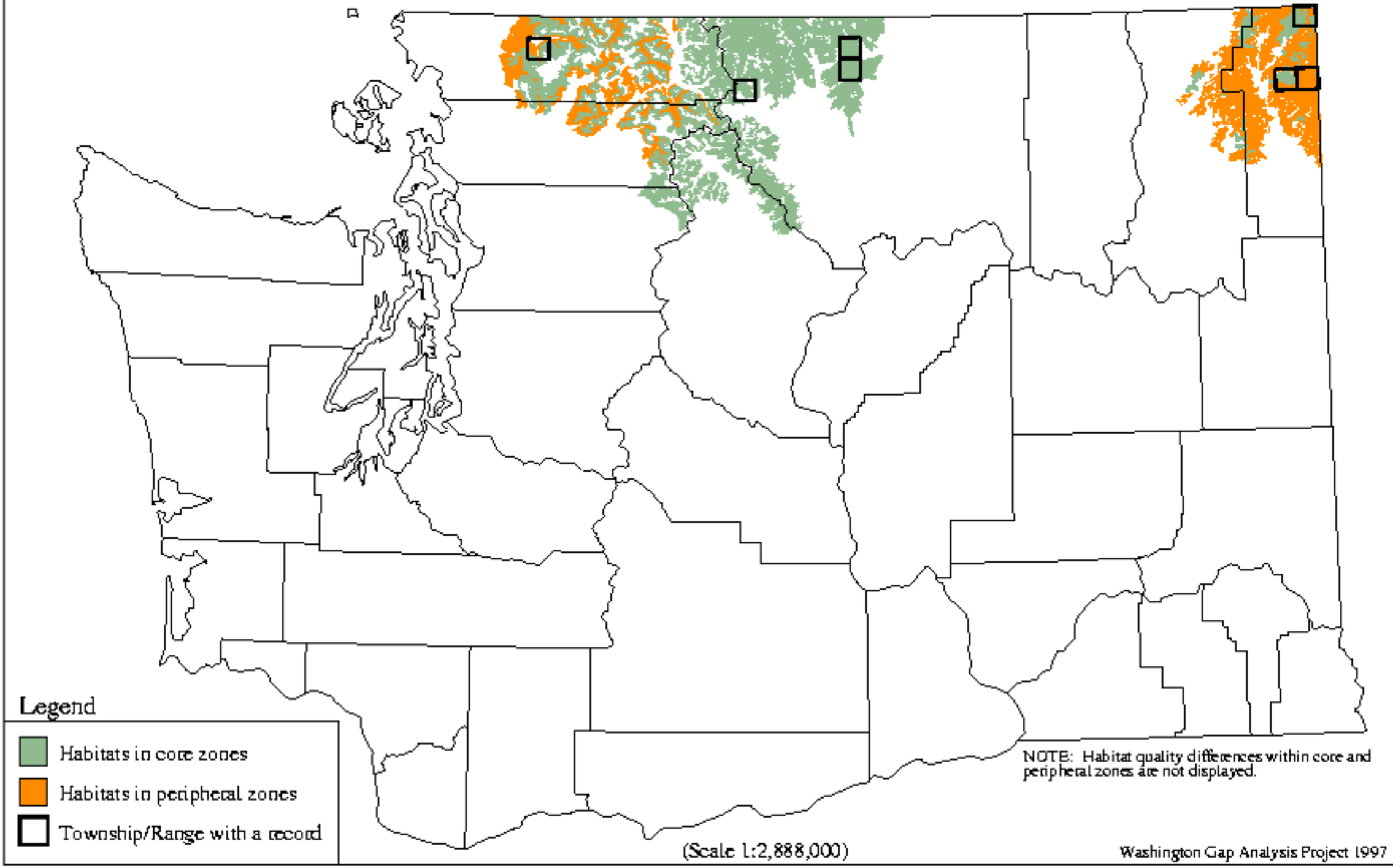
Ondatra zibethicus - Muskrat



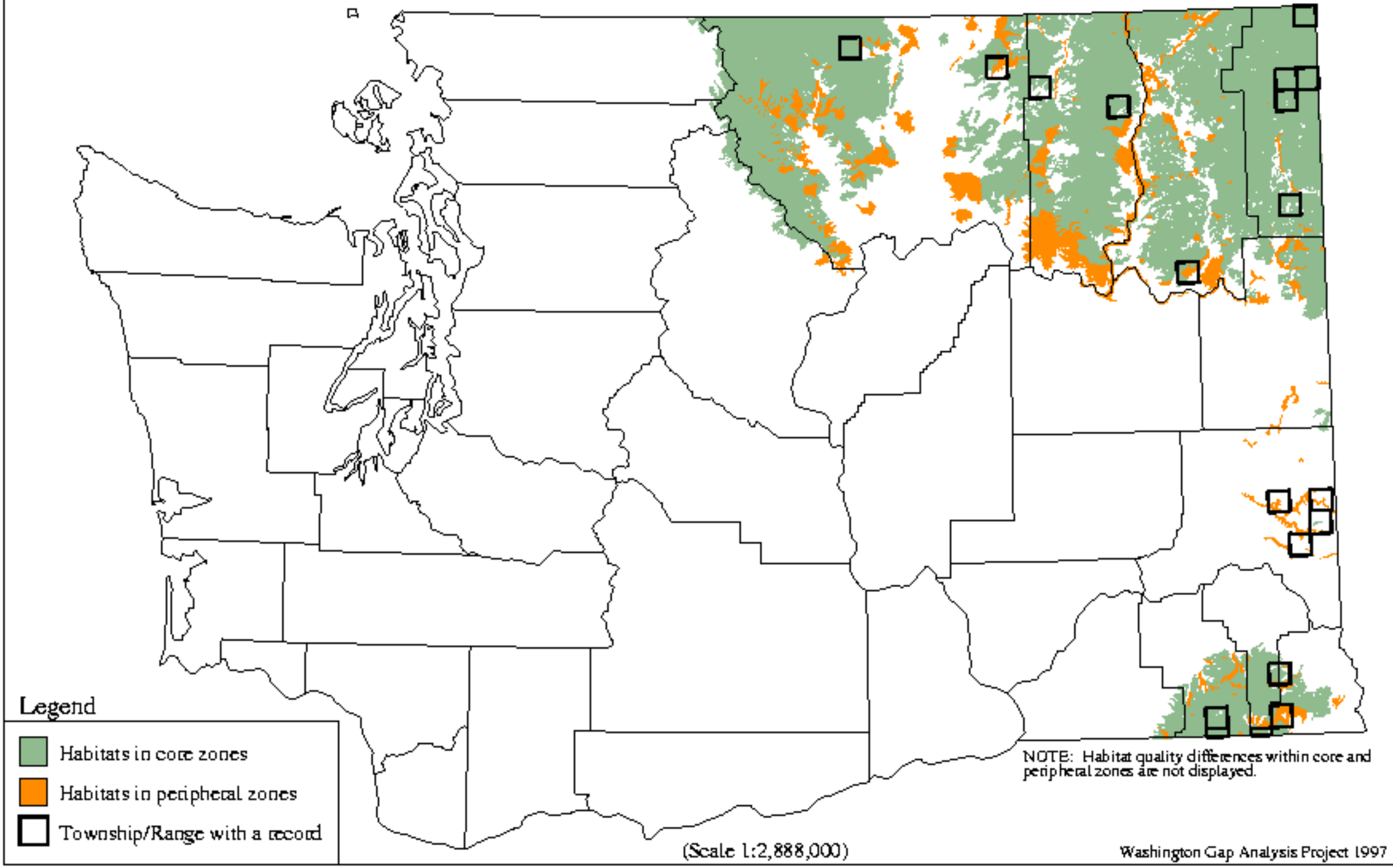
Phenacomys intermedius - Heather Vole



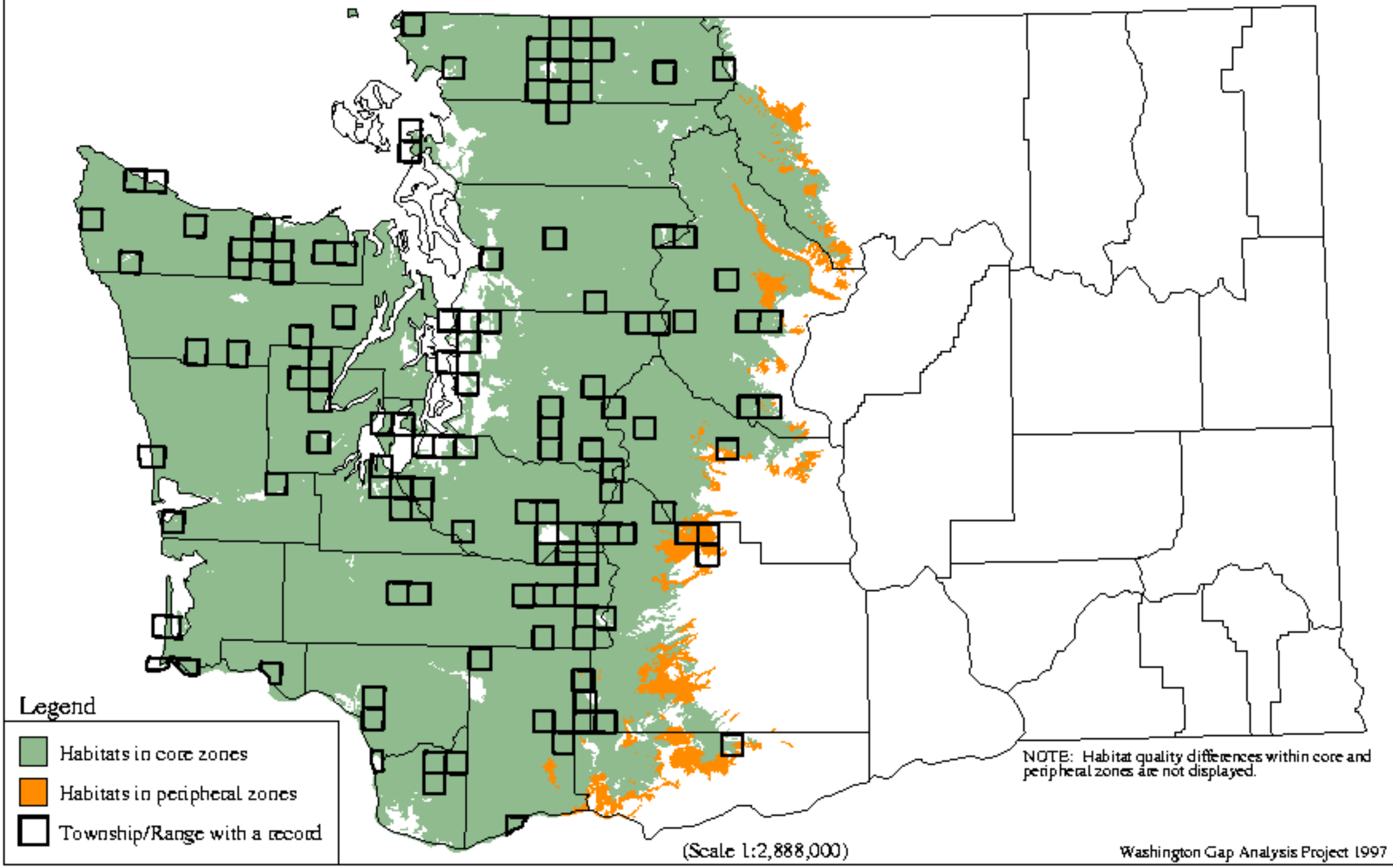
Synaptomys borealis - Northern Bog Lemming



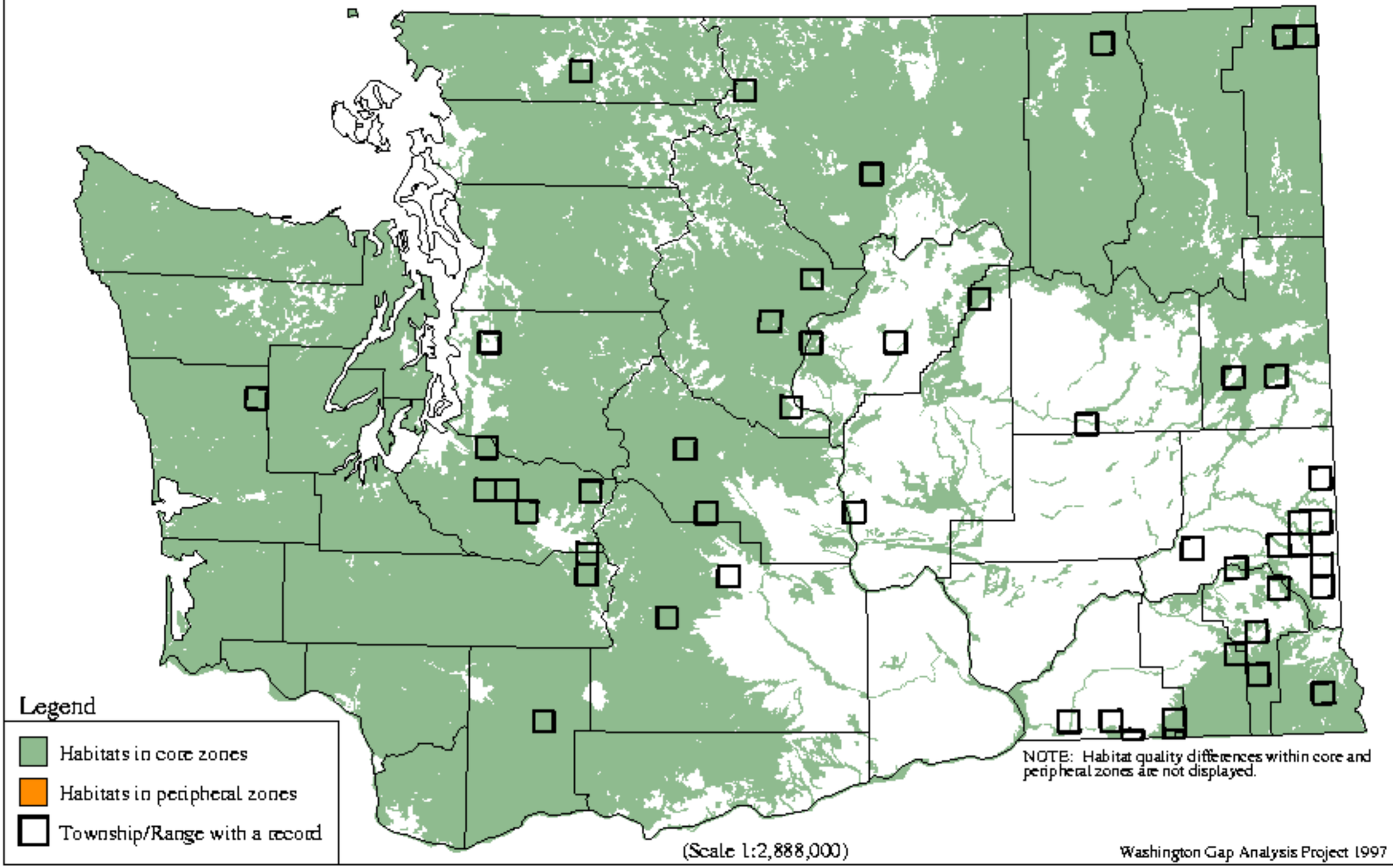
Zapus princeps - Western Jumping Mouse



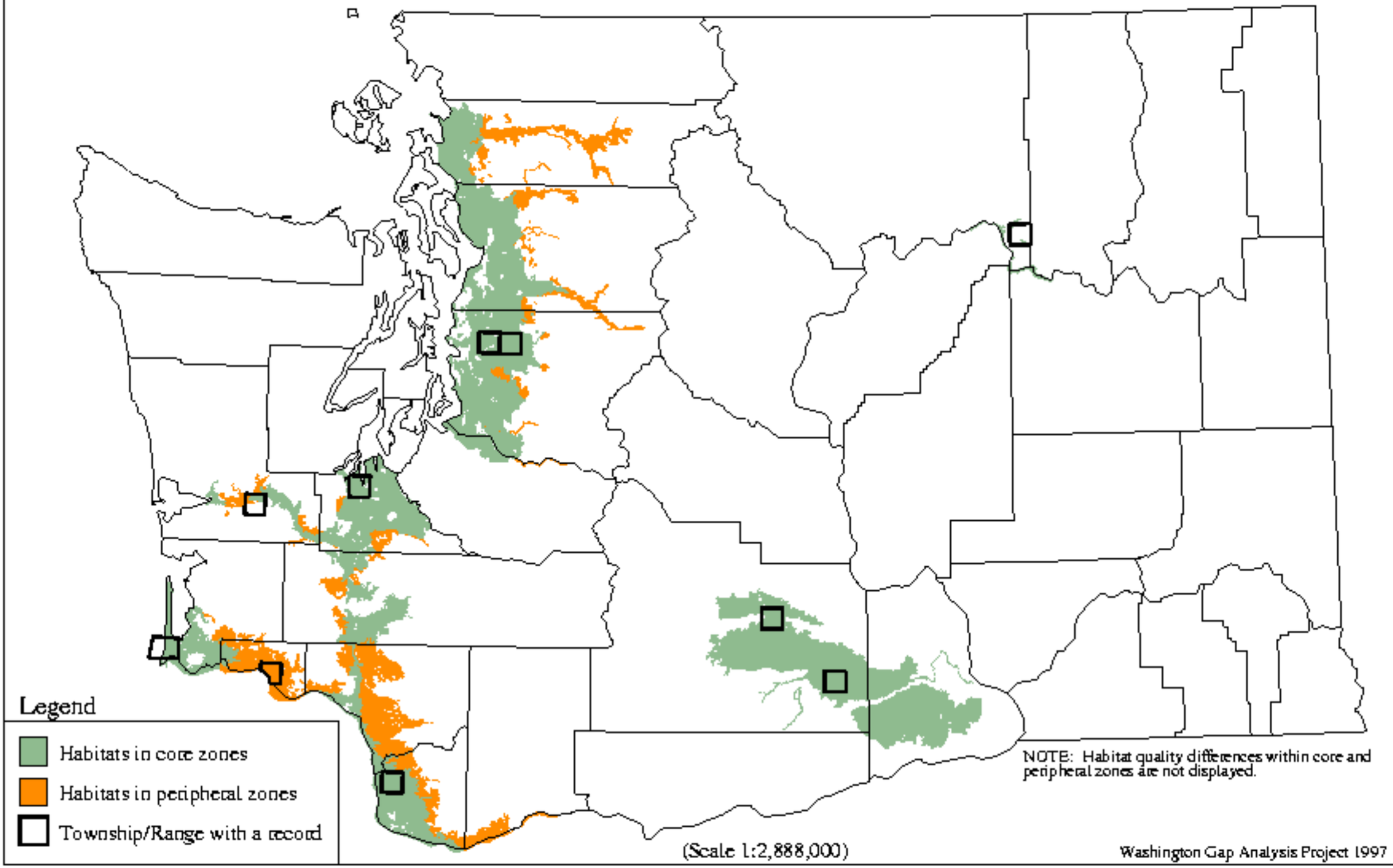
Zapus trinotatus - Pacific Jumping Mouse



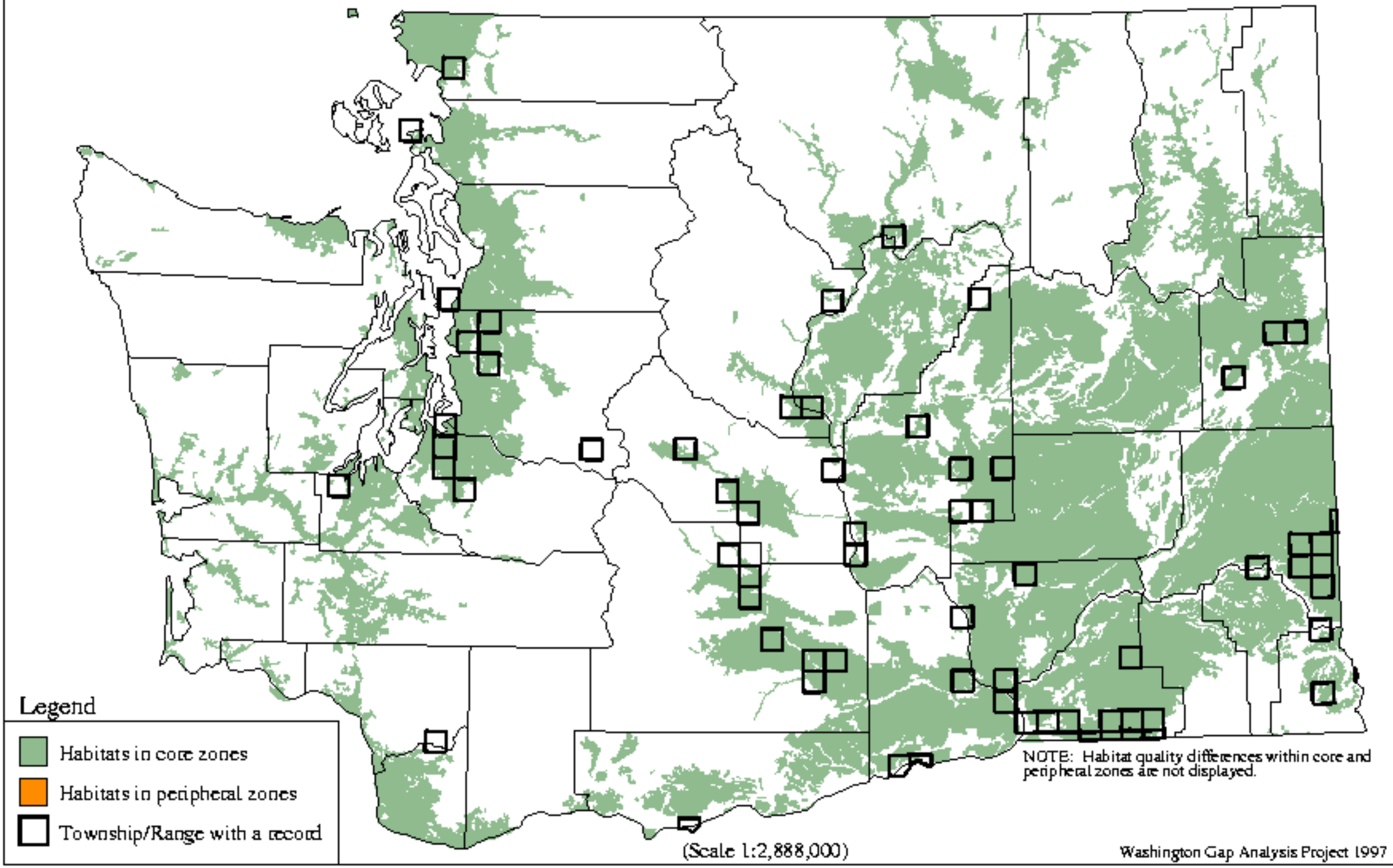
Erethizon dorsatum - Porcupine



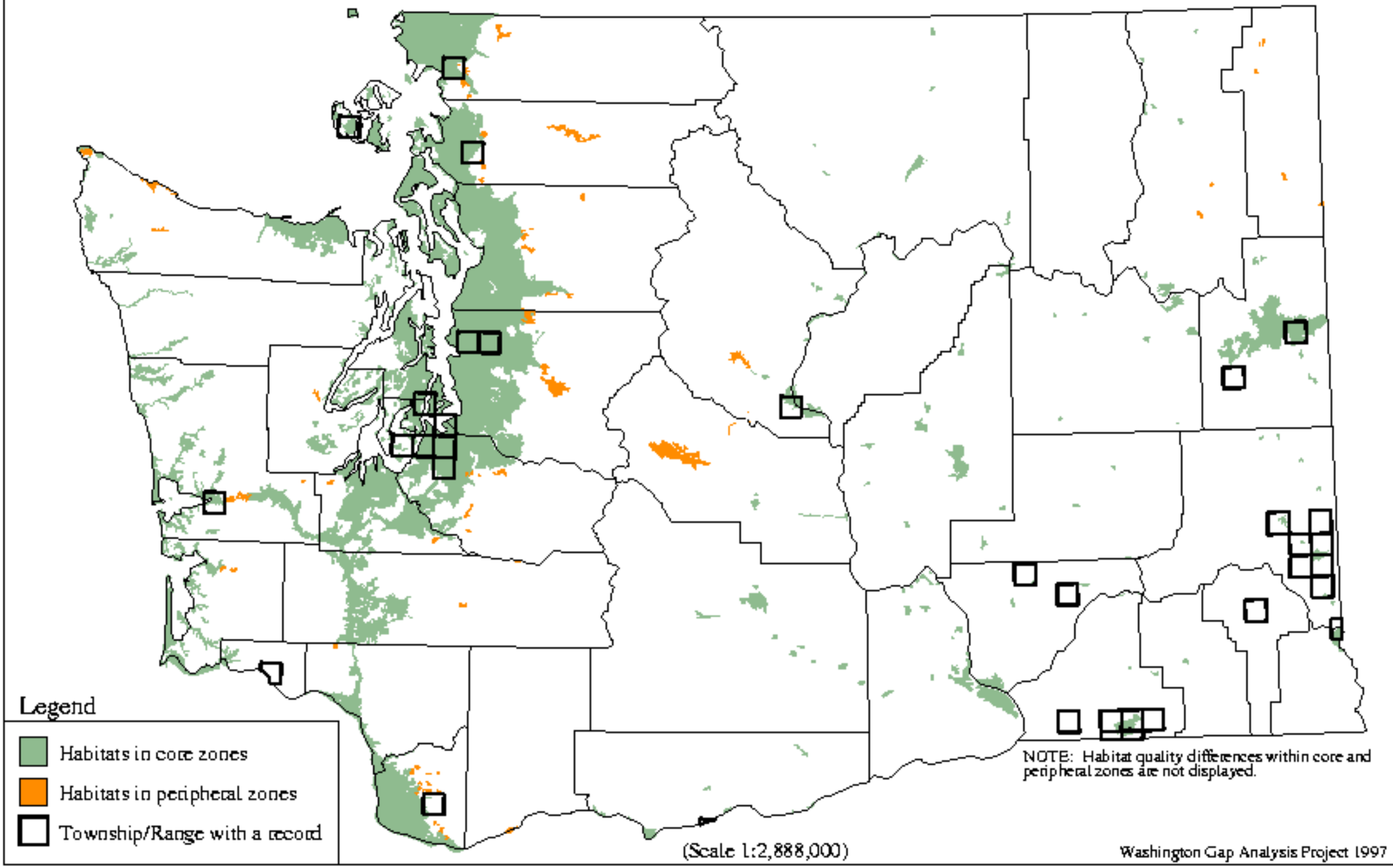
Myocastor coypus - Nutria



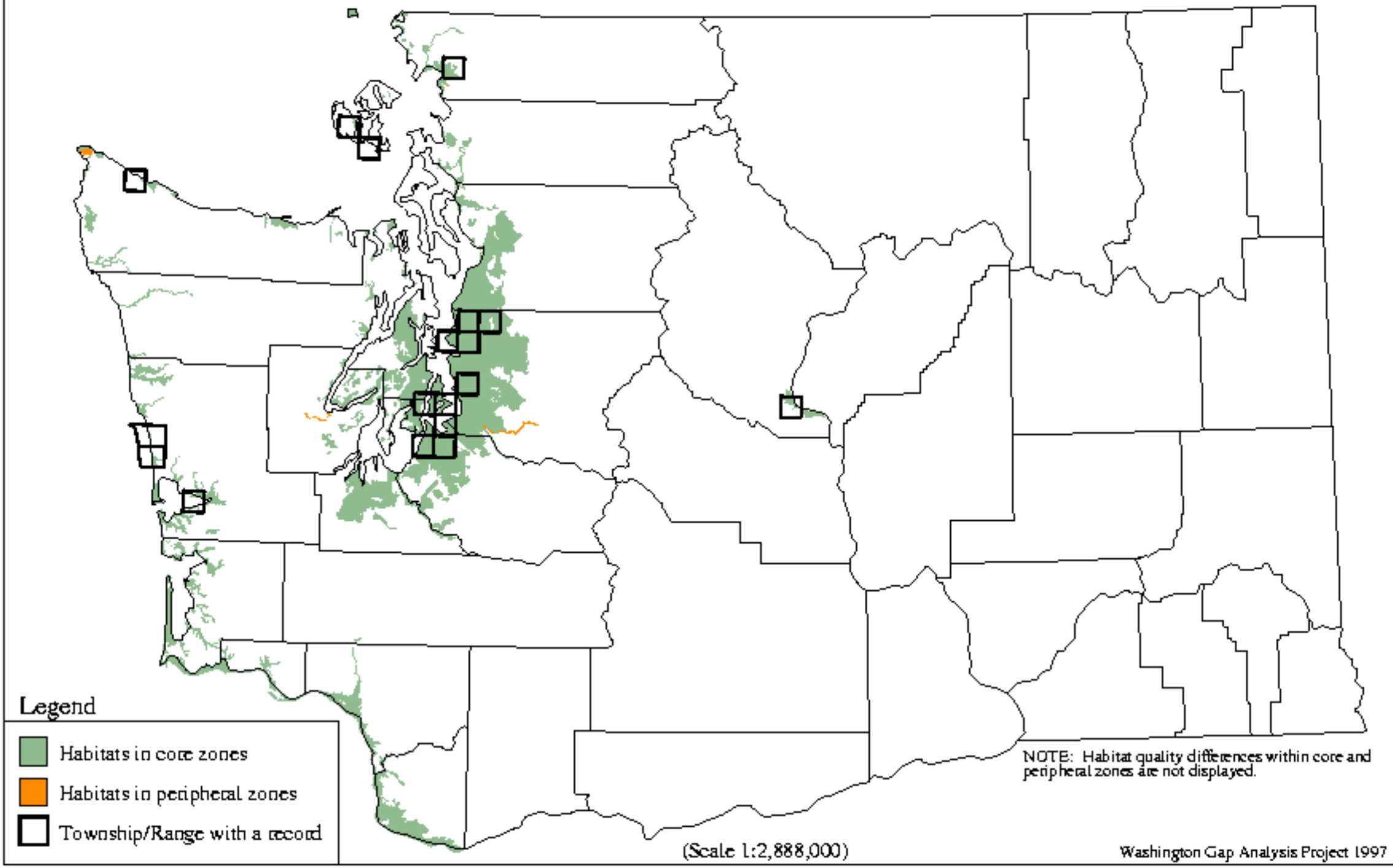
Mus musculus - House Mouse



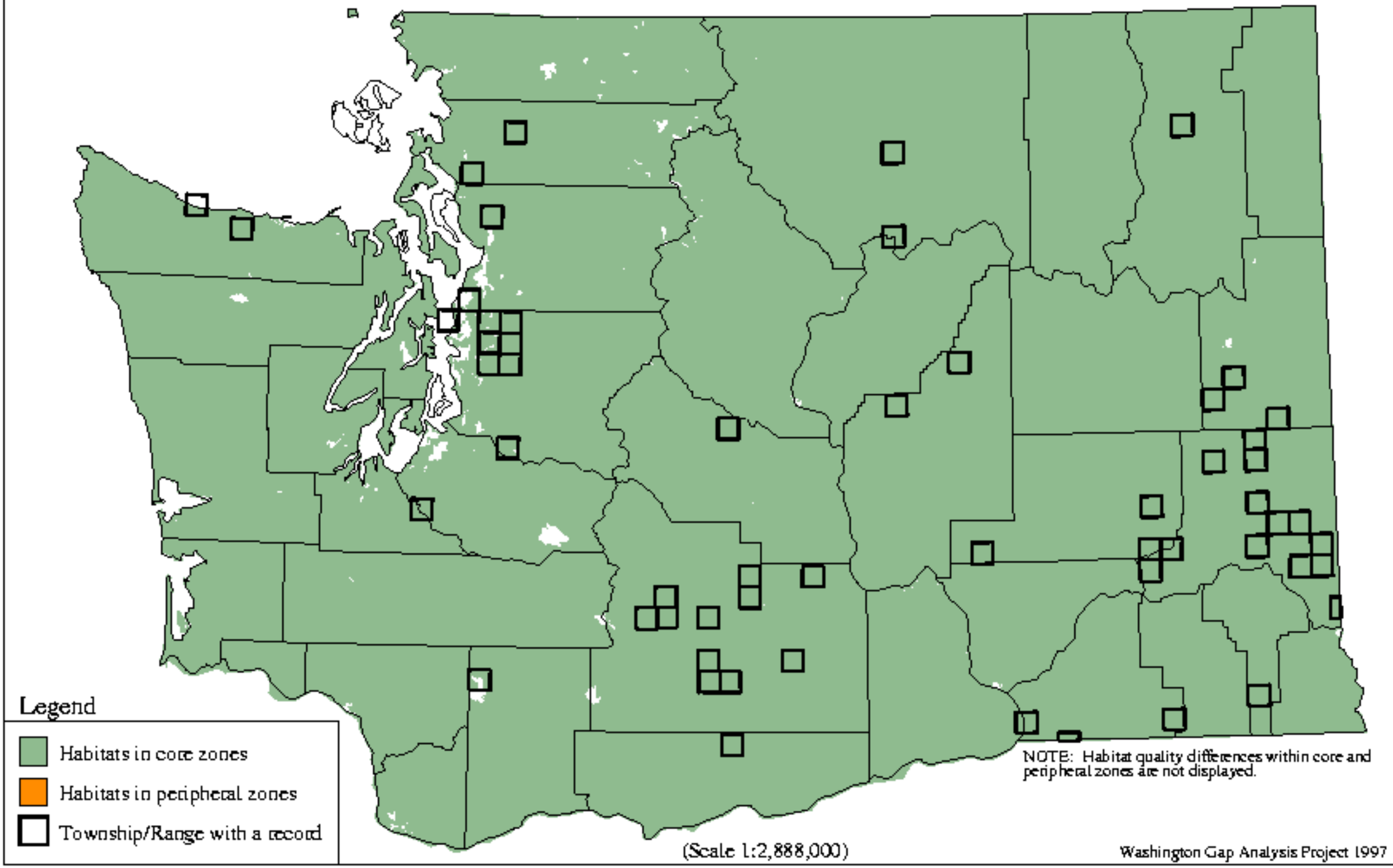
Rattus norvegicus - Norway Rat



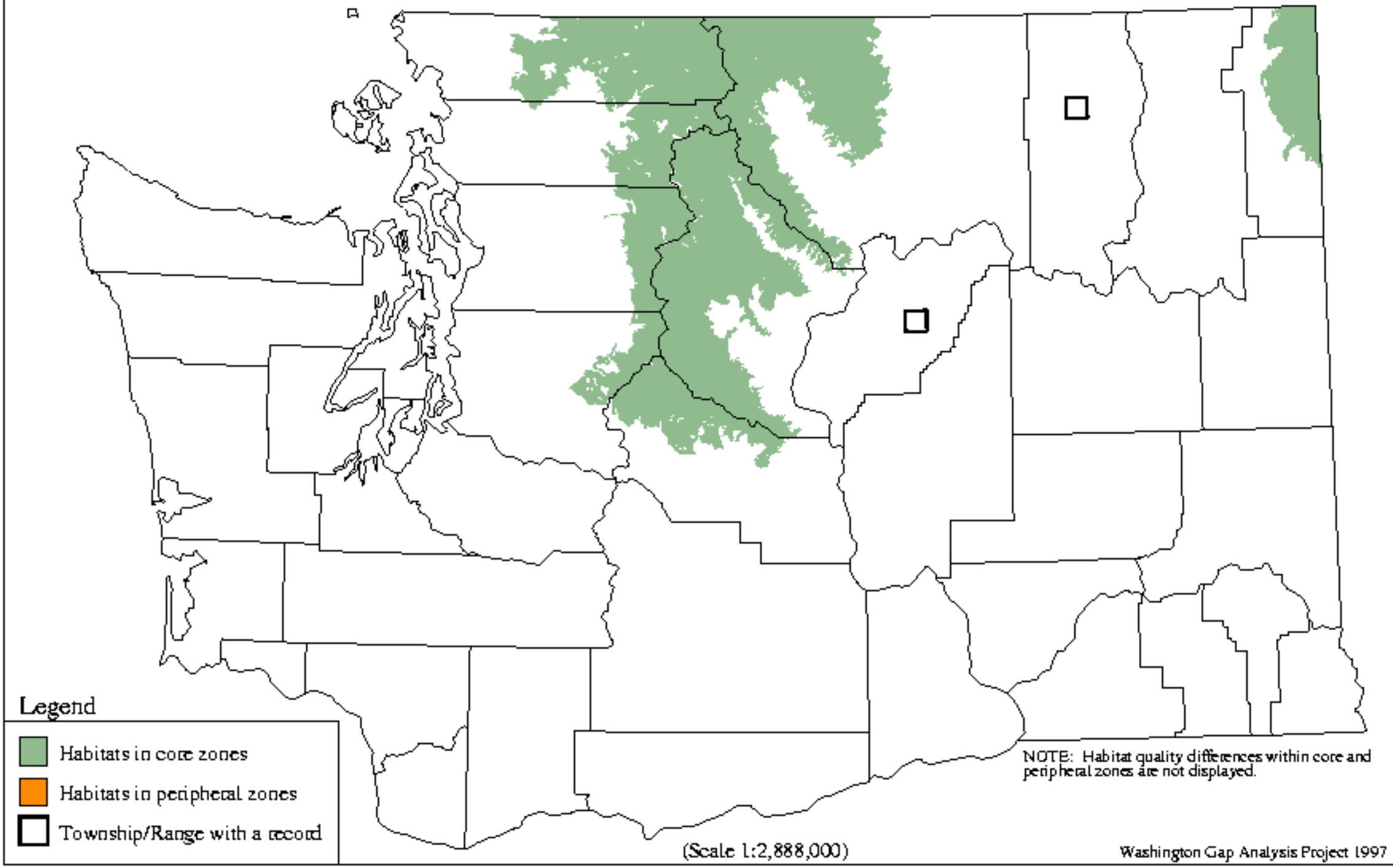
Rattus rattus - Black Rat



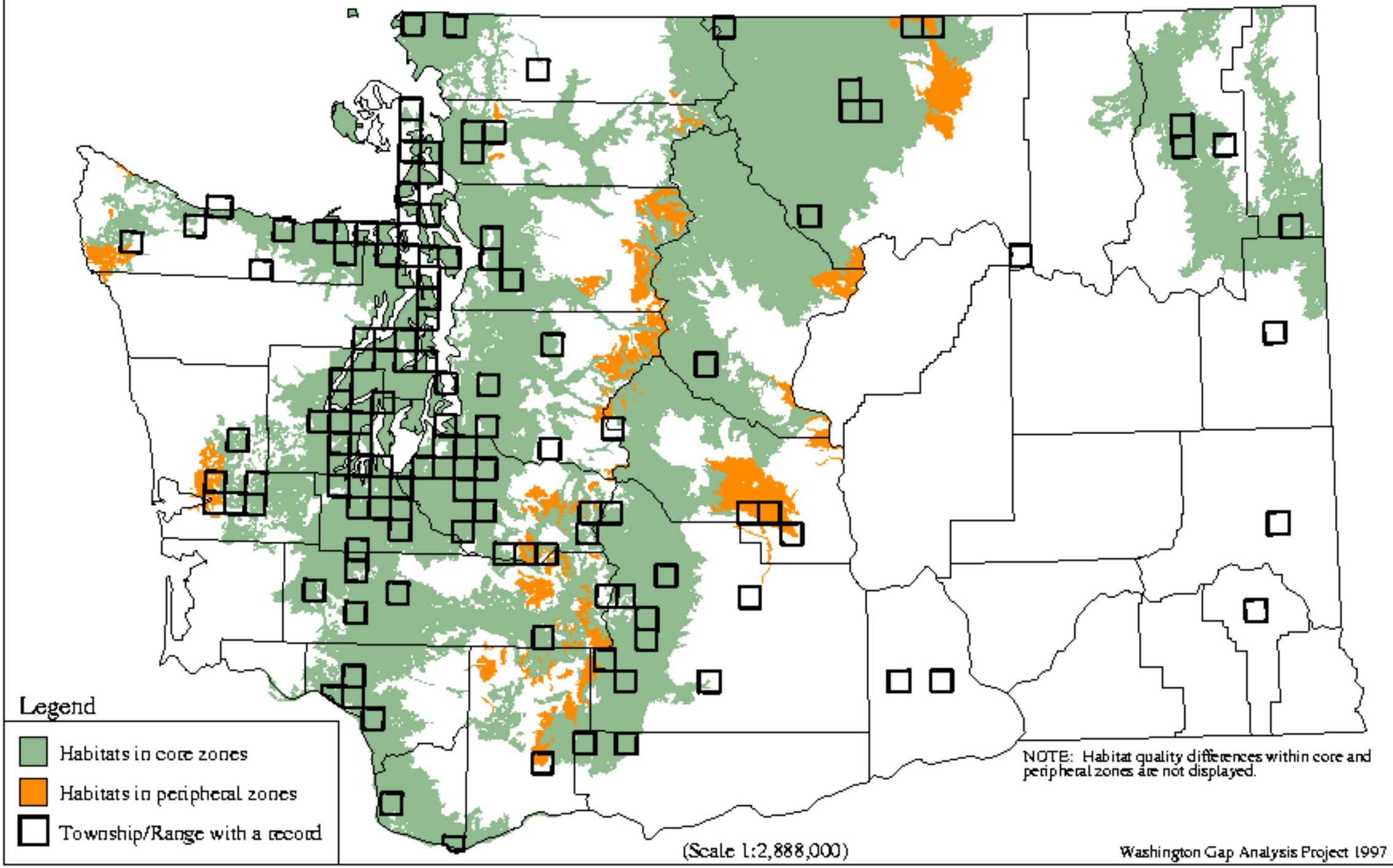
Canis latrans - Coyote



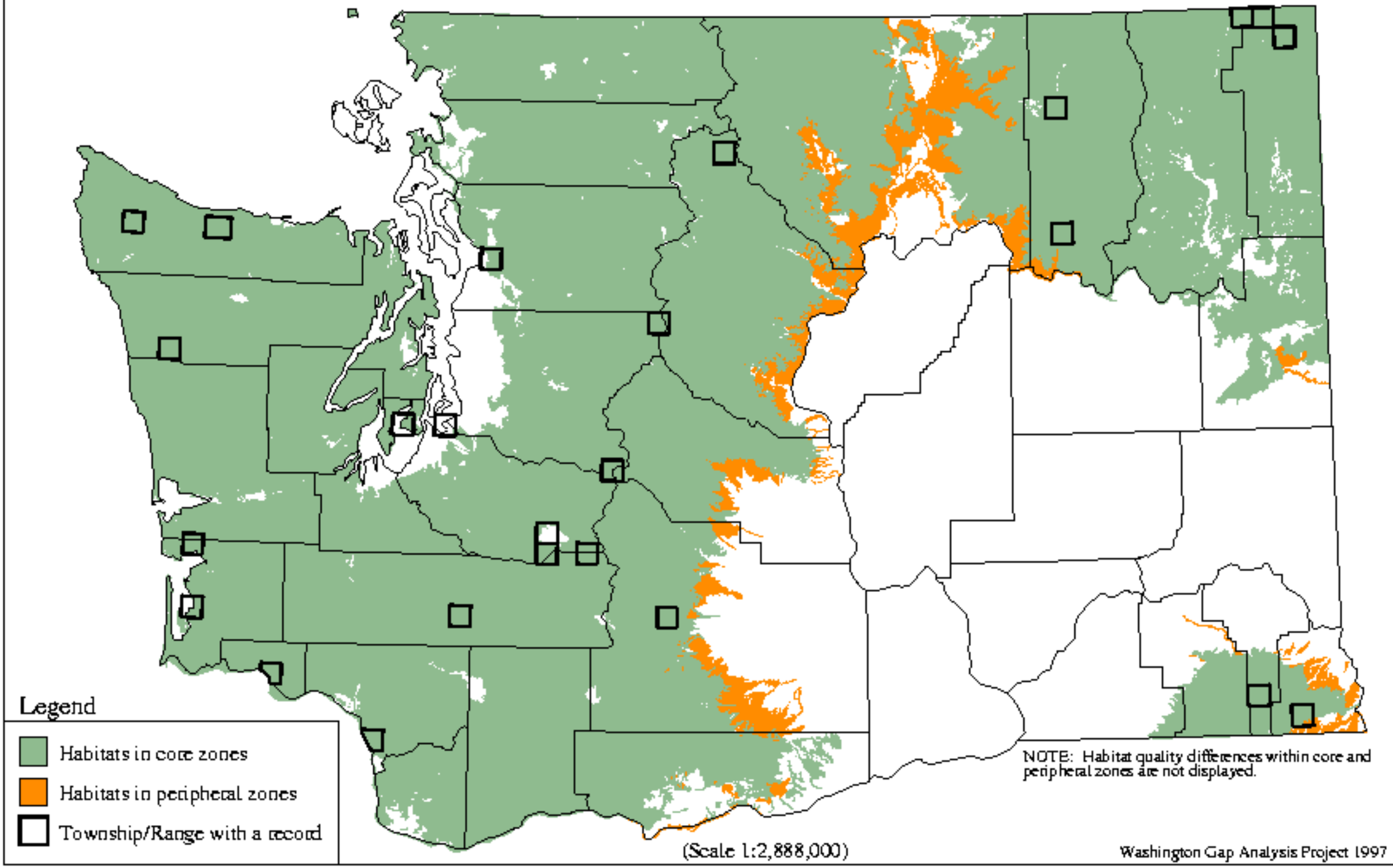
Canis lupus - Gray Wolf



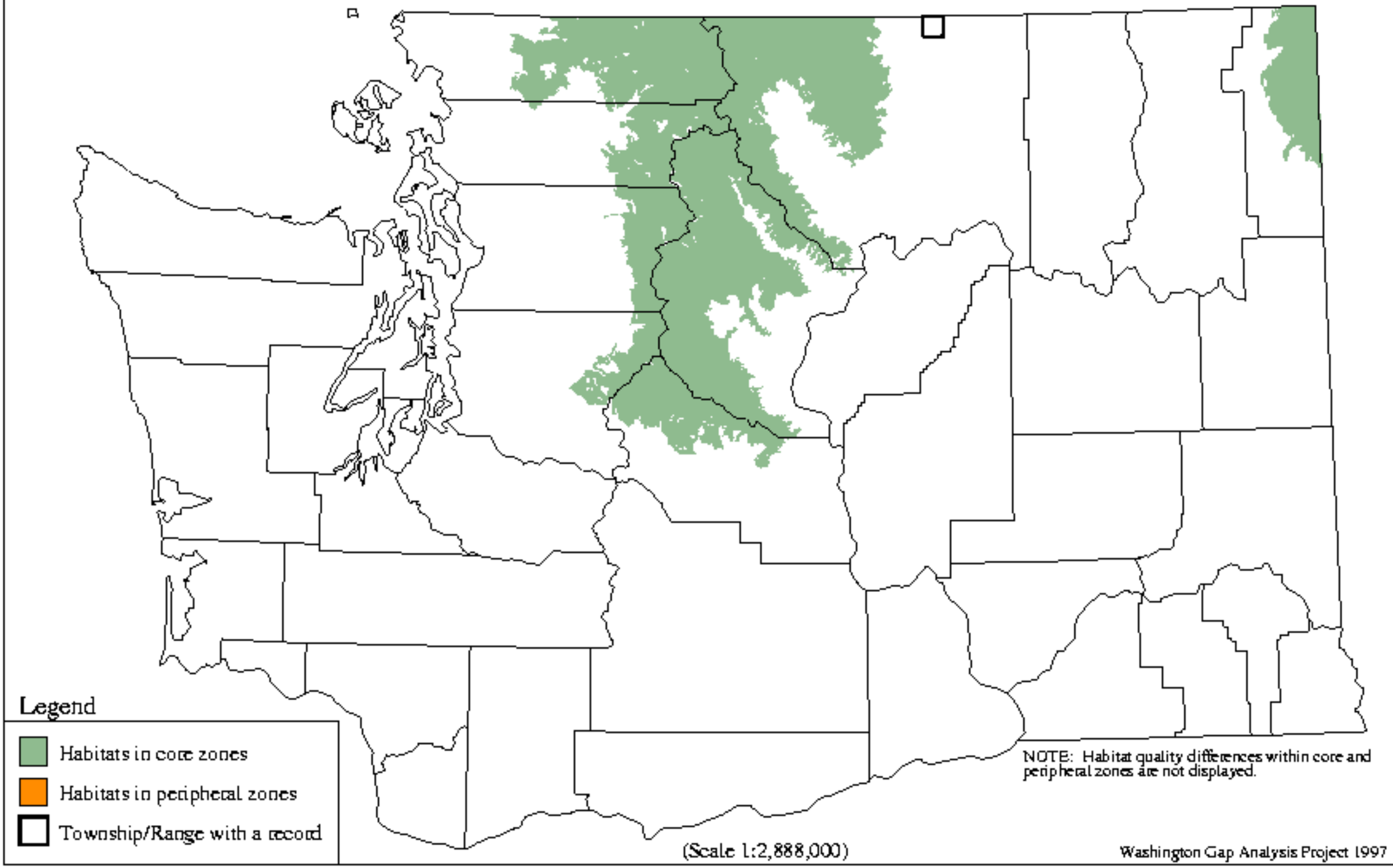
Vulpes vulpes - **Red Fox**



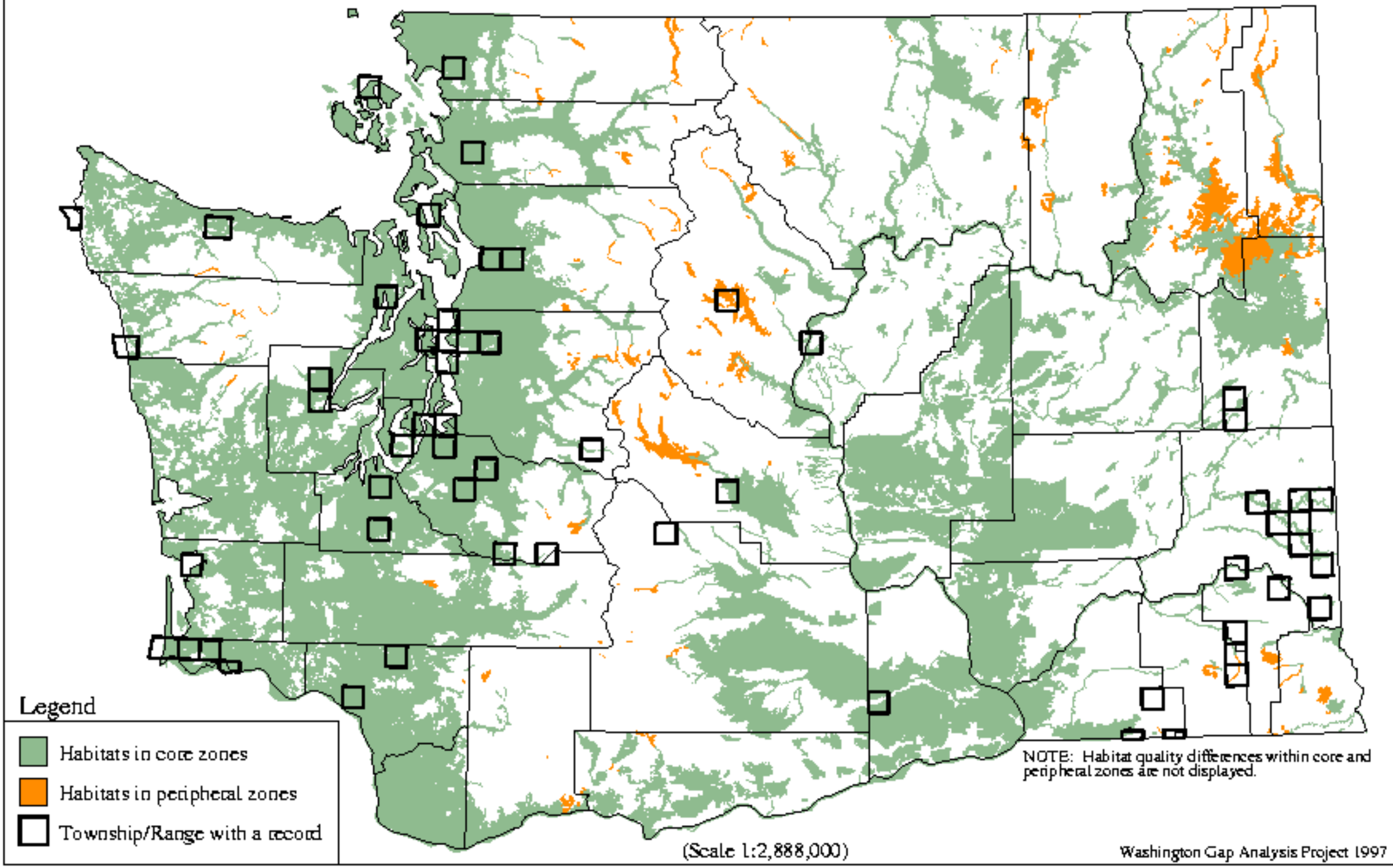
Ursus americanus - Black Bear



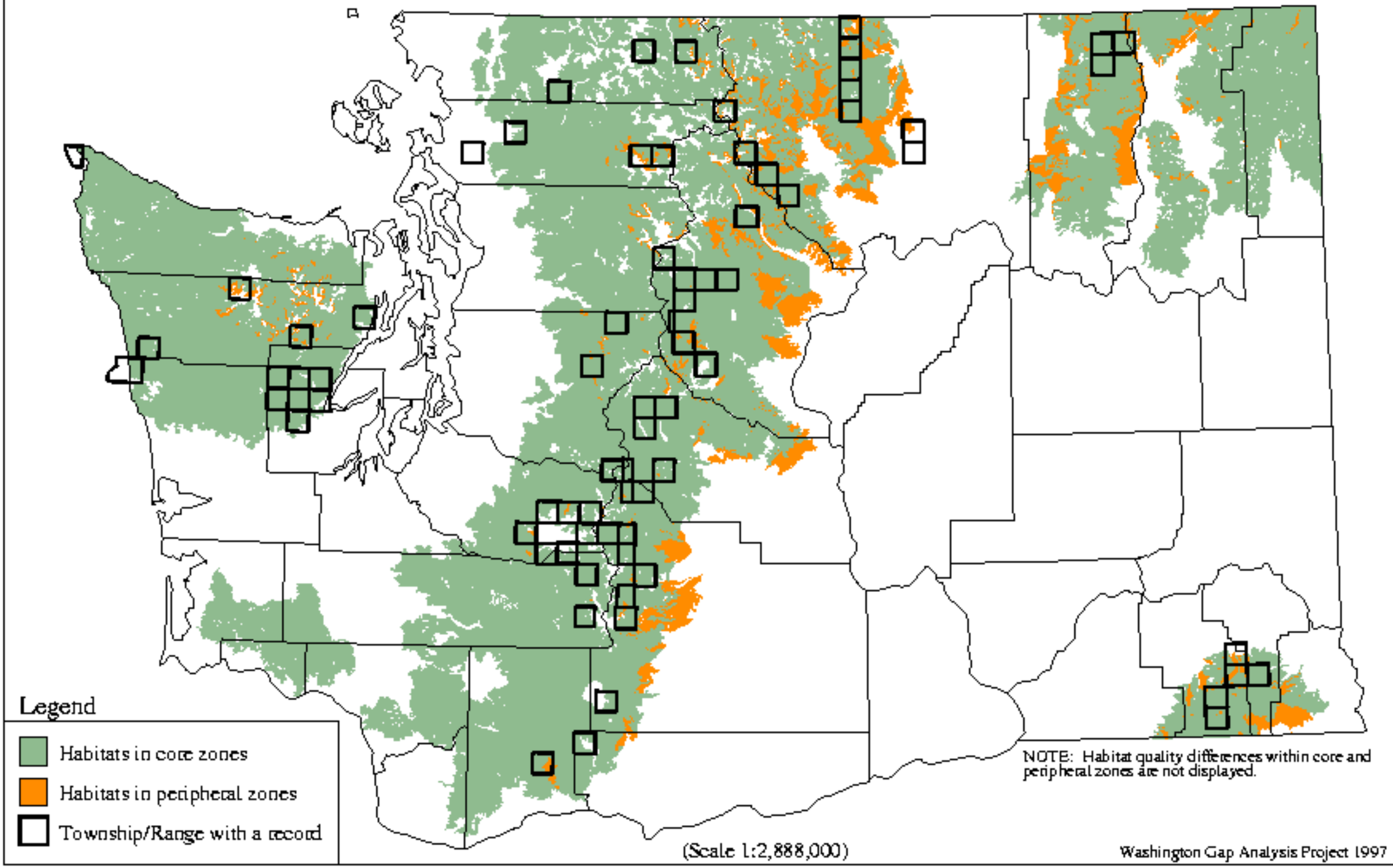
Ursus arctos - Grizzly Bear



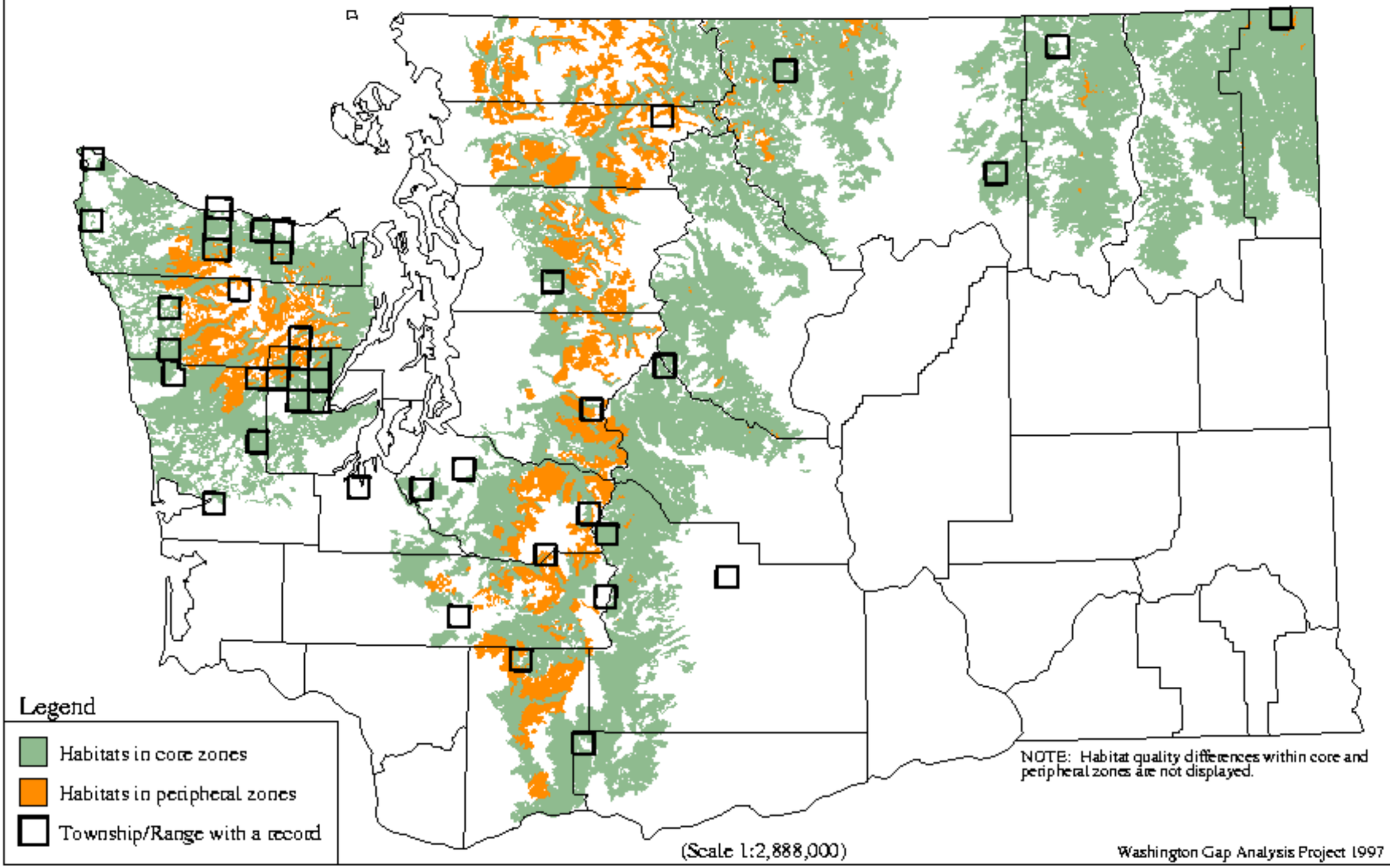
Procyon lotor - Raccoon



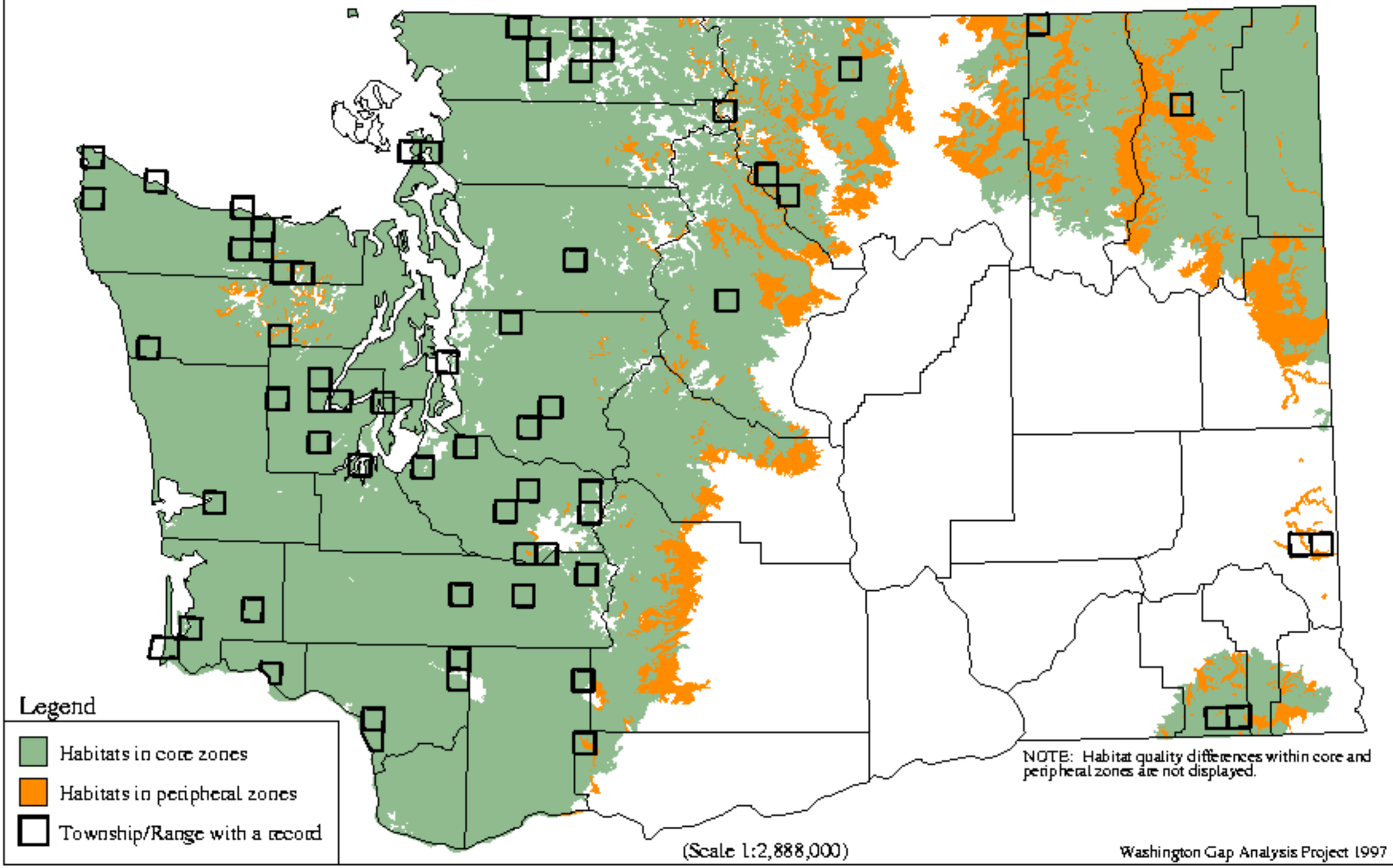
Martes americana - Marten



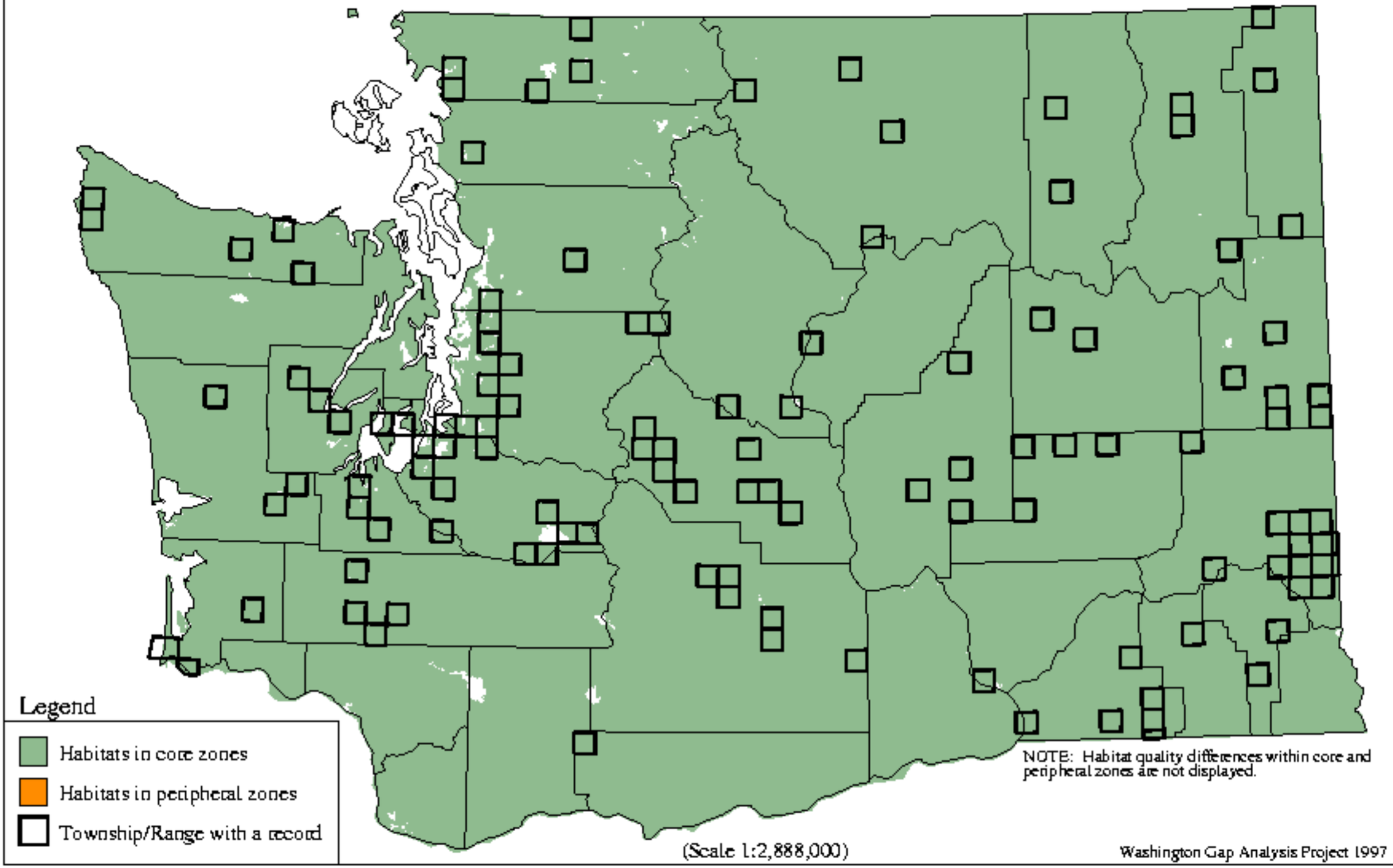
Martes pennanti - **Fisher**



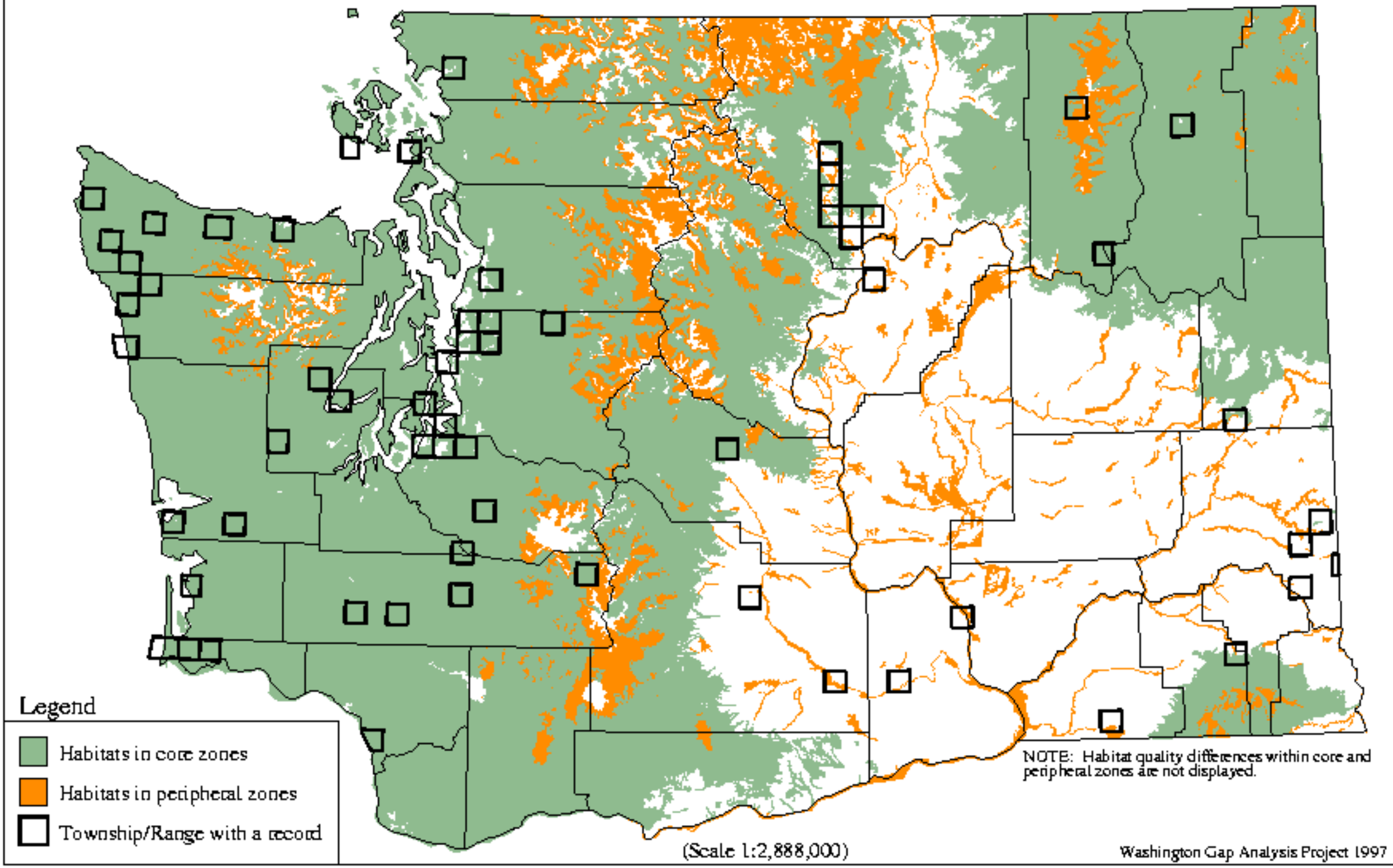
Mustela erminea - Ermine



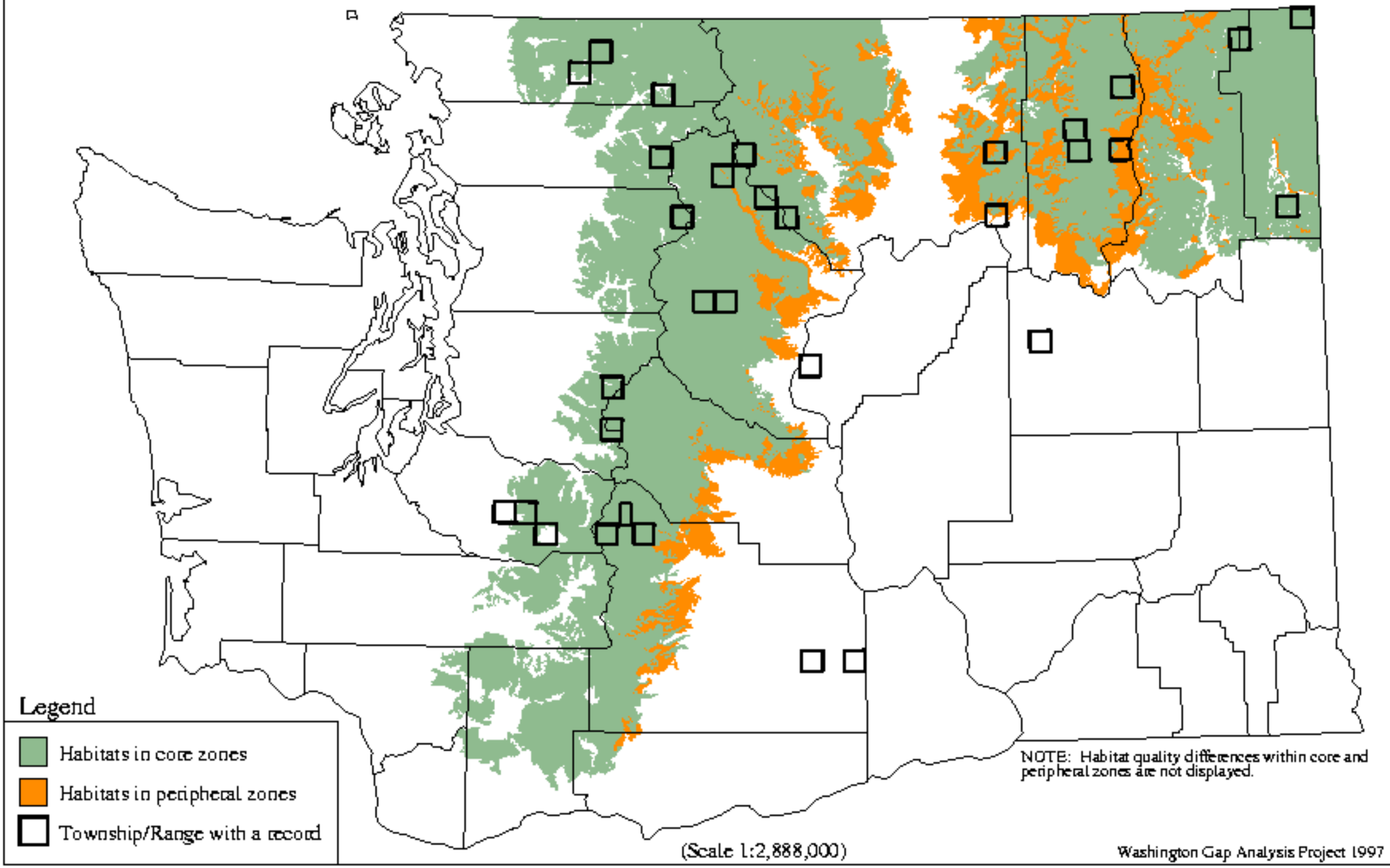
Mustela frenata - Long-tailed Weasel



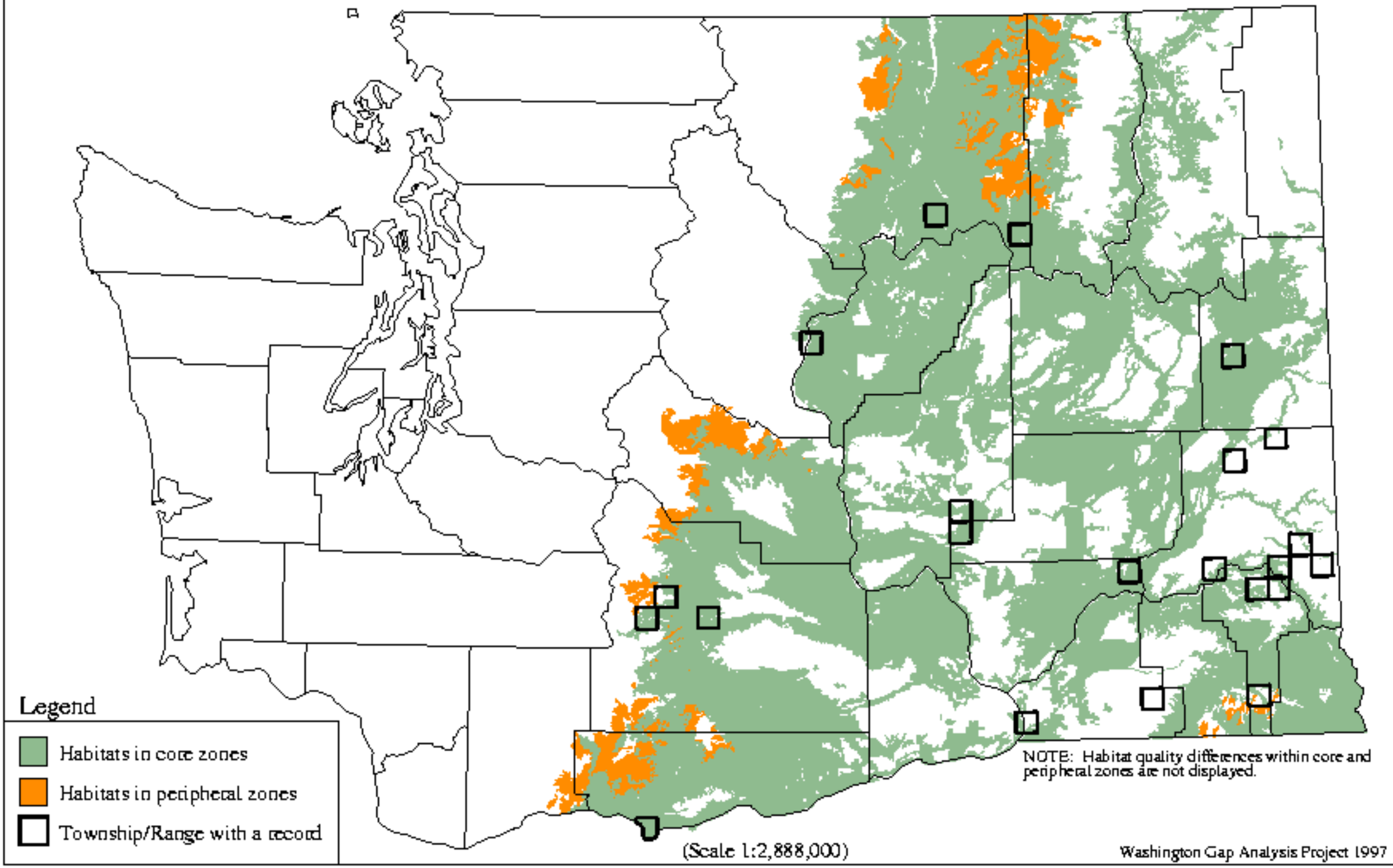
Mustela vison - Mink



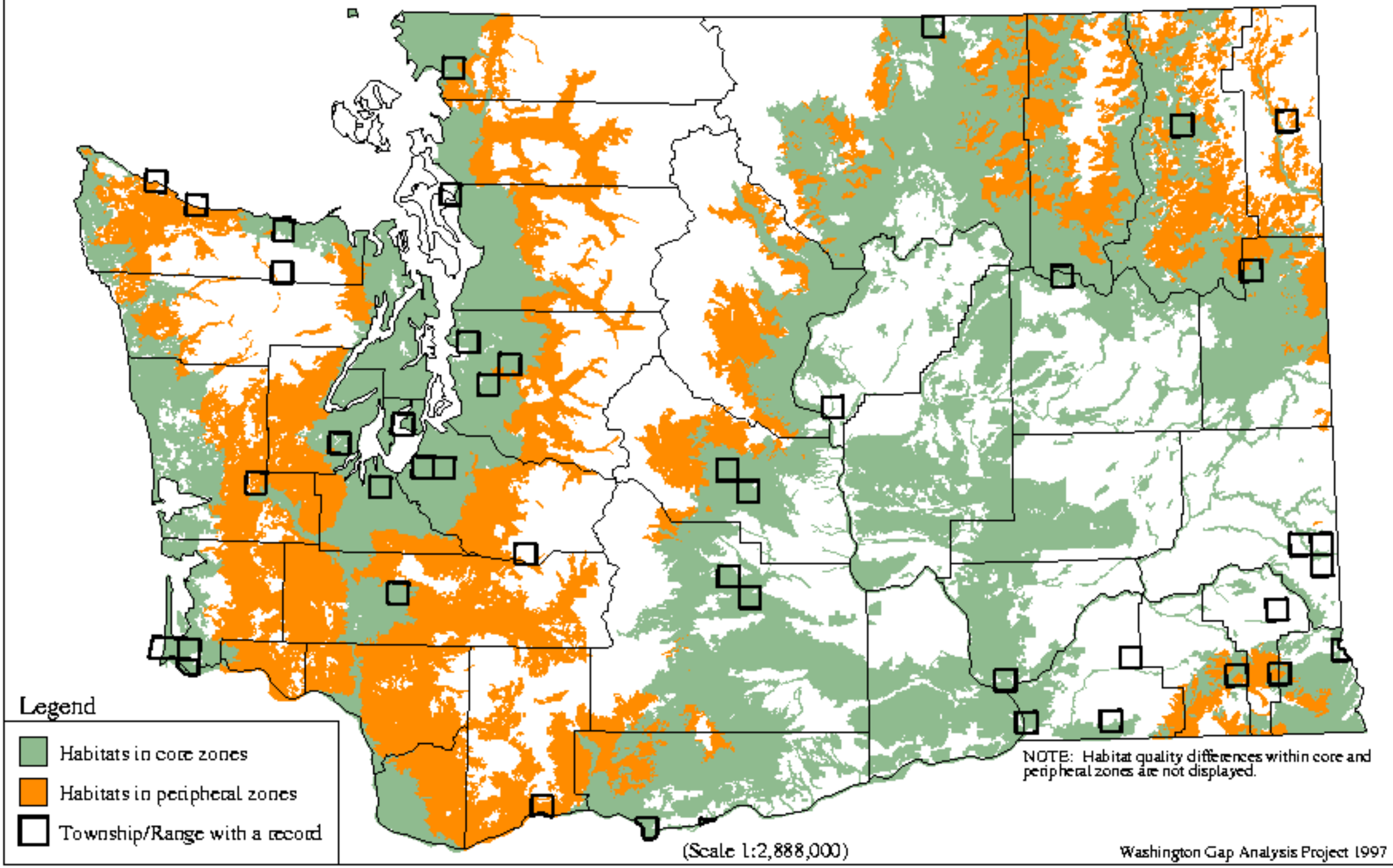
Gulo gulo - Wolverine



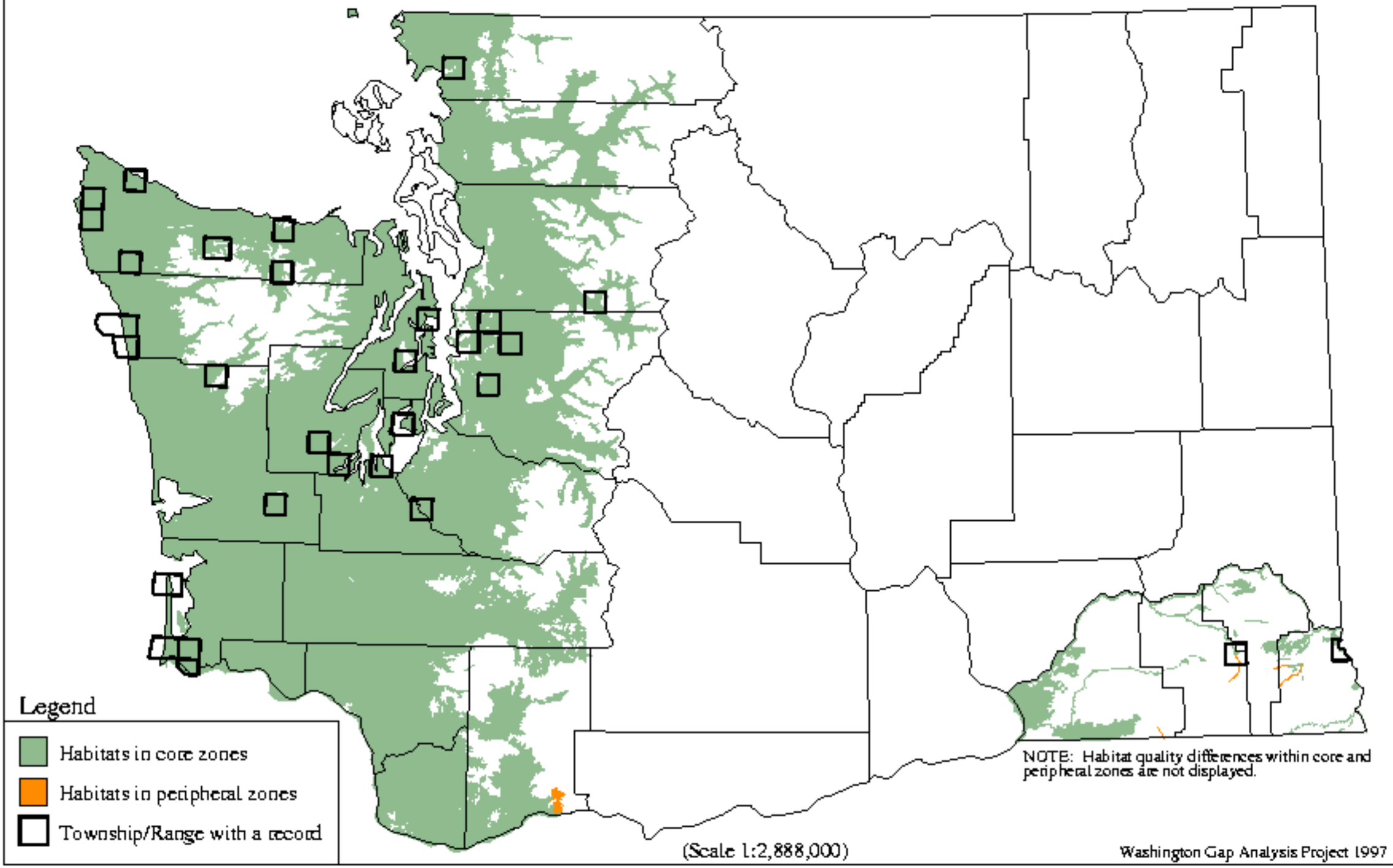
Taxidea taxus - Badger



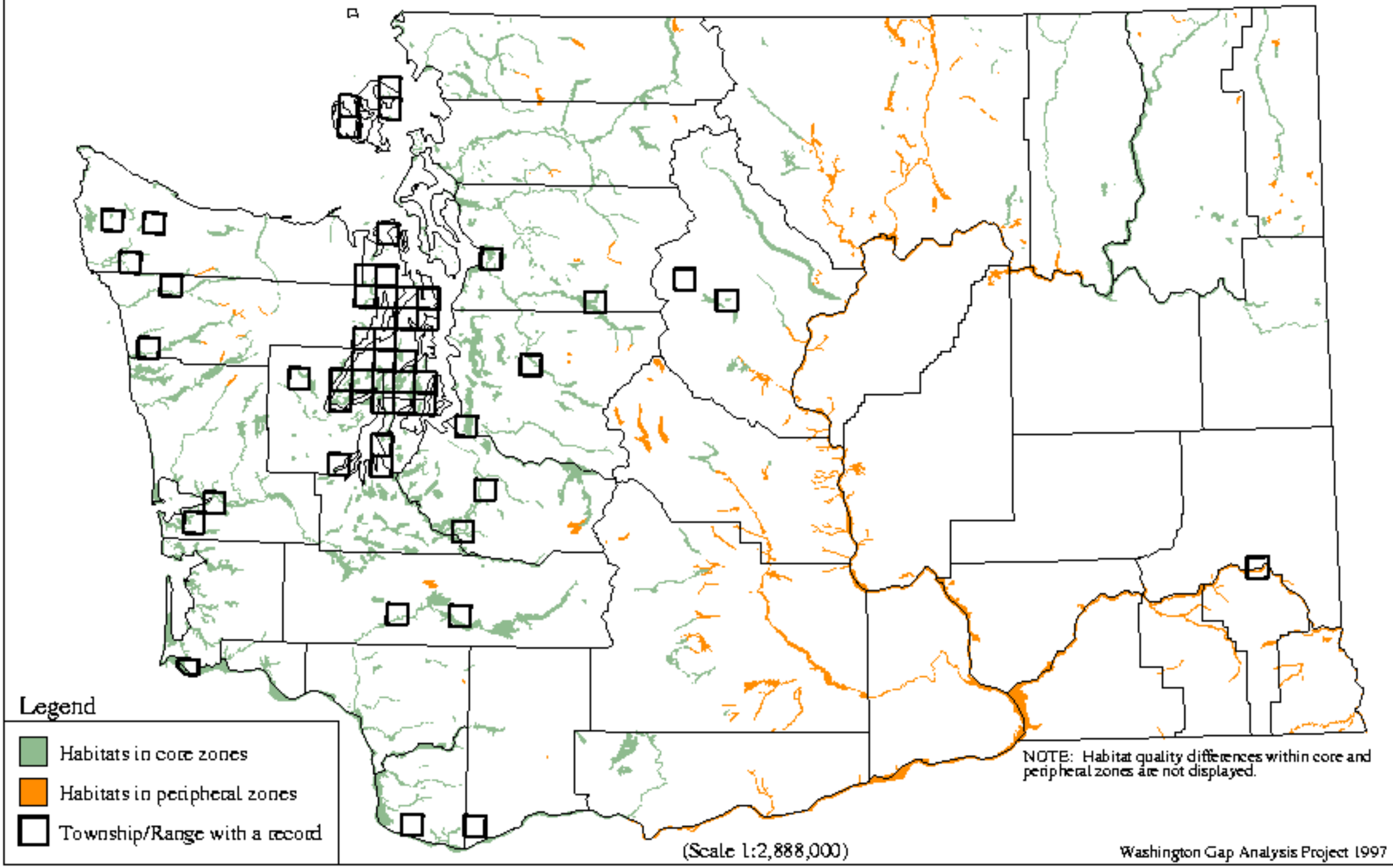
Mephitis mephitis - Striped Skunk



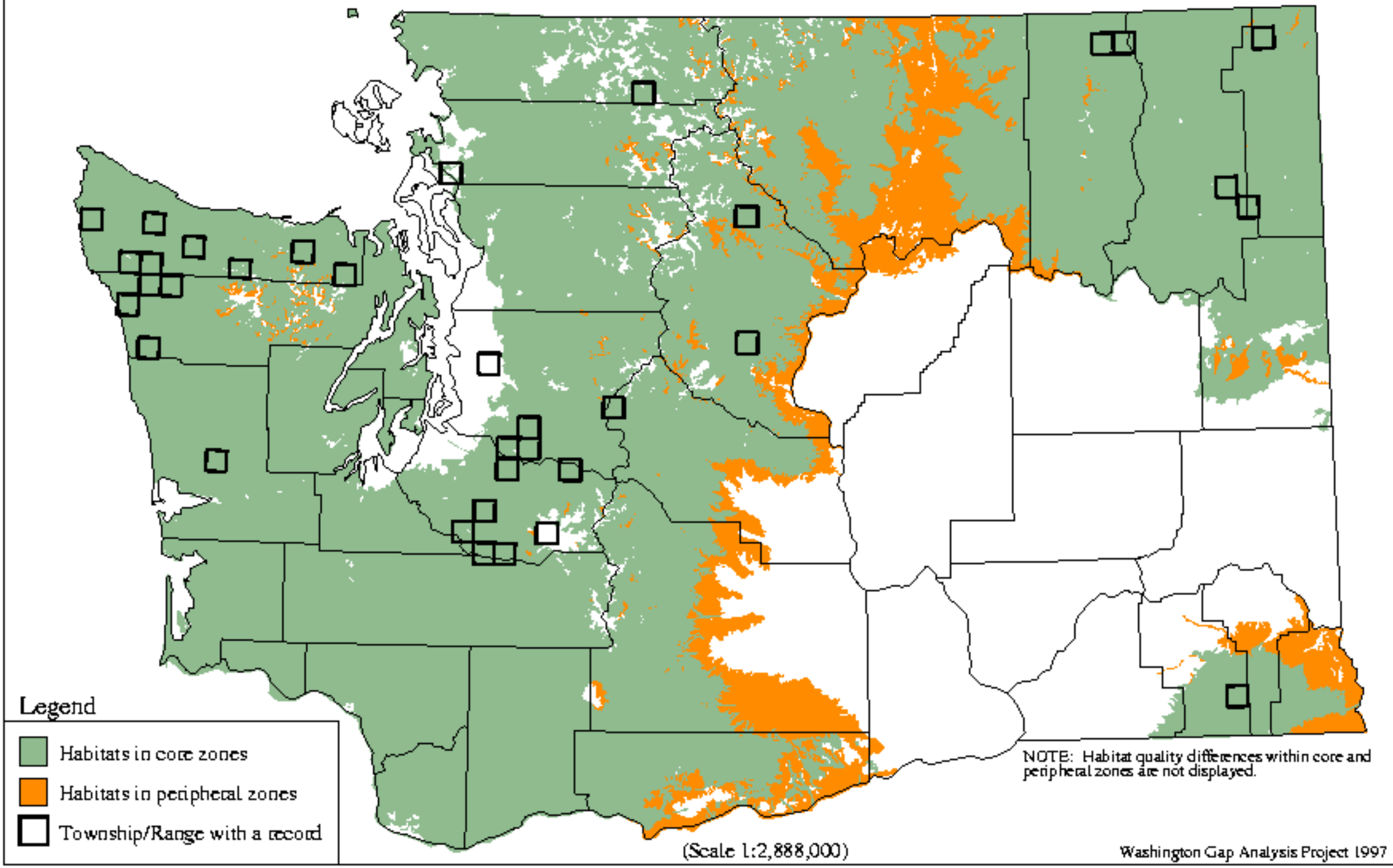
Spilogale gracilis - Spotted Skunk



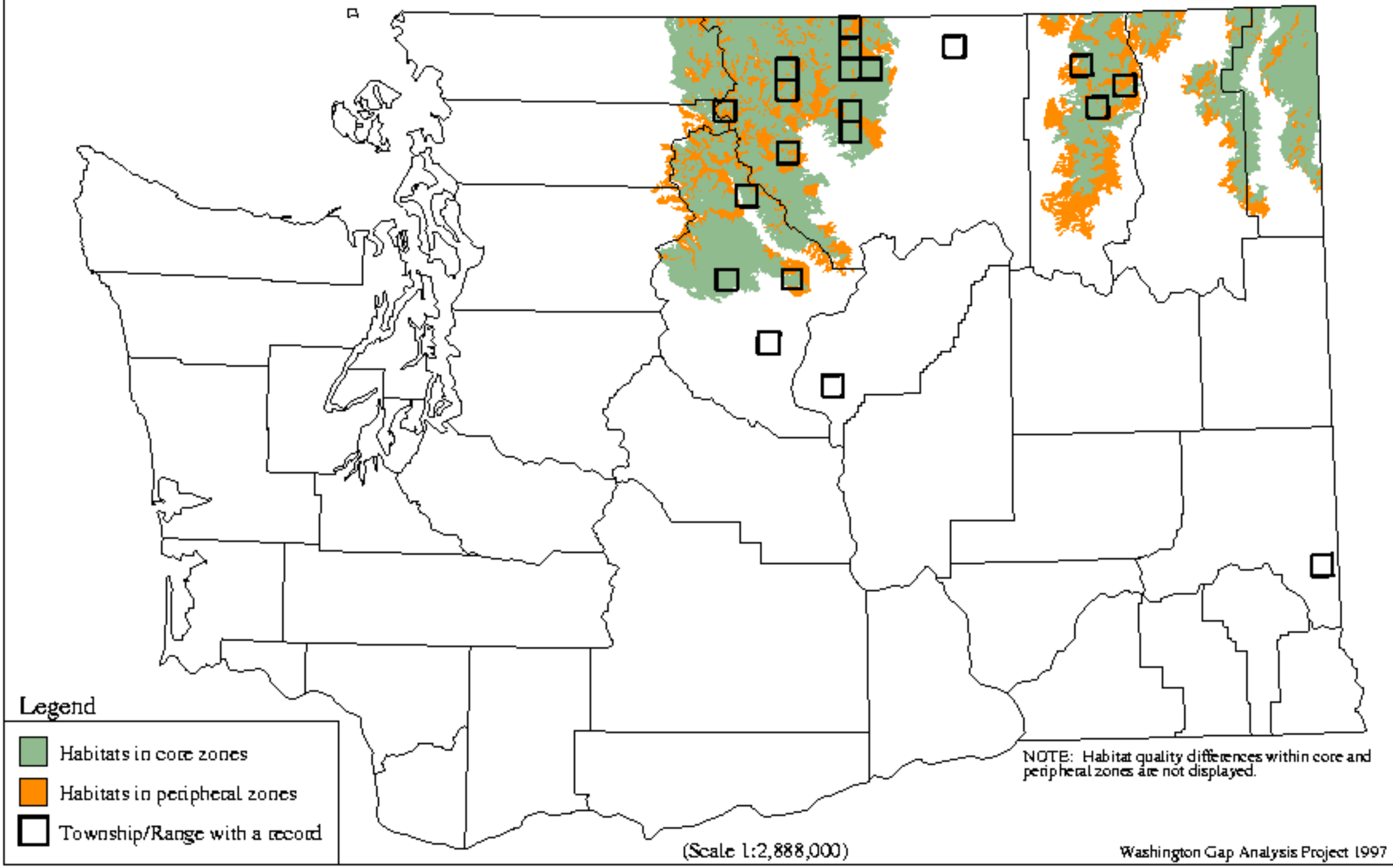
Lutra canadensis - River Otter



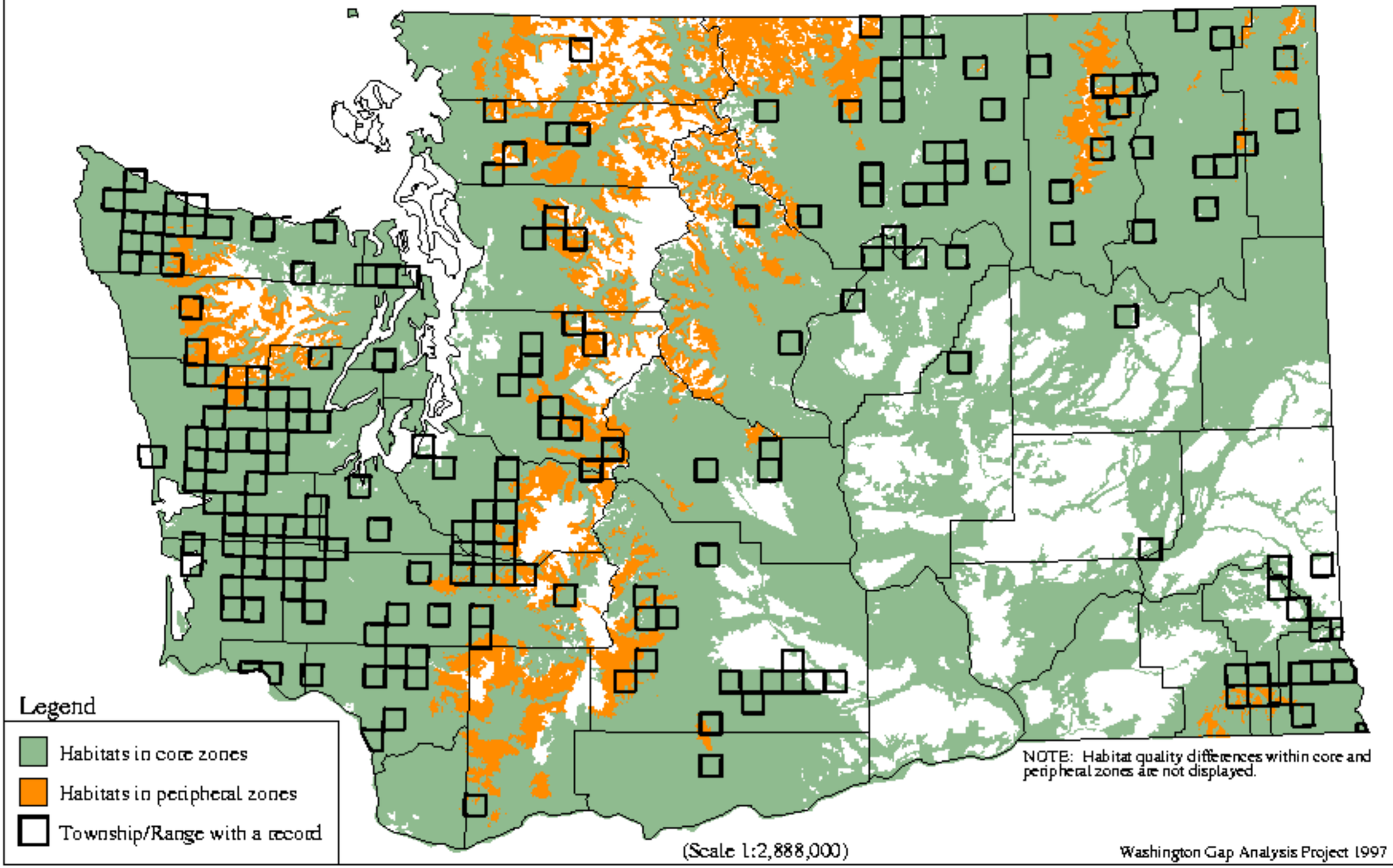
Felis concolor - Mountain Lion



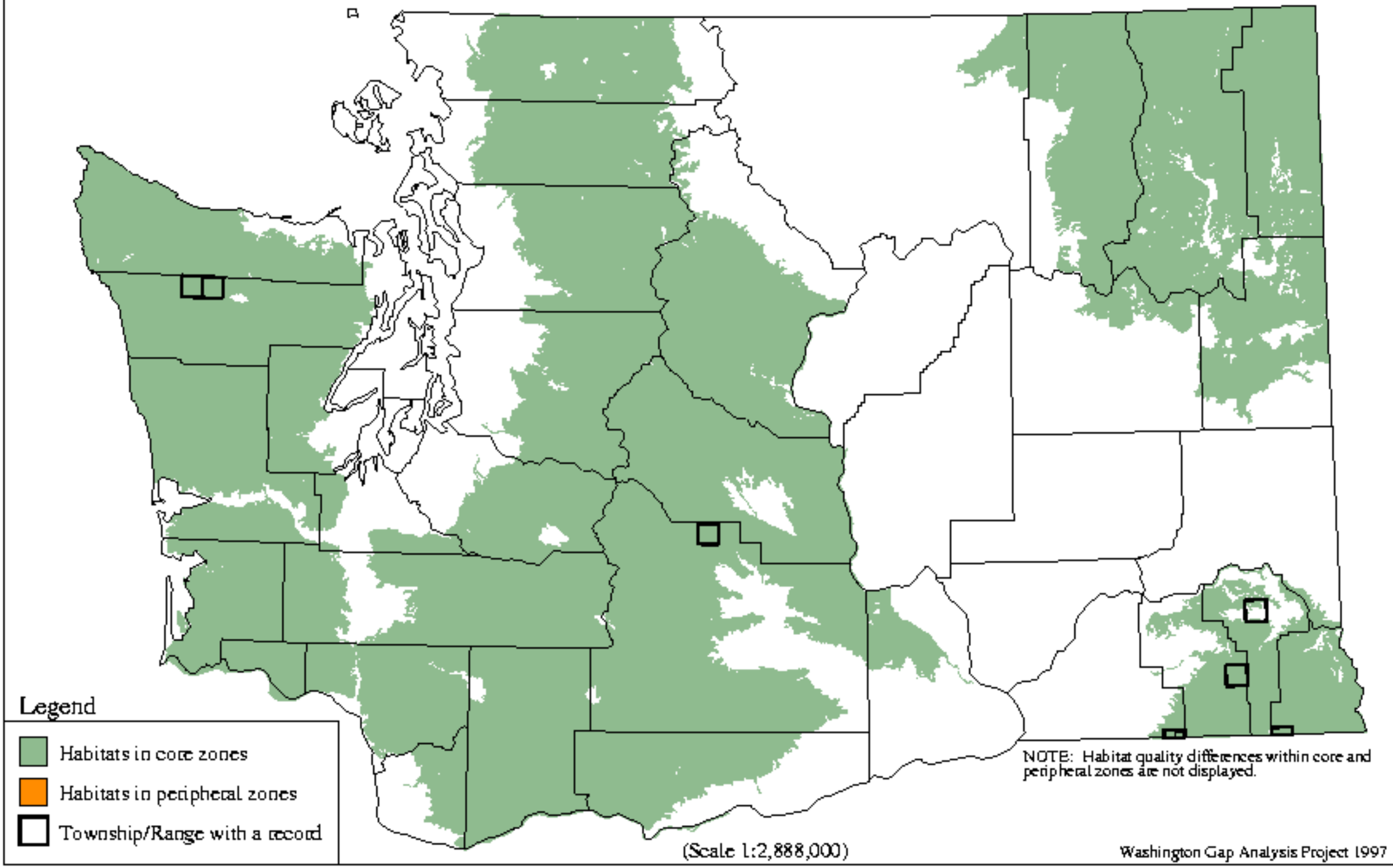
Lynx canadensis - **Lynx**



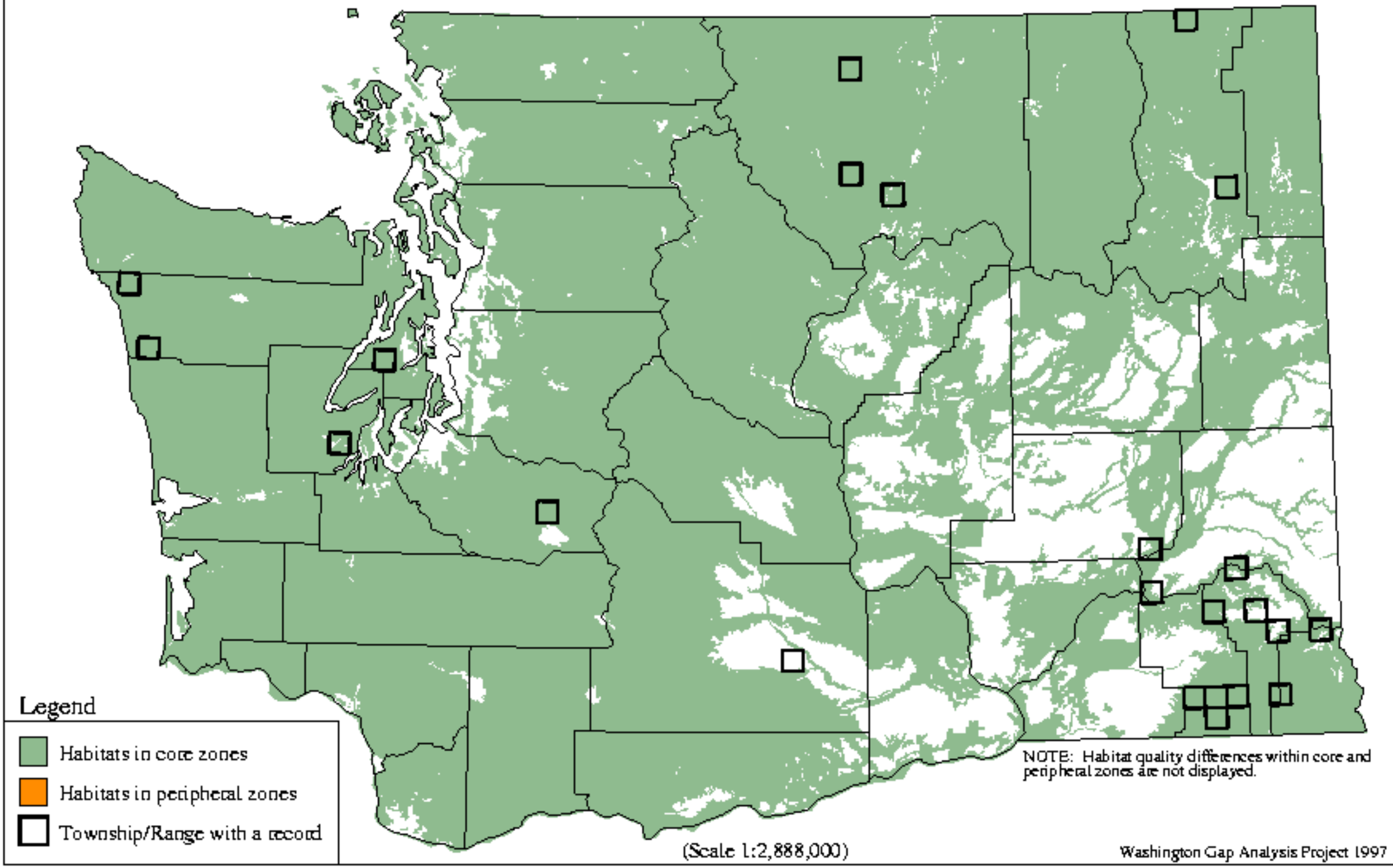
Lynx rufus - Bobcat



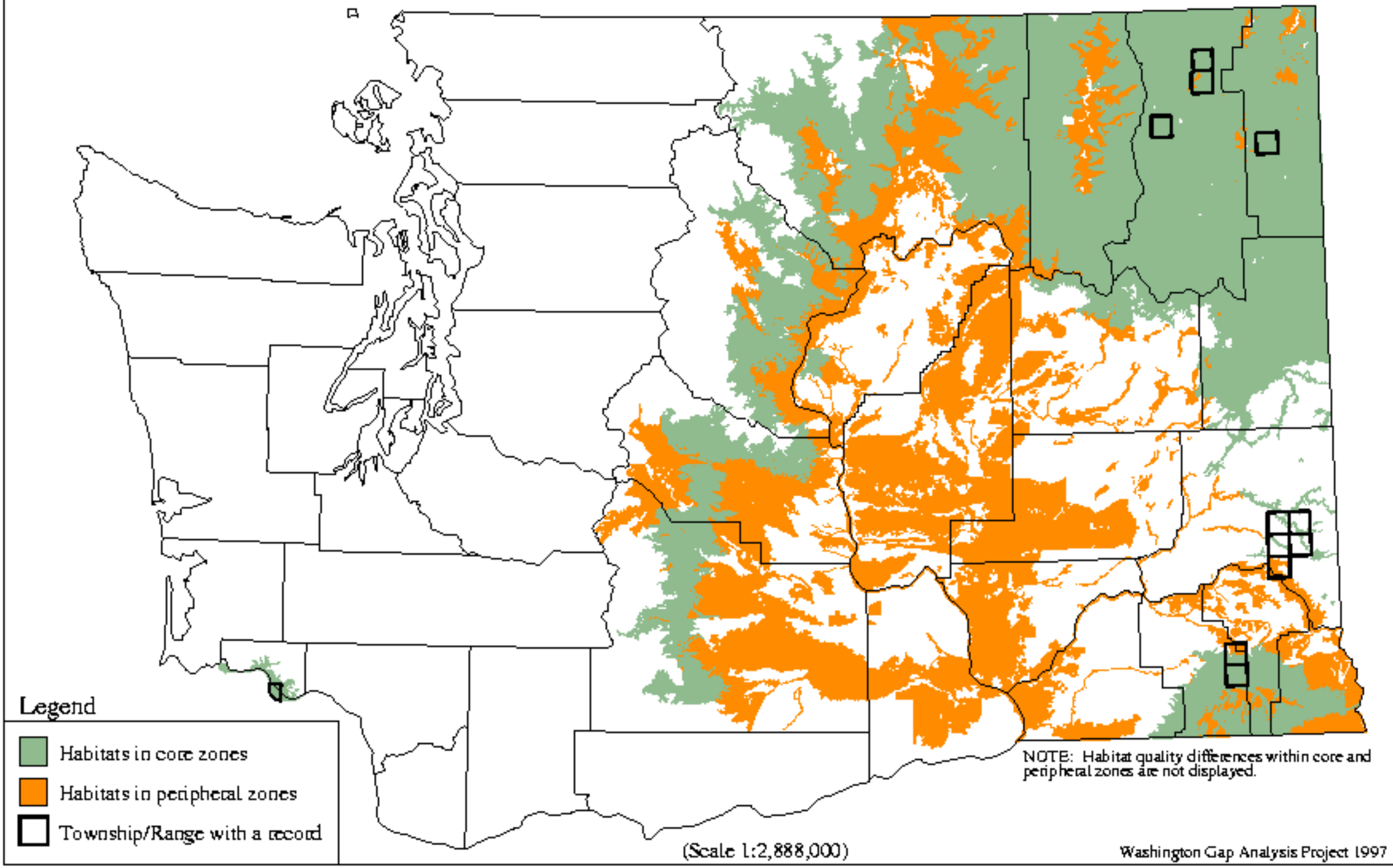
Cervus elaphus - **Elk**



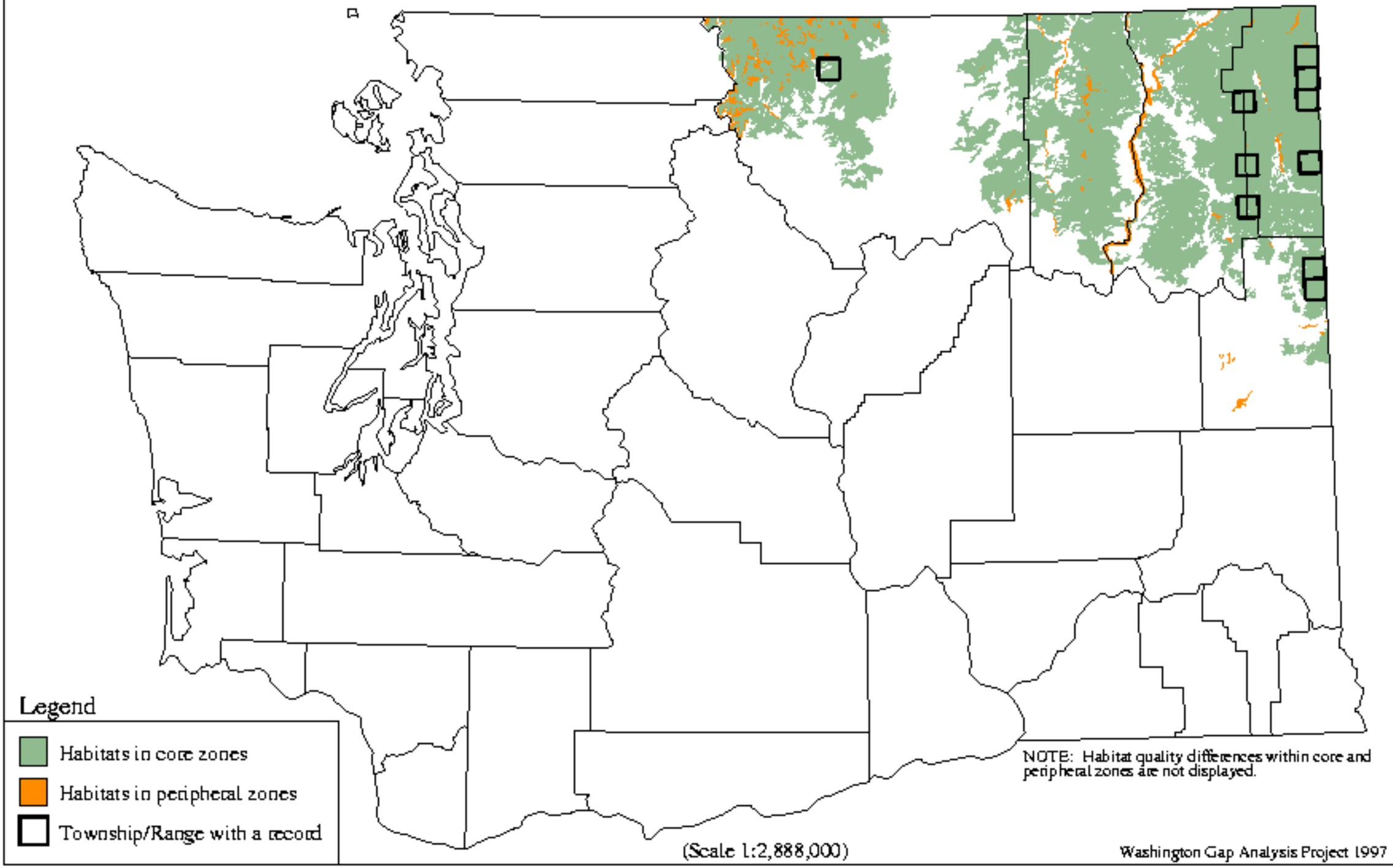
Odocoileus hemionus - Mule Deer



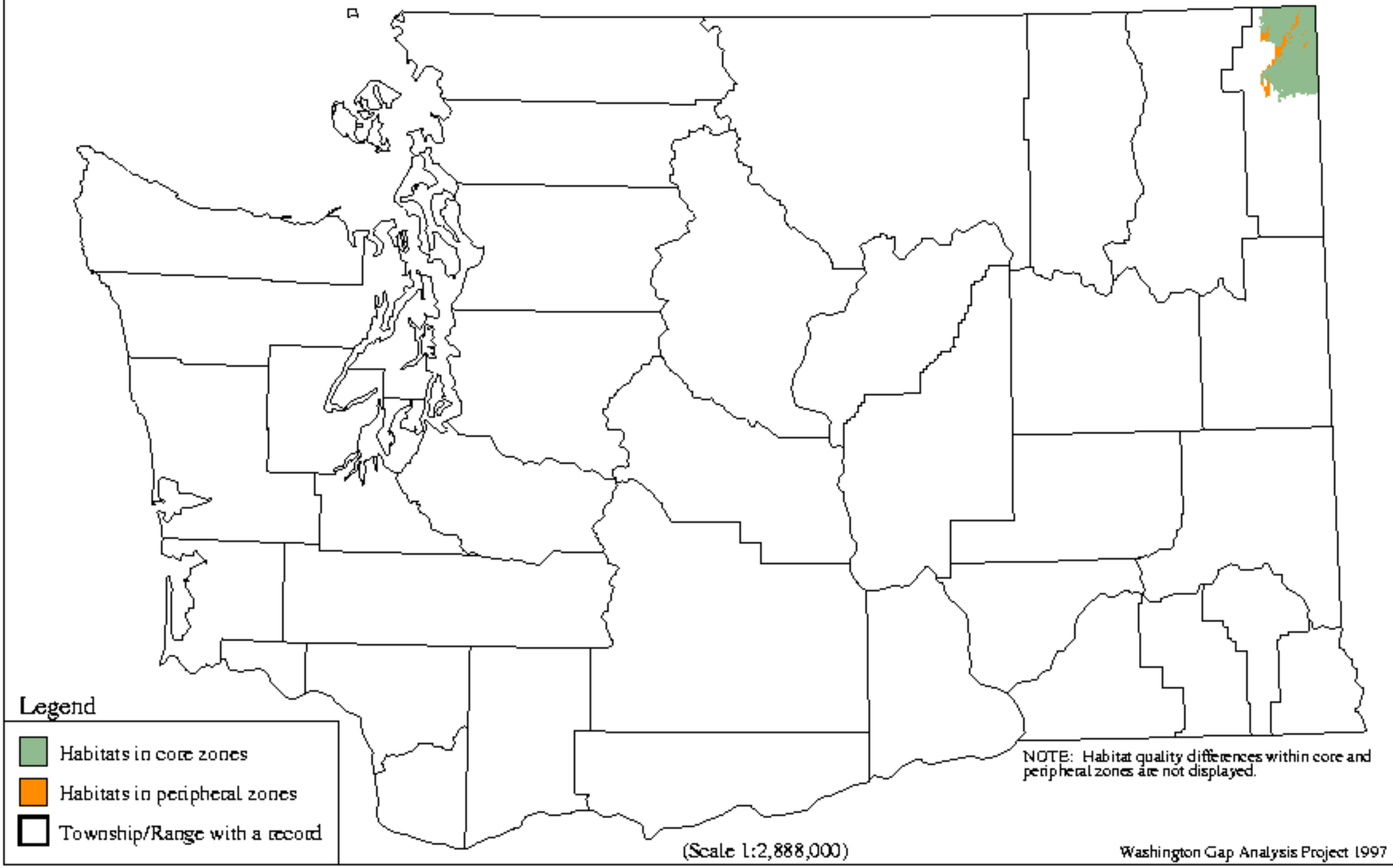
Odocoileus virginianus - White-tailed Deer



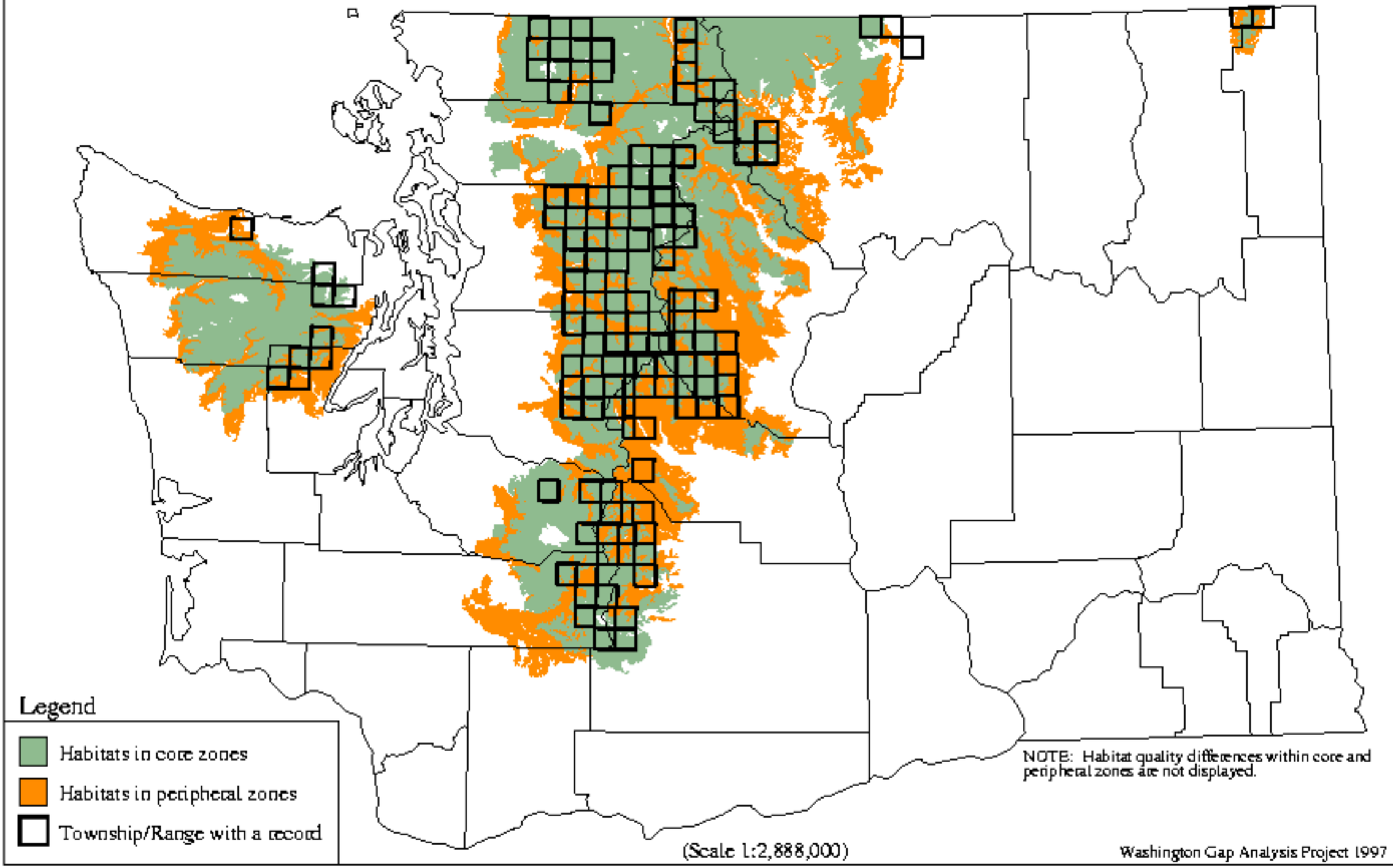
Alces alces - Moose



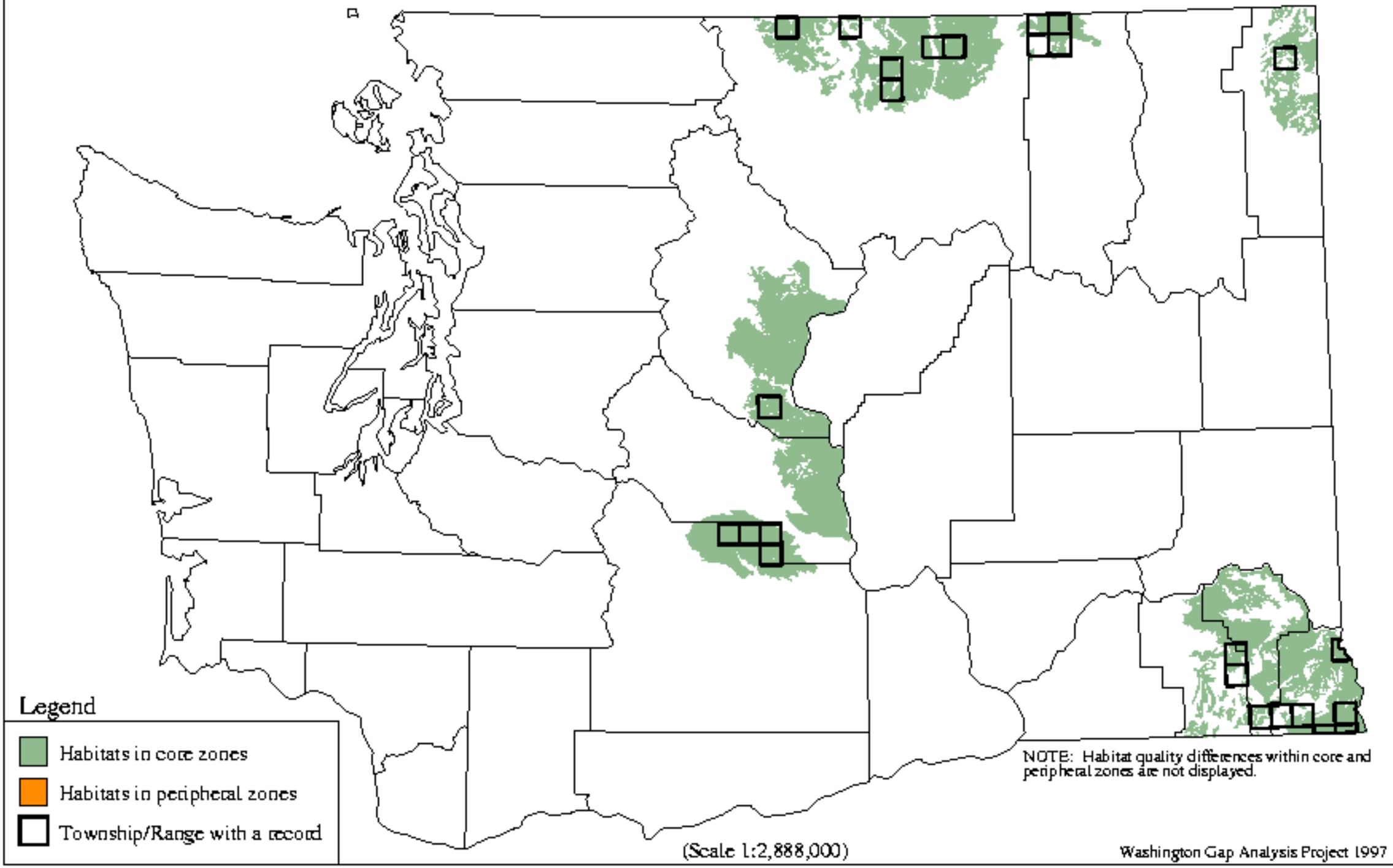
Rangifer tarandus - Caribou



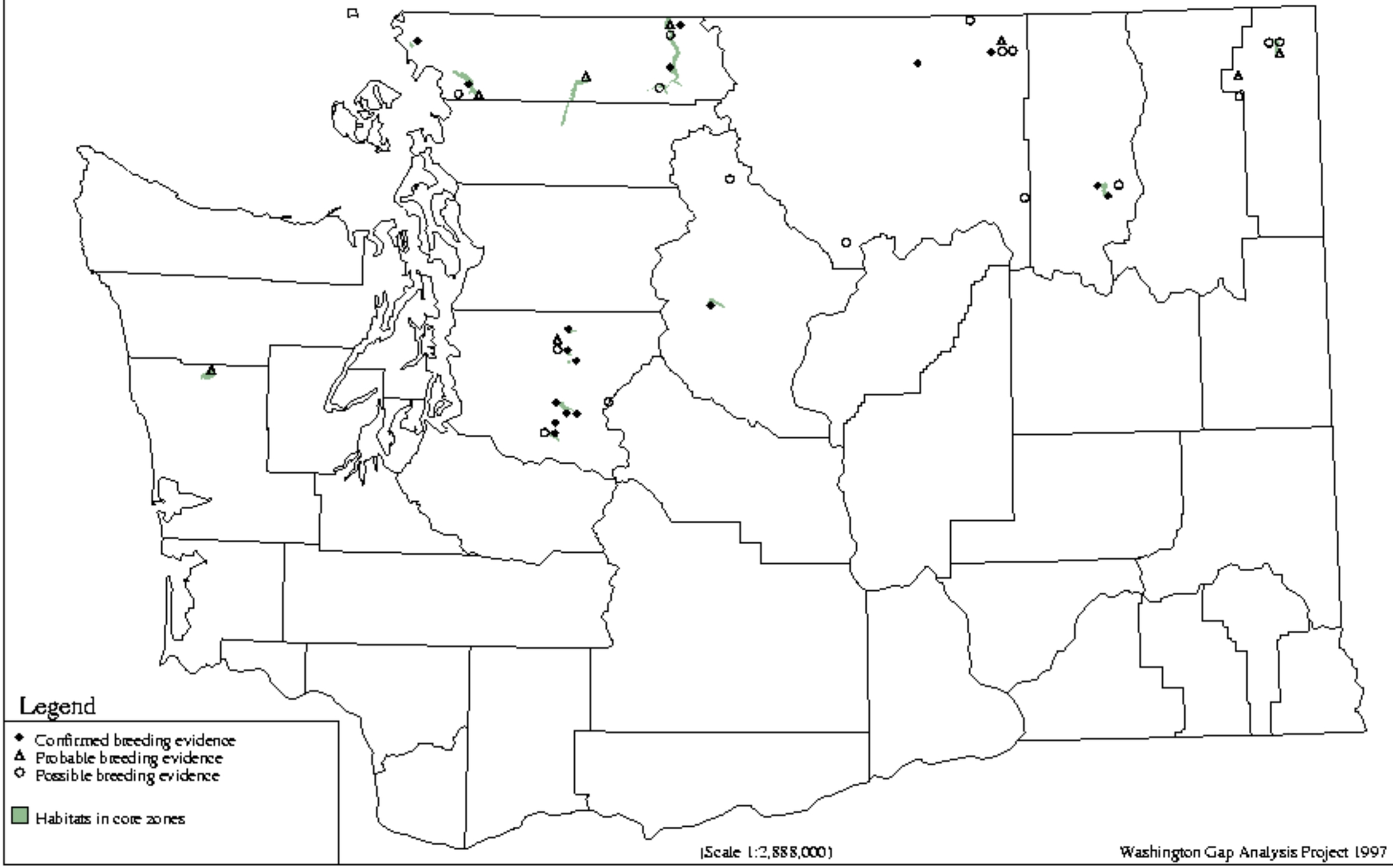
Oreamnos americanus - Mountain Goat



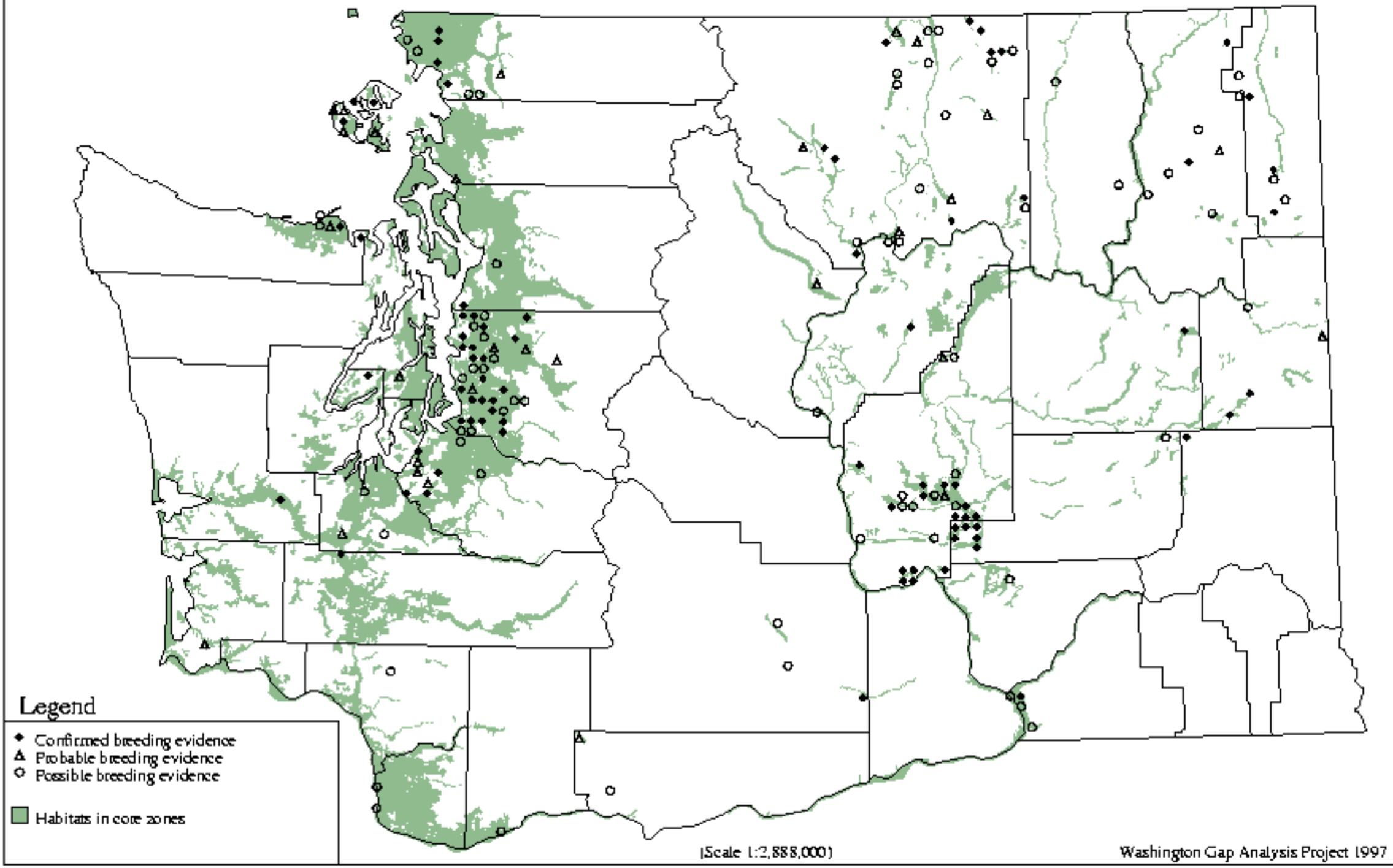
Ovis canadensis - Bighorn Sheep



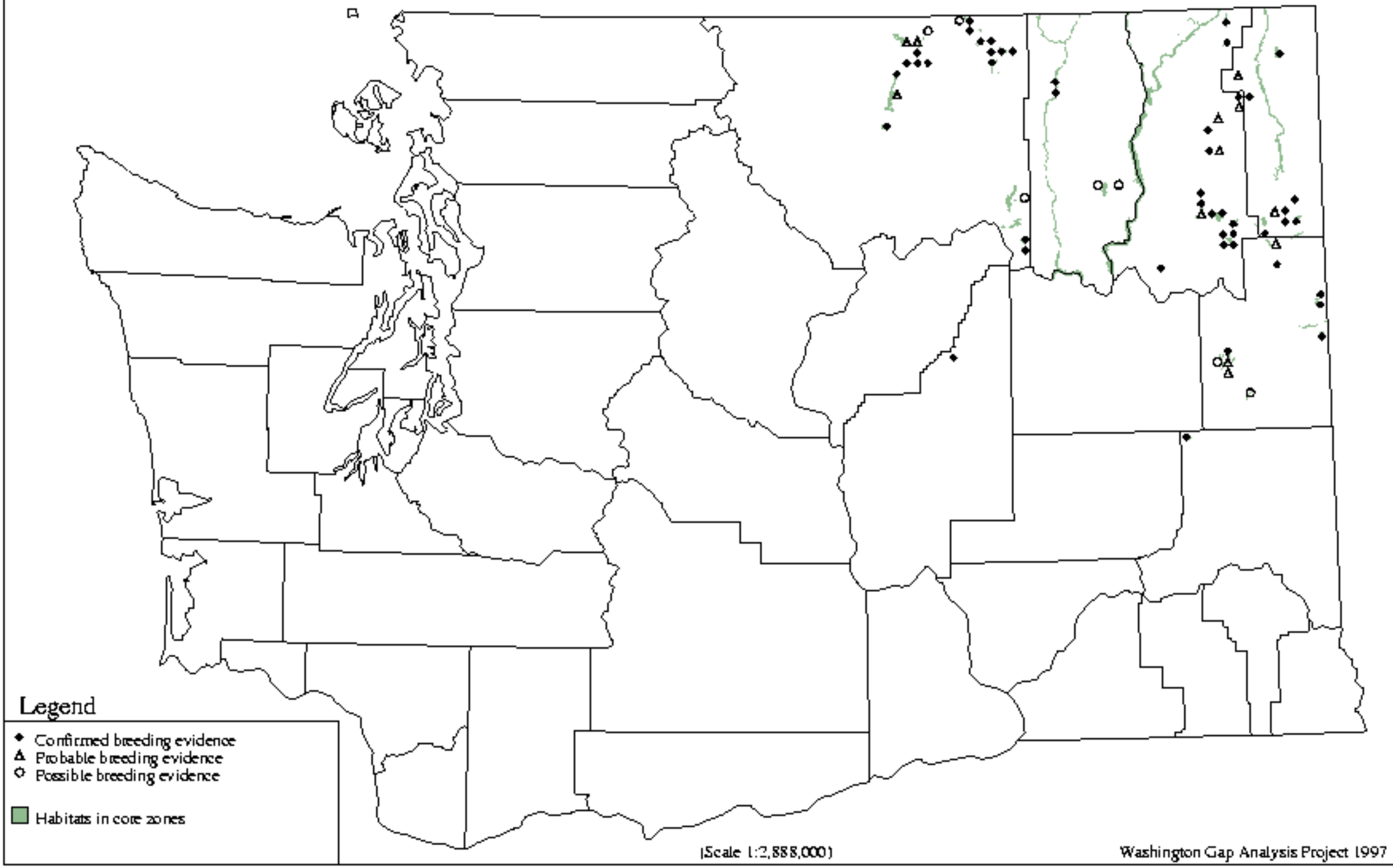
Common Loon - *Gavia immer*



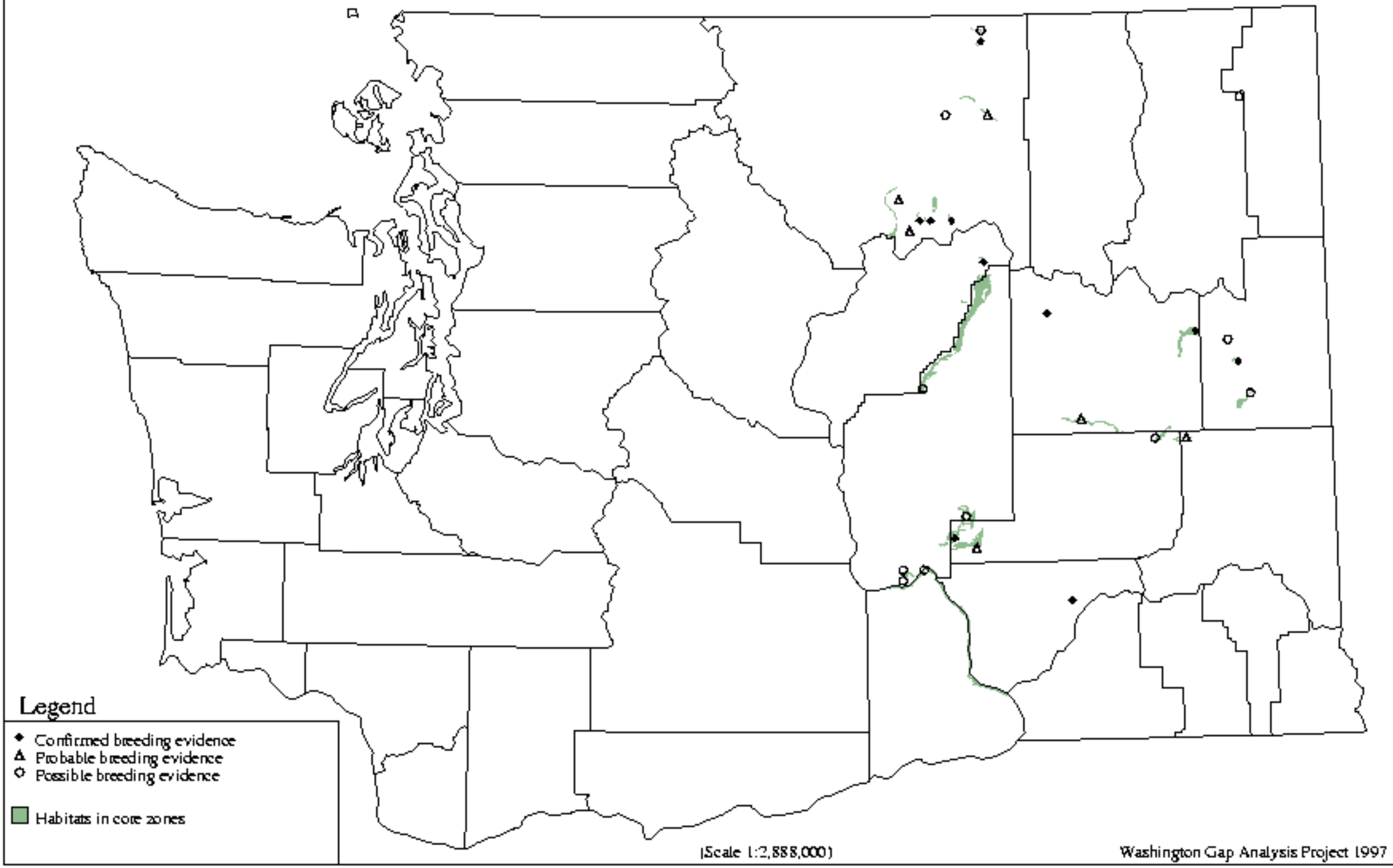
Pied-billed Grebe - *Podilymbus podiceps*



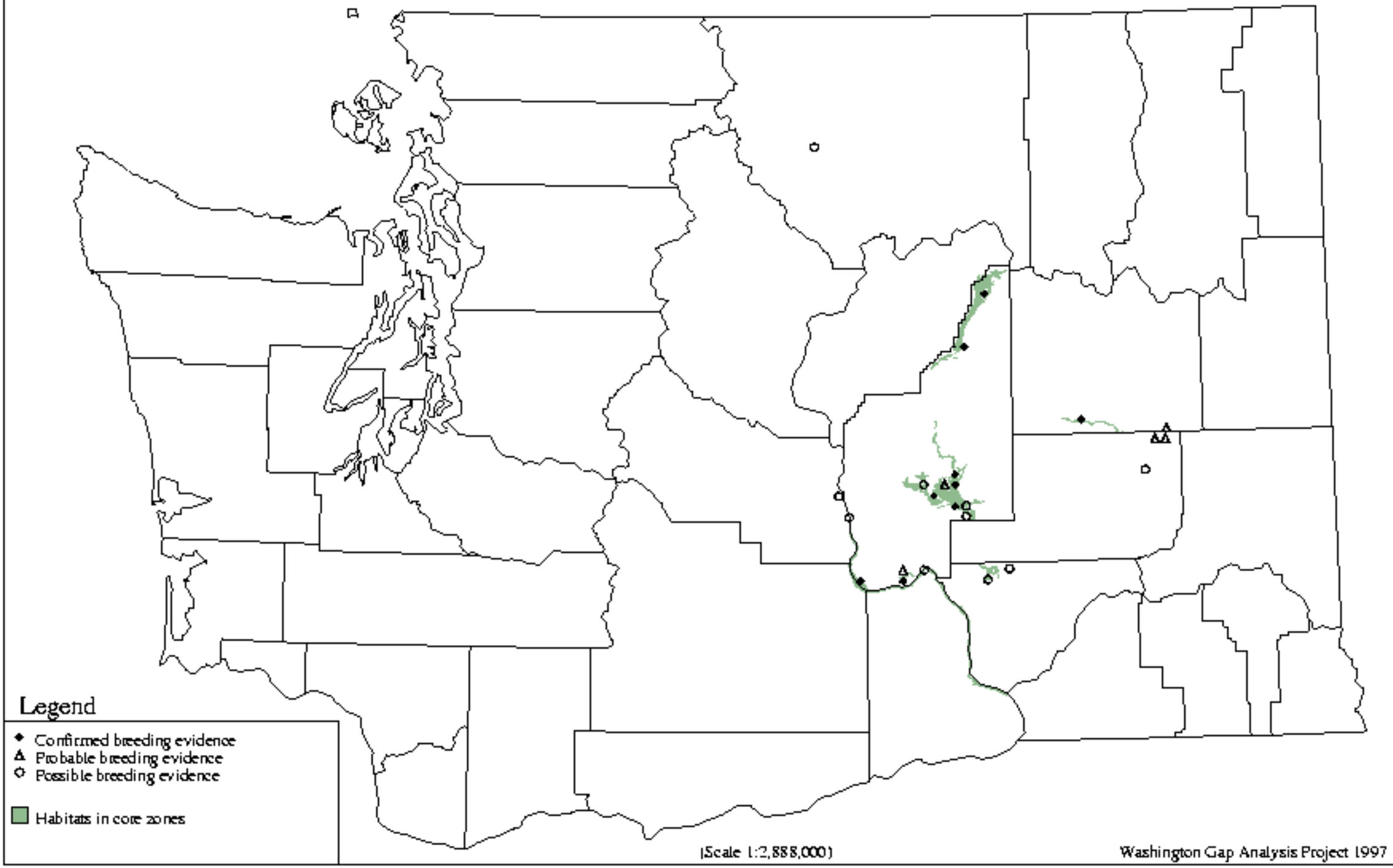
Red-necked Grebe - *Podiceps grisegena*



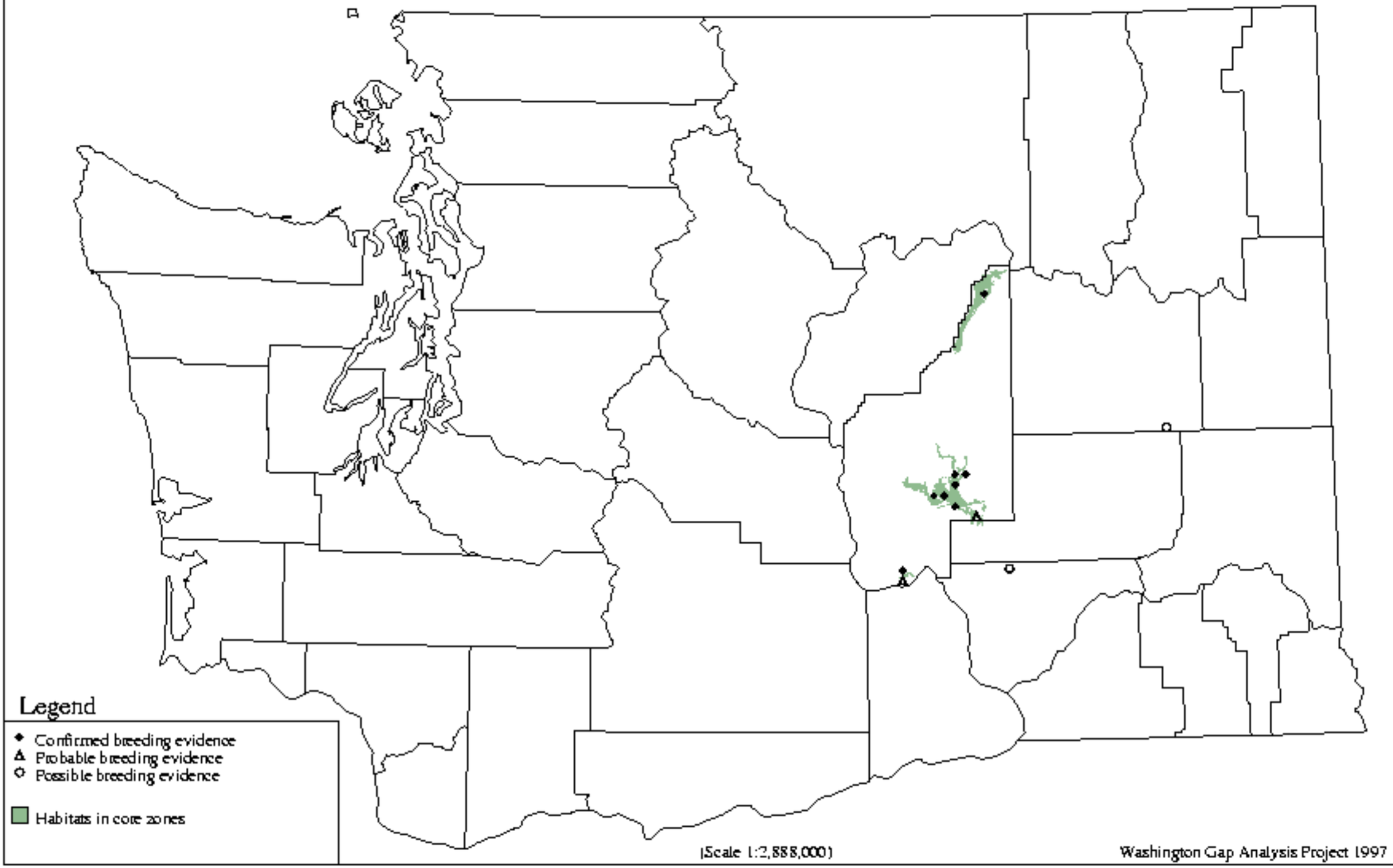
Eared Grebe - *Podiceps nigricollis*



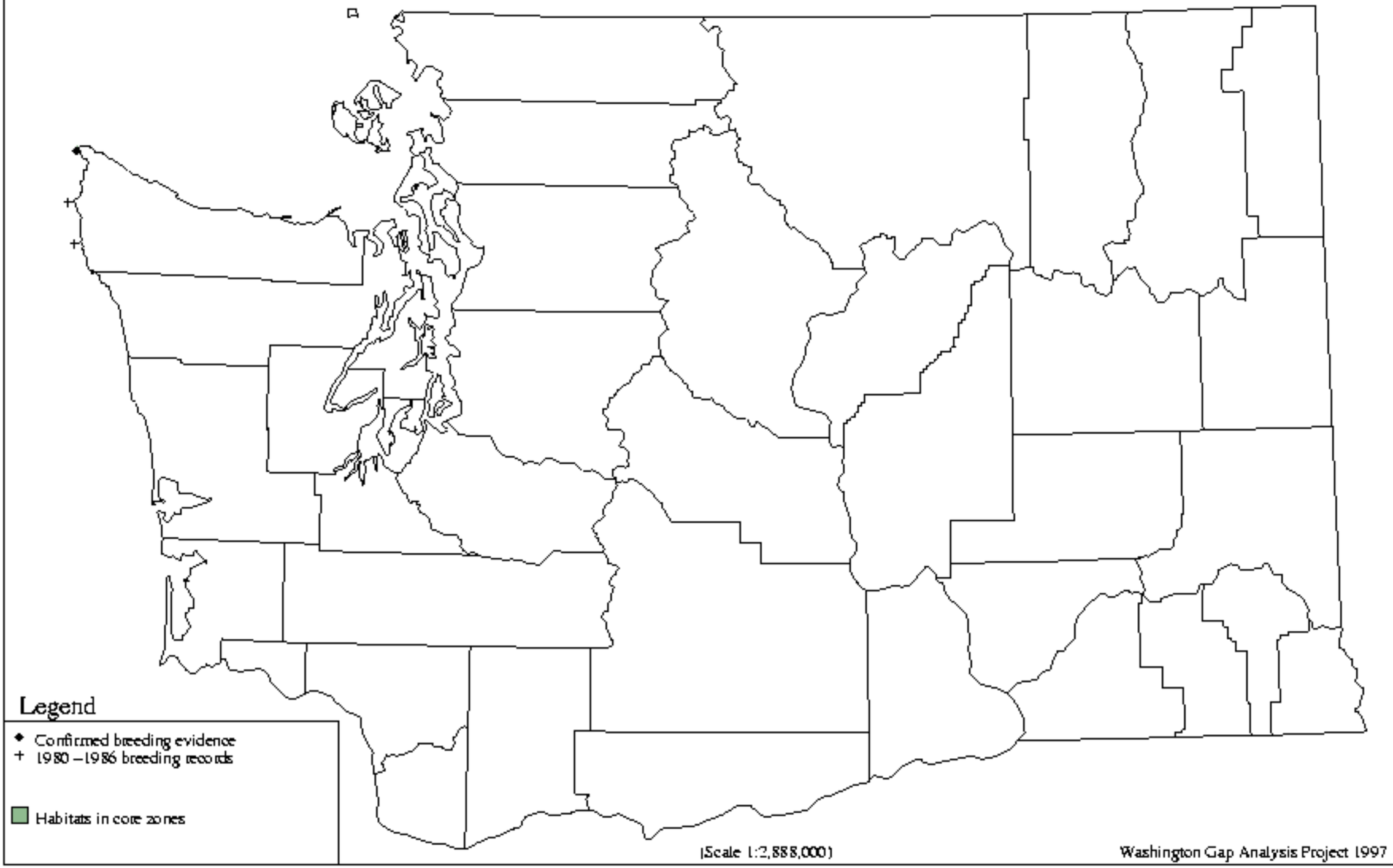
Western Grebe - *Aechmophorus occidentalis*



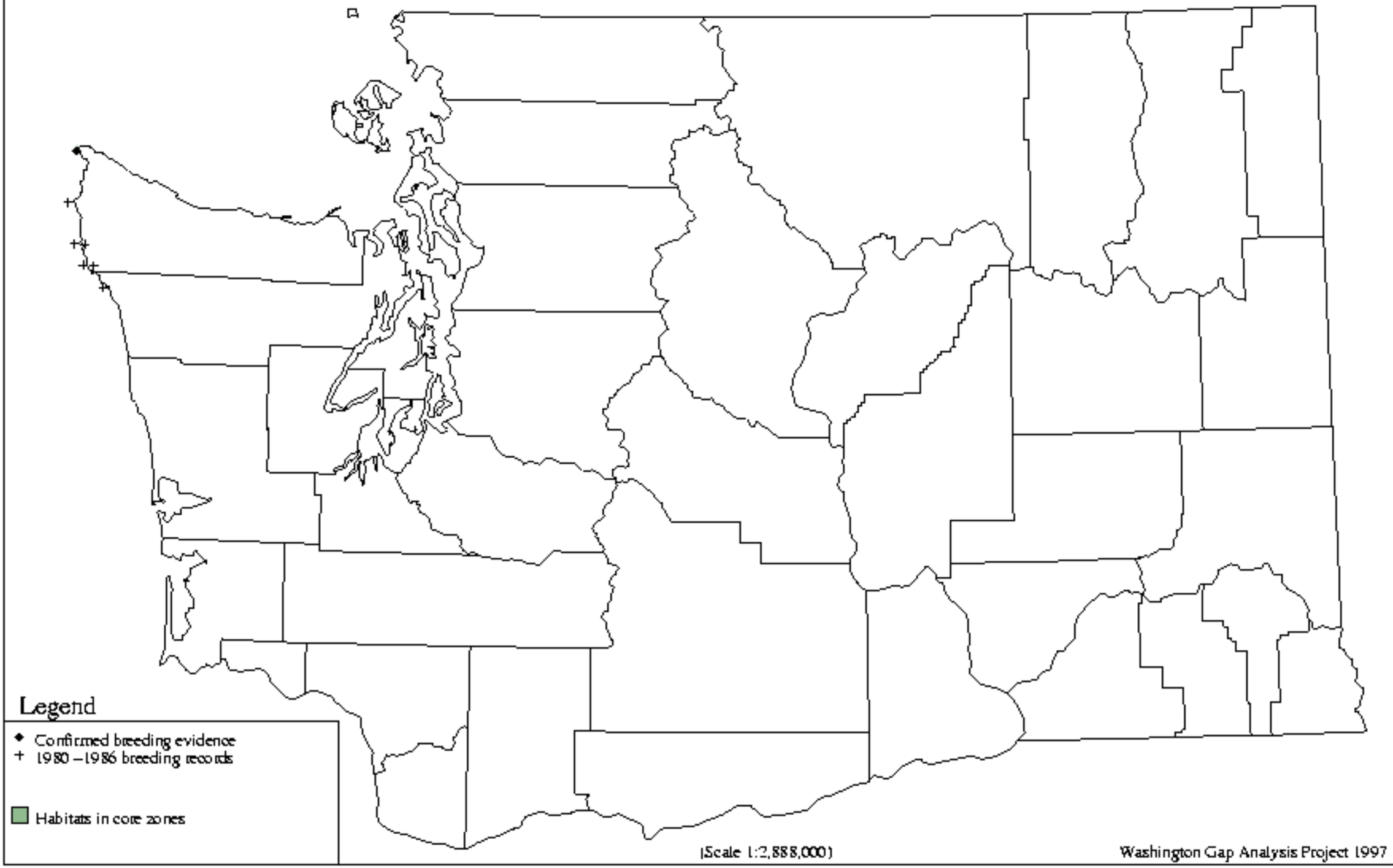
Clark`s Grebe - *Aechmophorus clarkii*



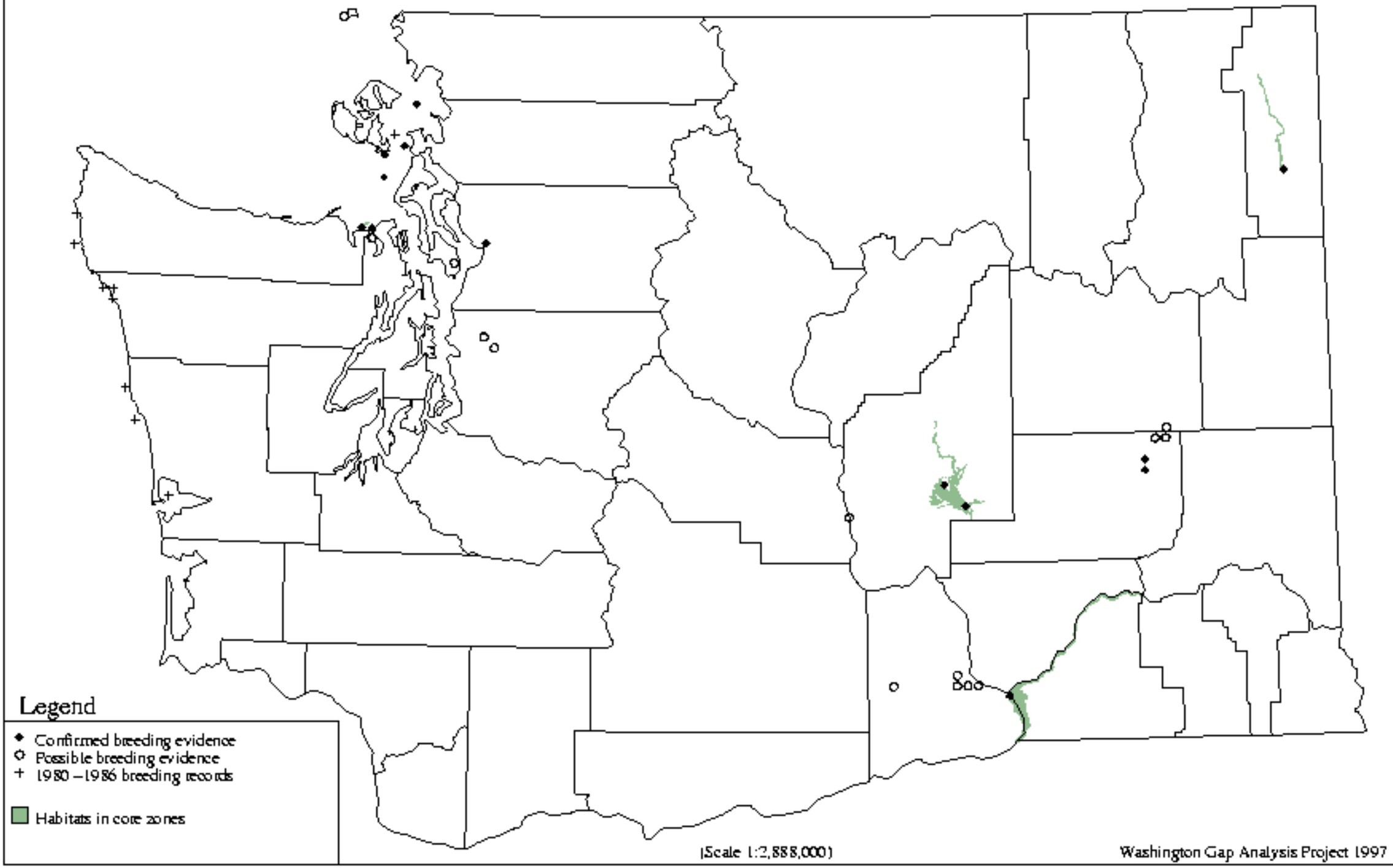
Fork-tailed Storm-Petrel - *Oceanodroma furcata*



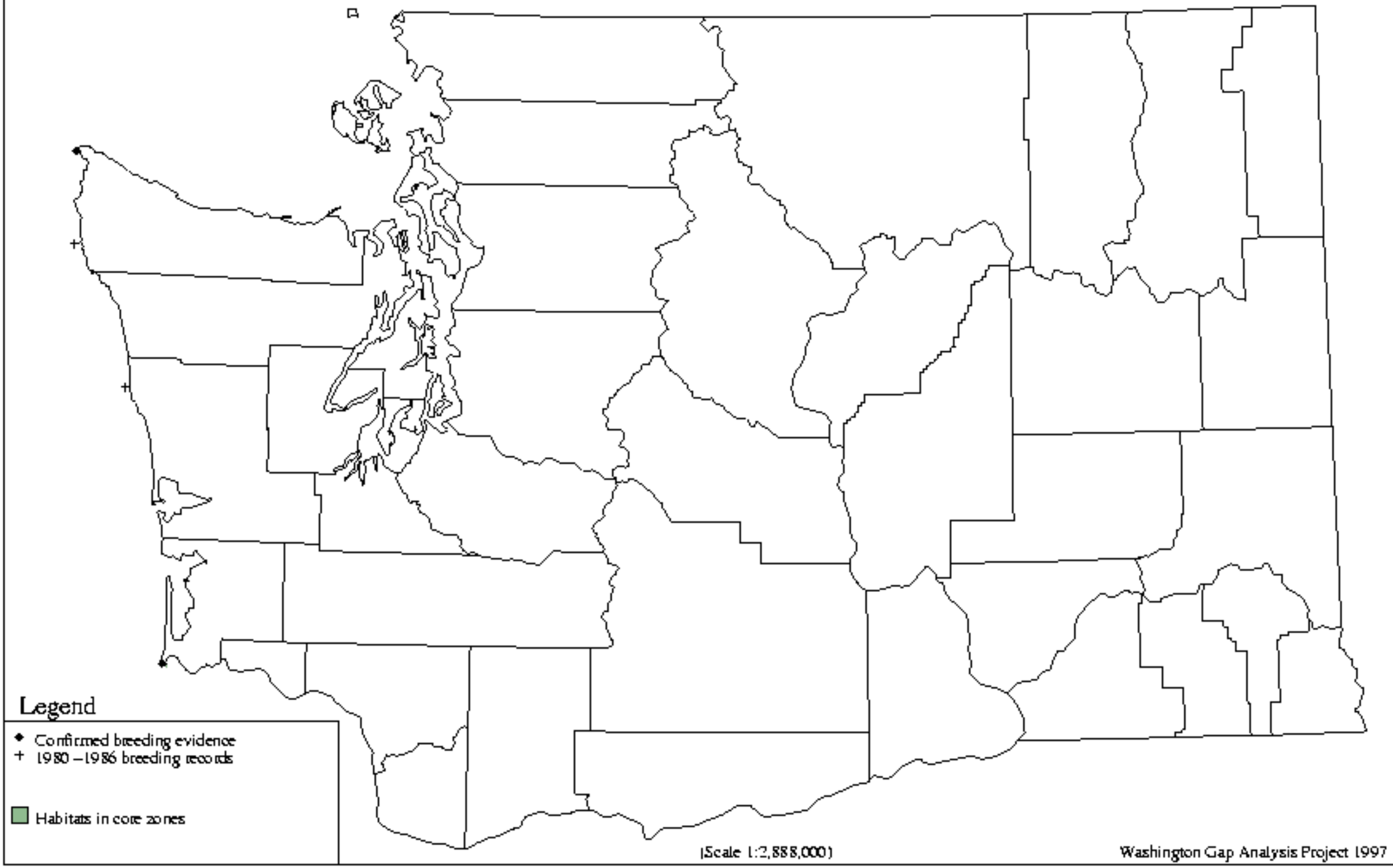
Leach`s Storm-Petrel - *Oceanodroma leucorhoa*



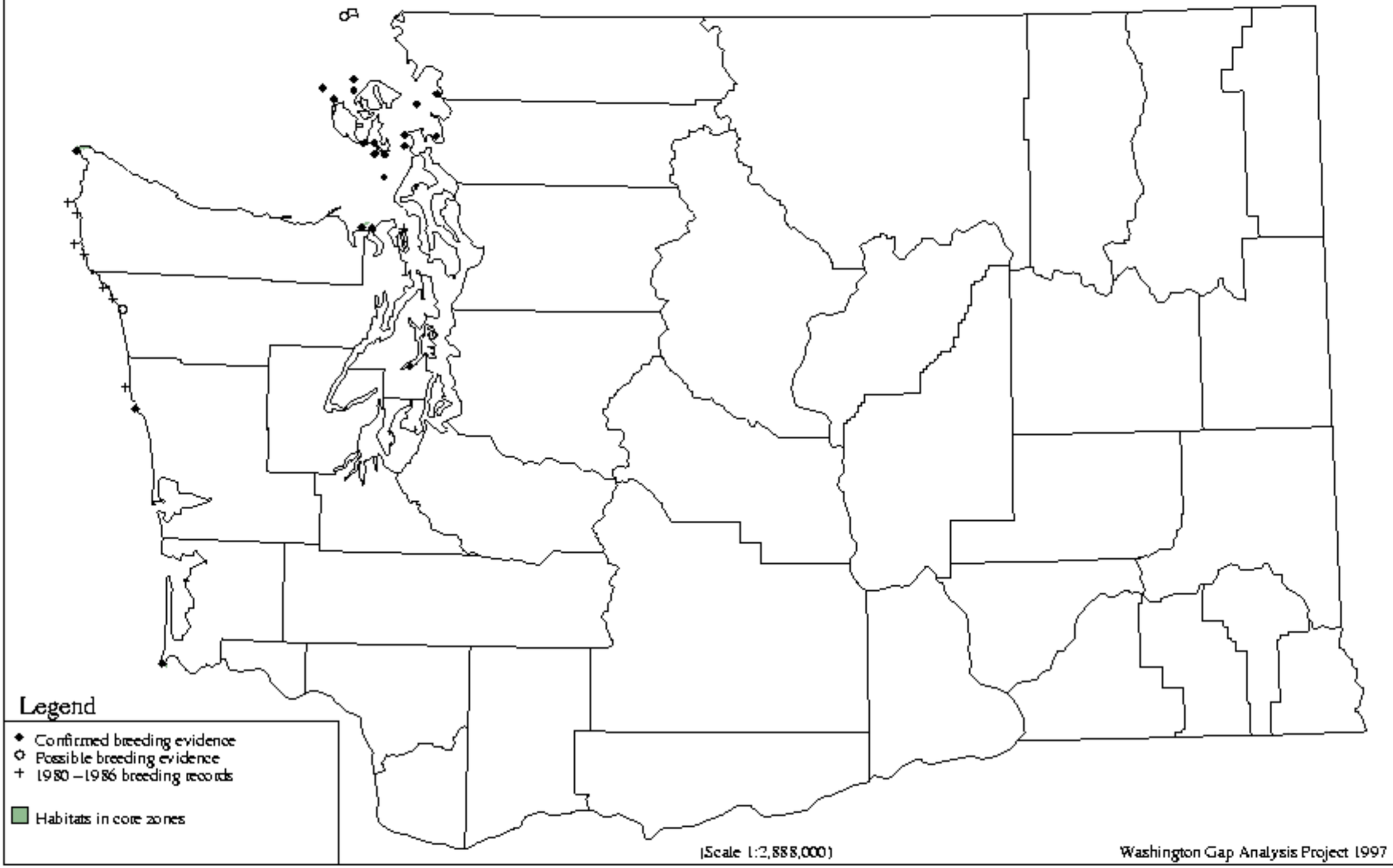
Double-crested Cormorant - *Phalacrocorax auritus*



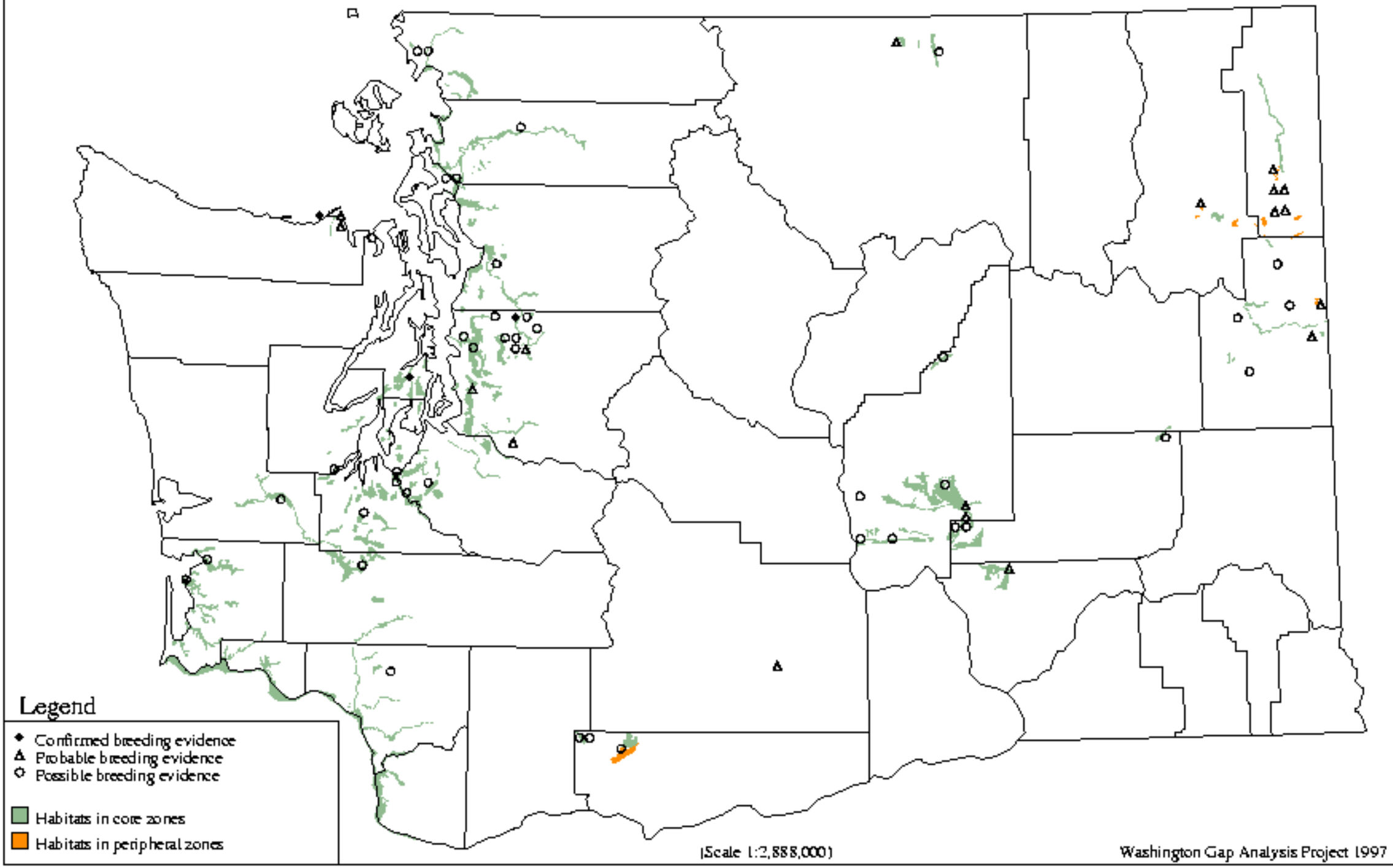
Brandt`s Cormorant - *Phalacrocorax penicillatus*



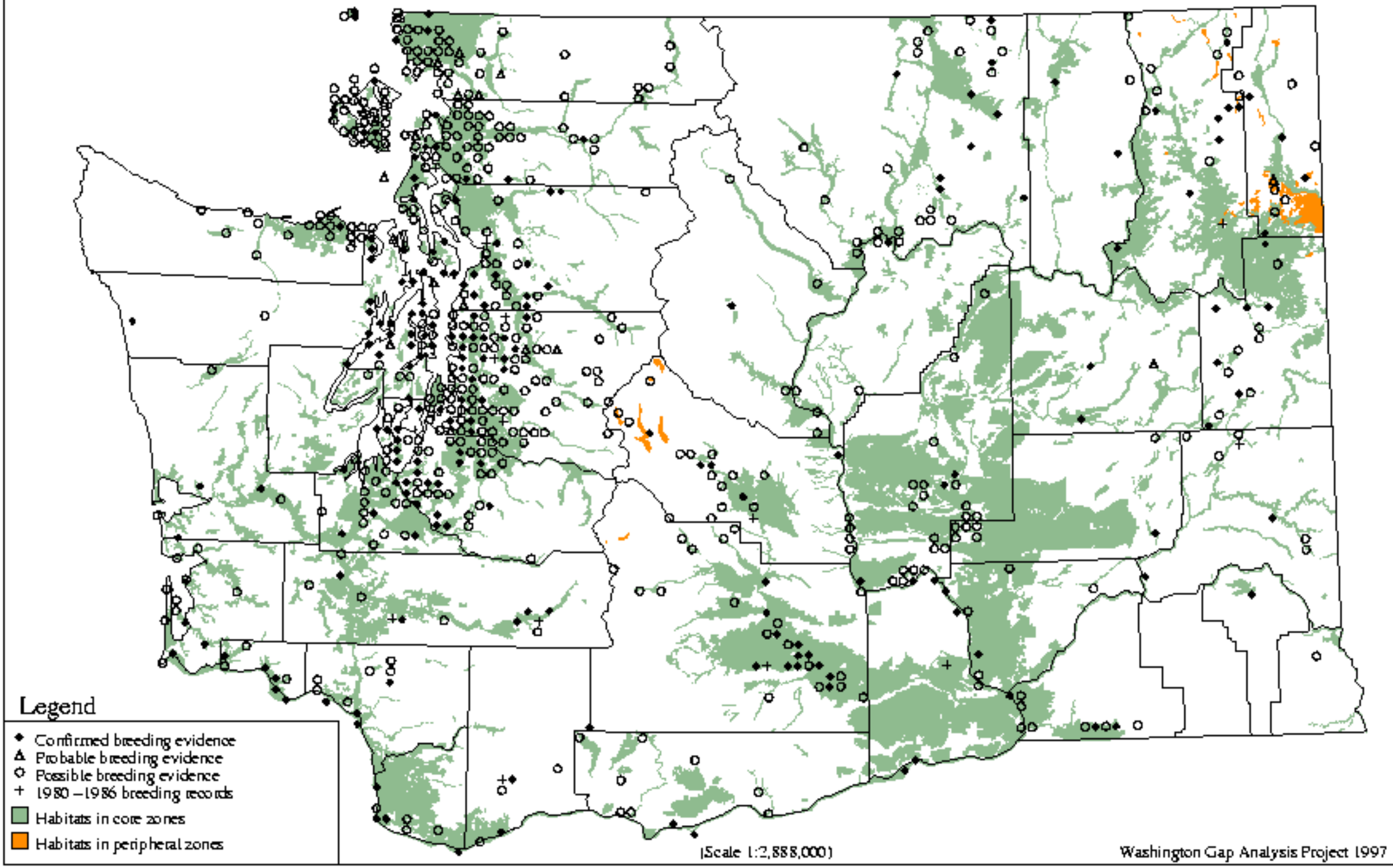
Pelagic Cormorant - *Phalacrocorax pelagicus*



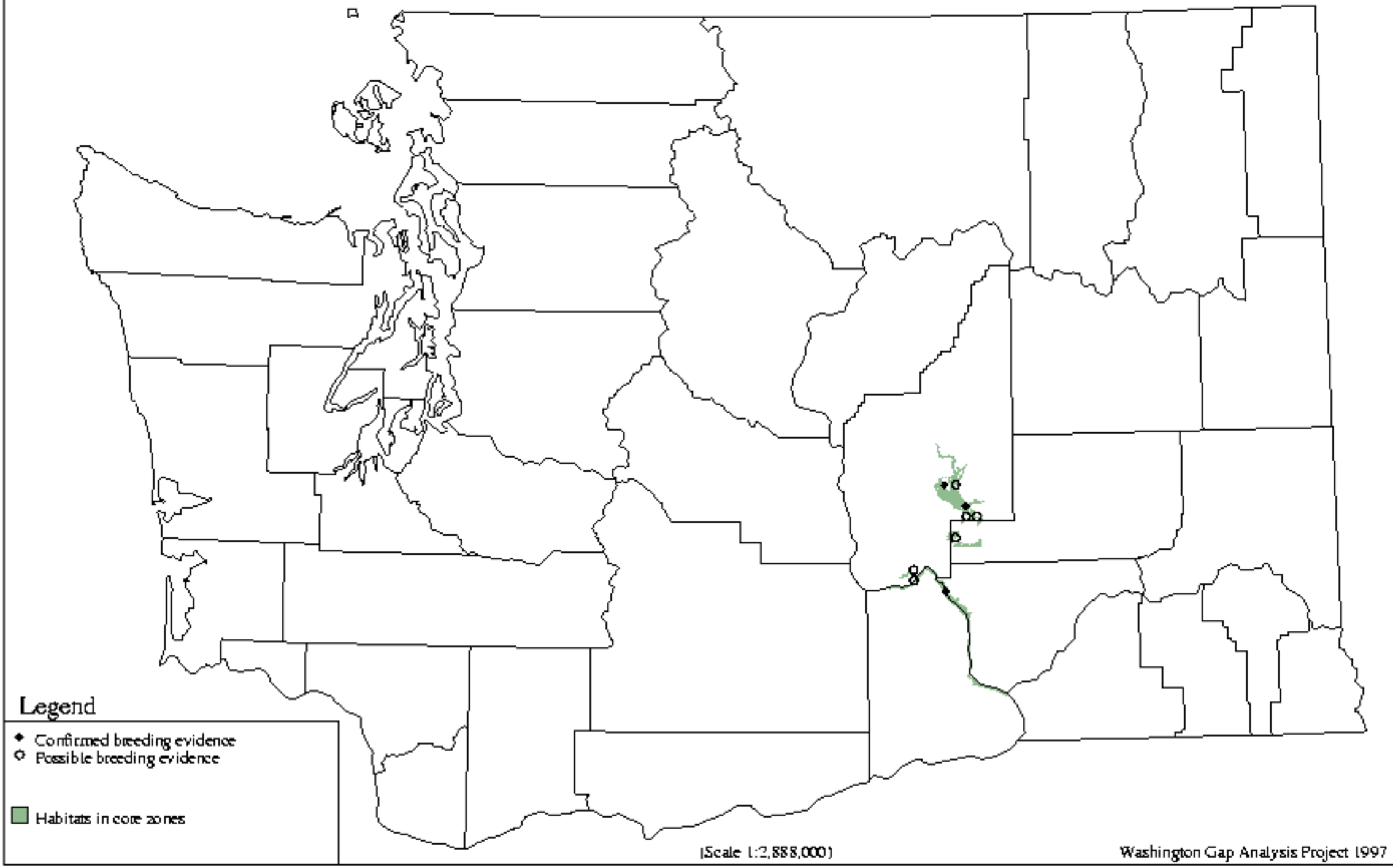
American Bittern - *Botaurus lentiginosus*



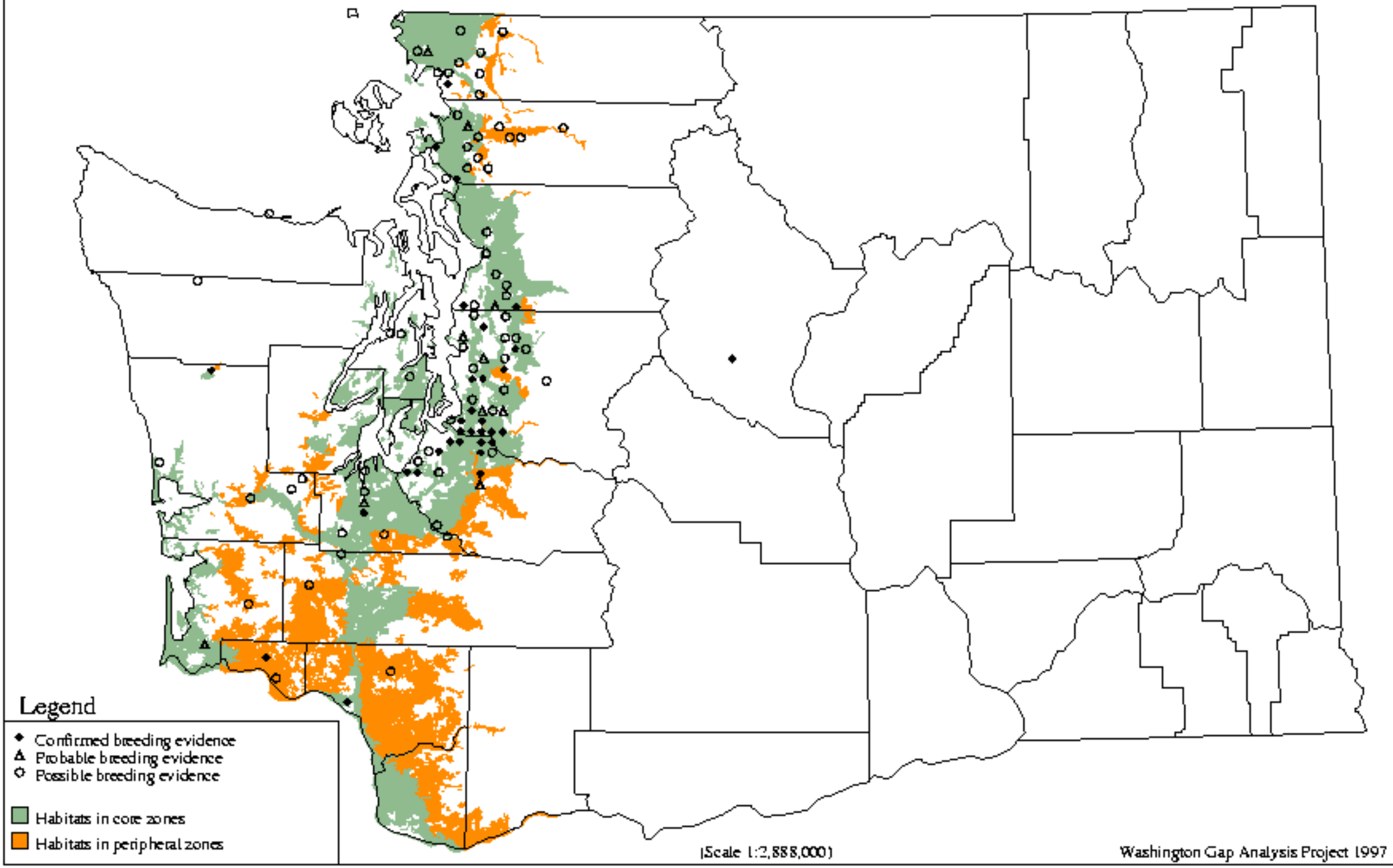
Great Blue Heron - *Ardea herodias*



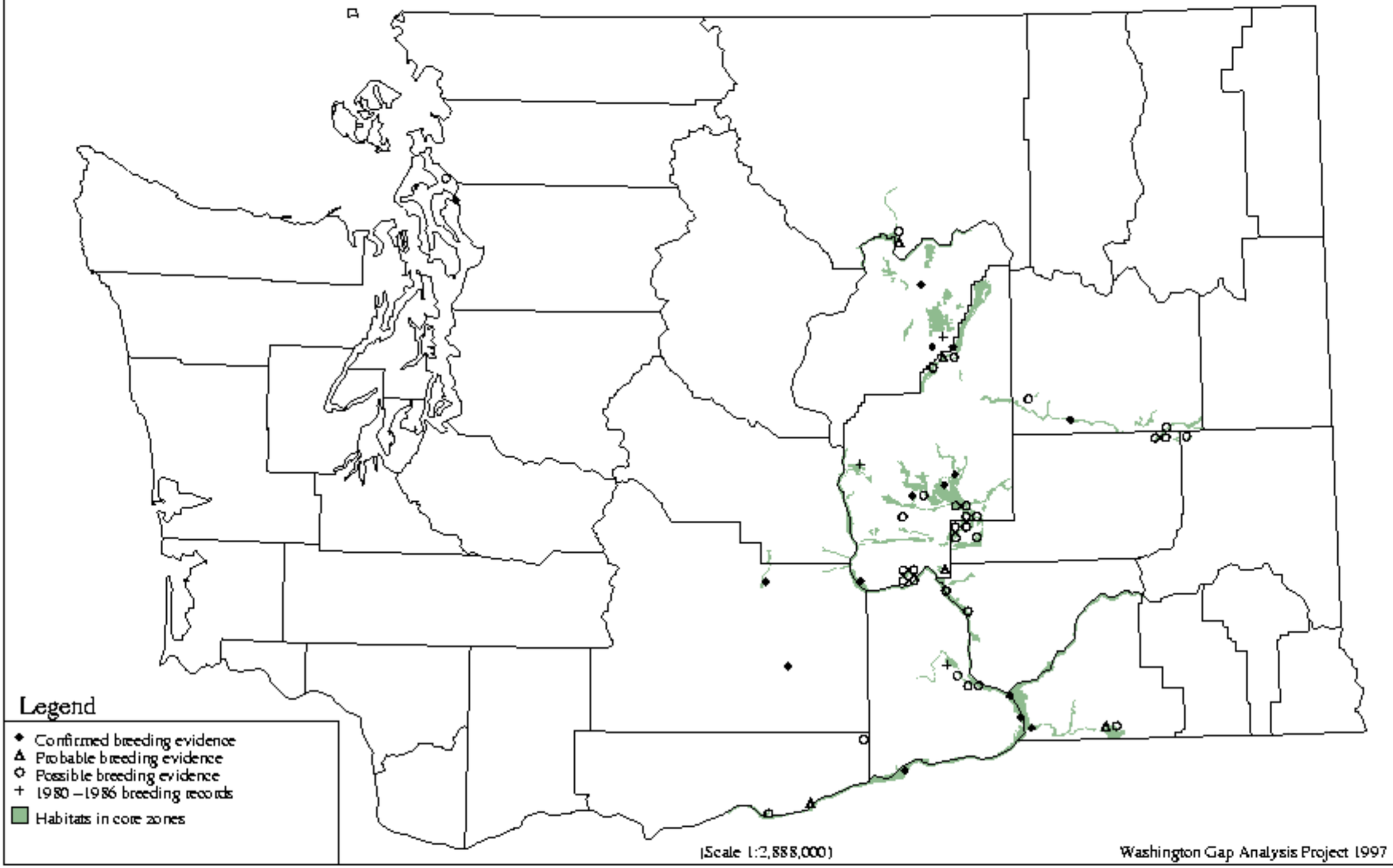
Great Egret - *Ardea alba*



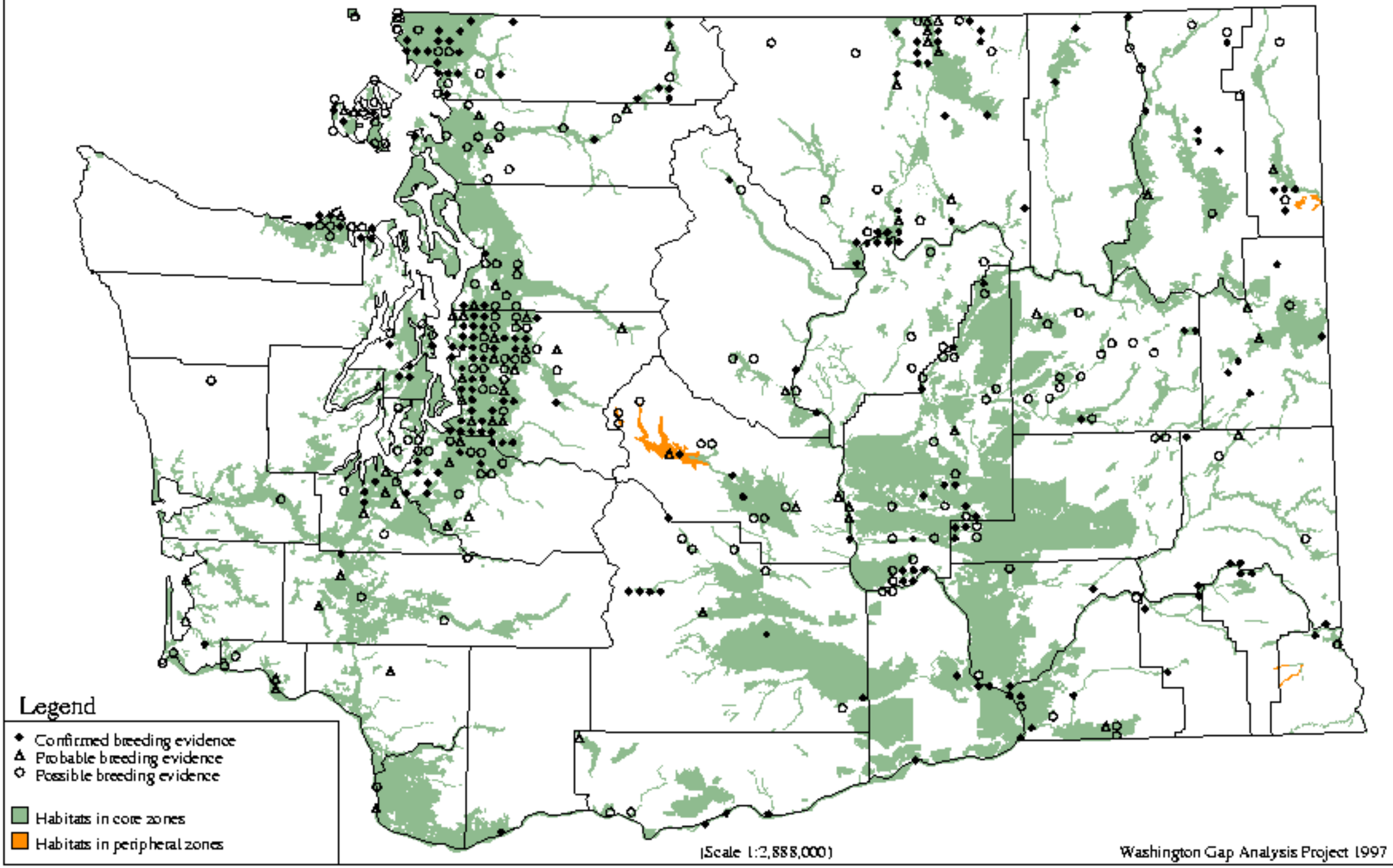
Green Heron - *Butorides virescens*



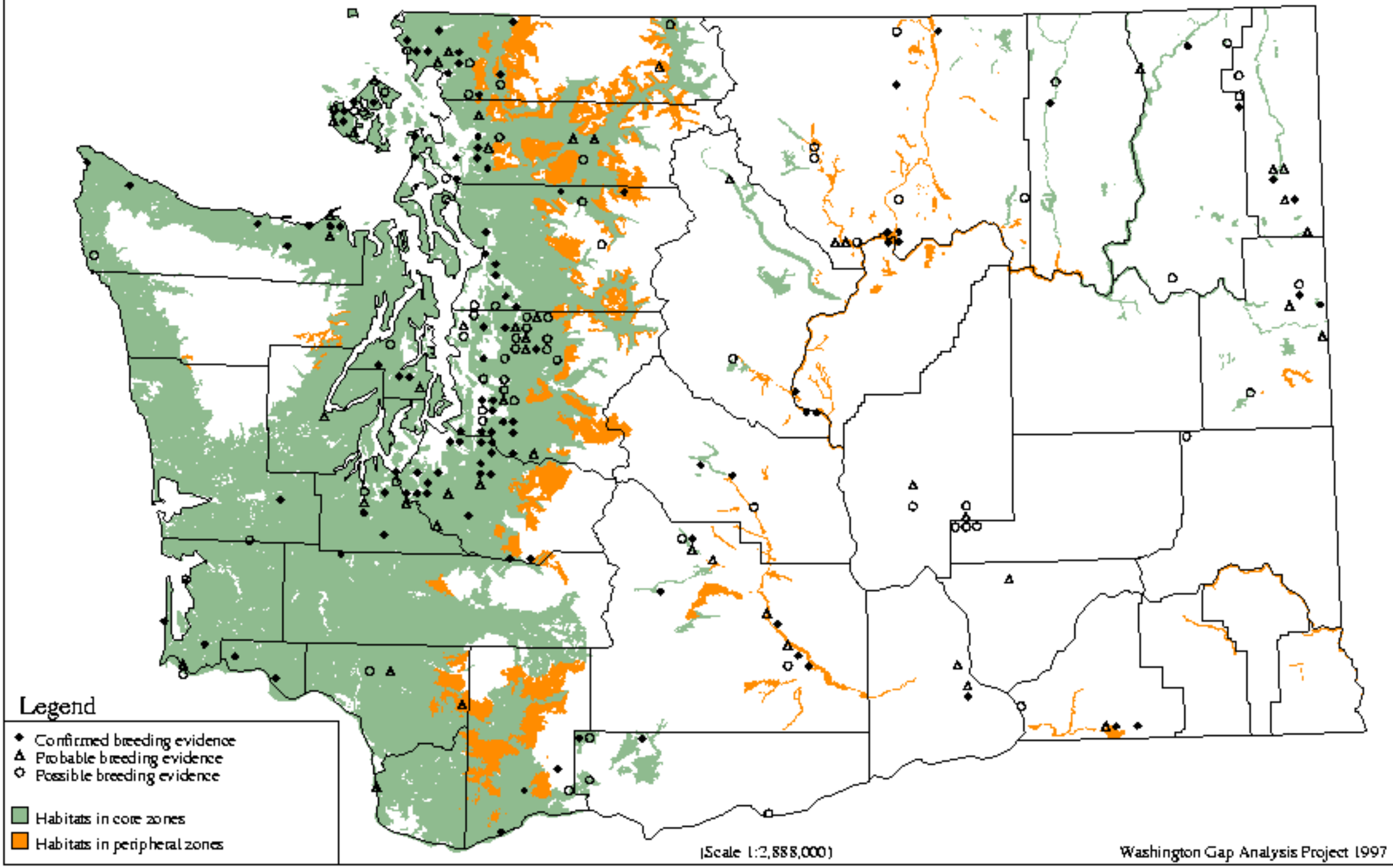
Black-crowned Night-Heron - *Nycticorax nycticorax*



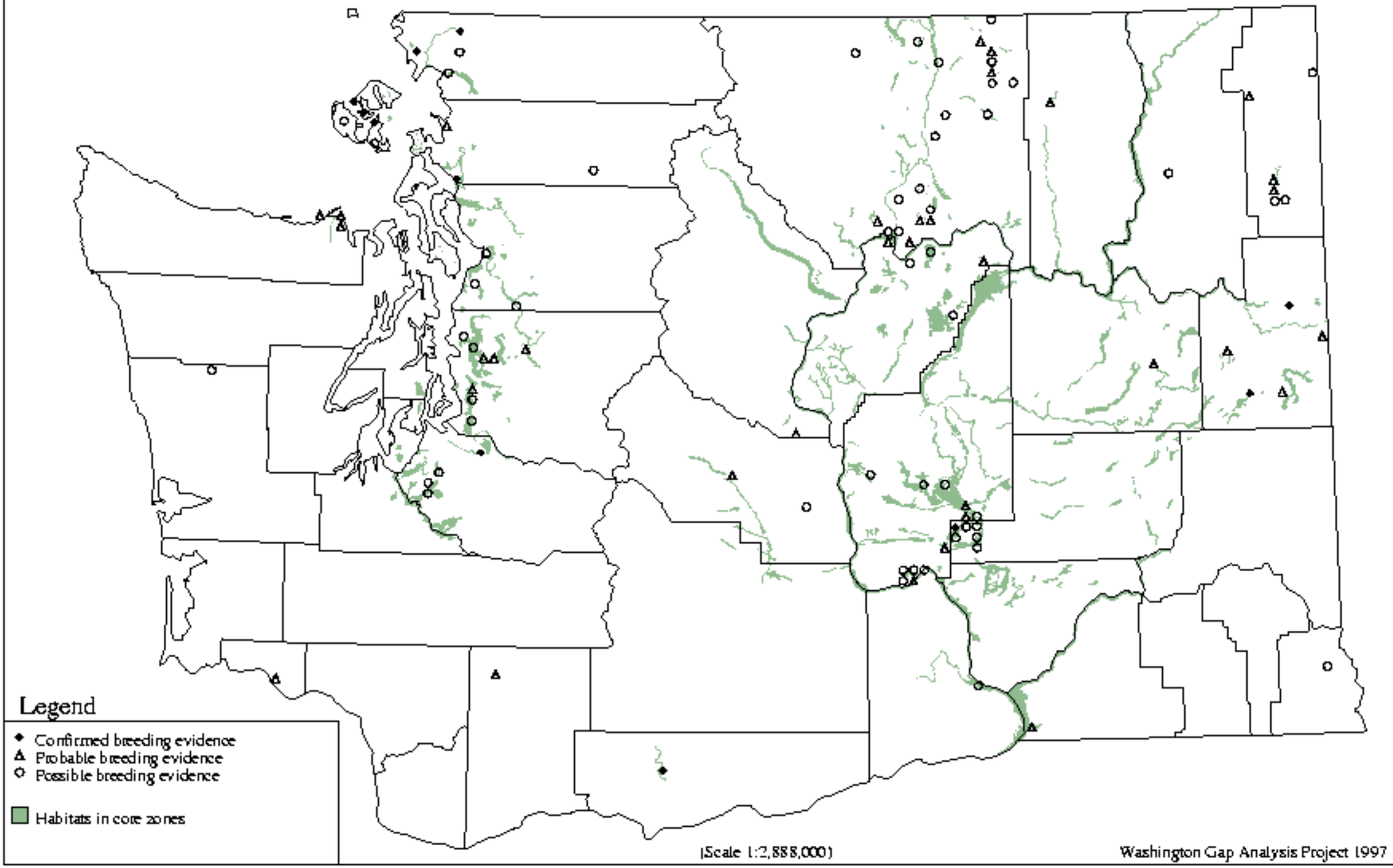
Canada Goose - *Branta canadensis*



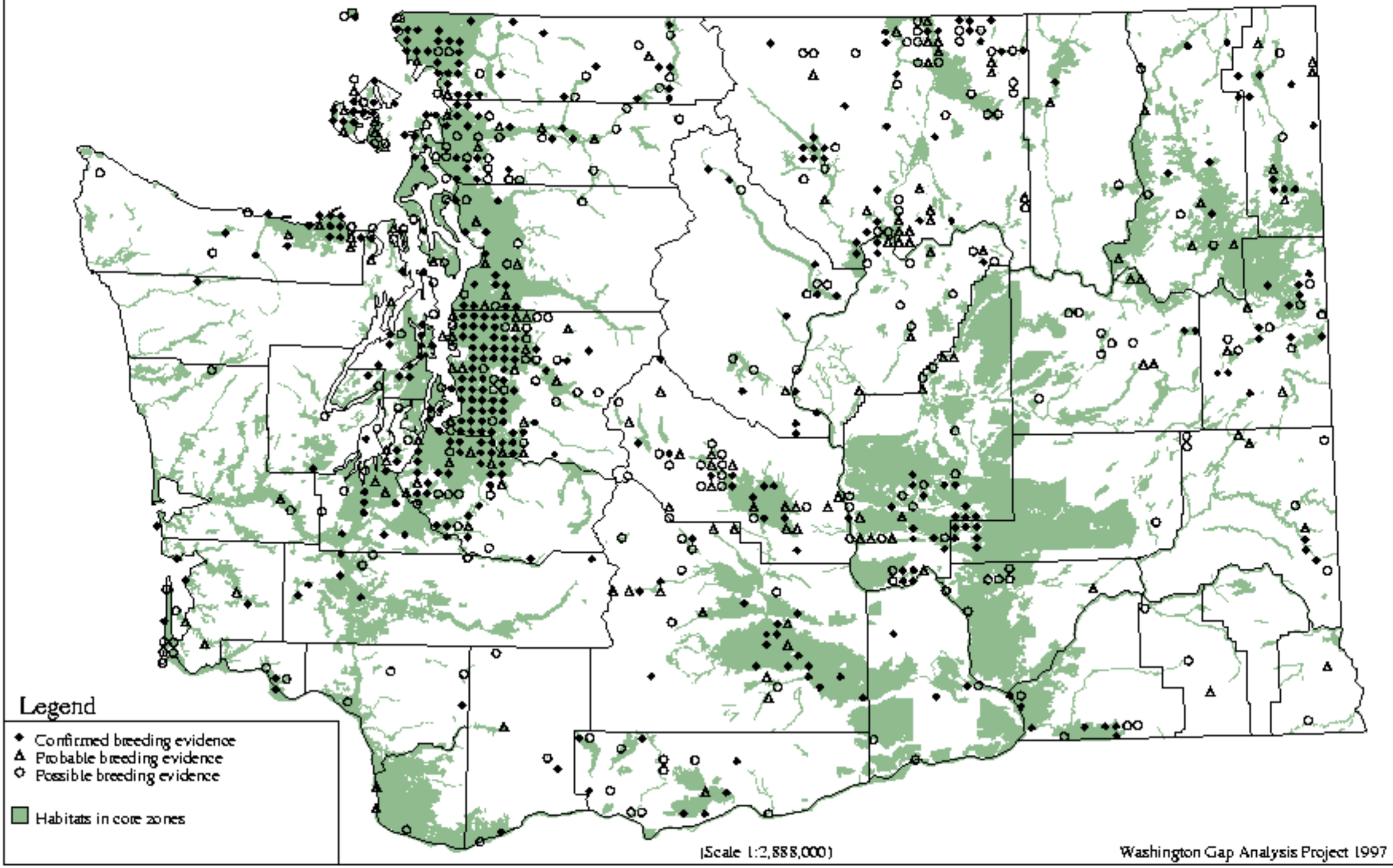
Wood Duck - *Aix sponsa*



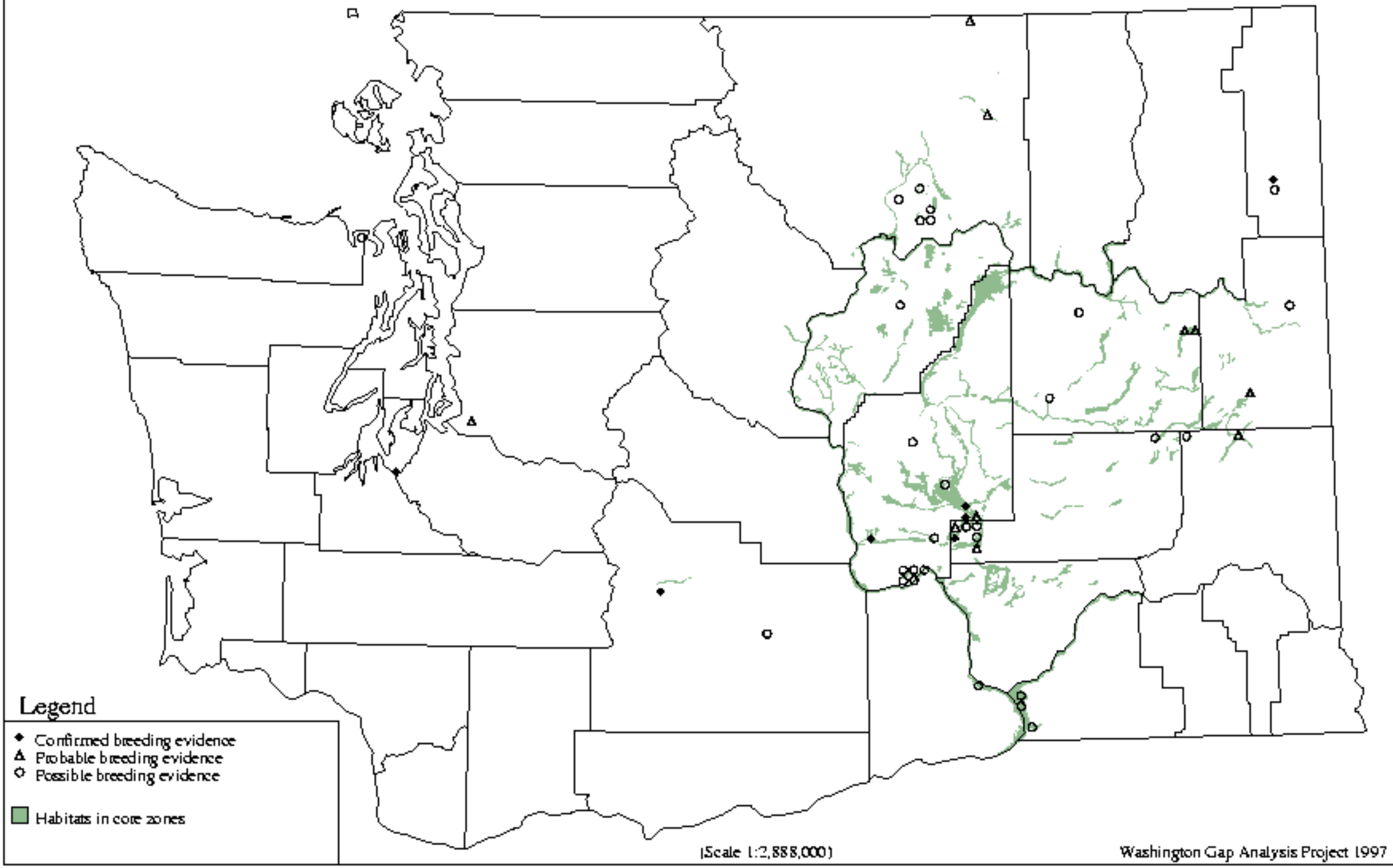
Green-winged Teal - *Anas crecca*



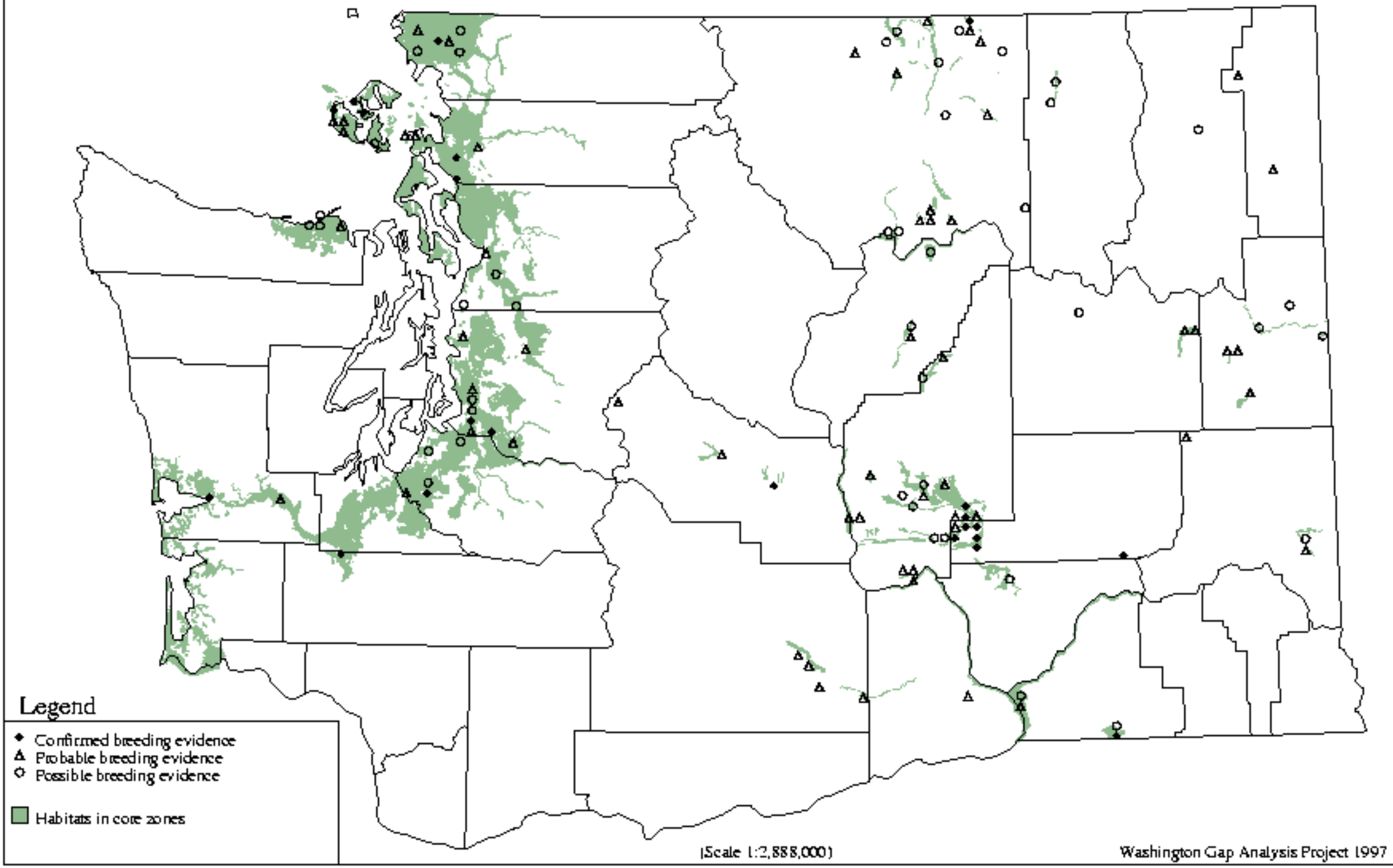
Mallard - *Anas platyrhynchos*



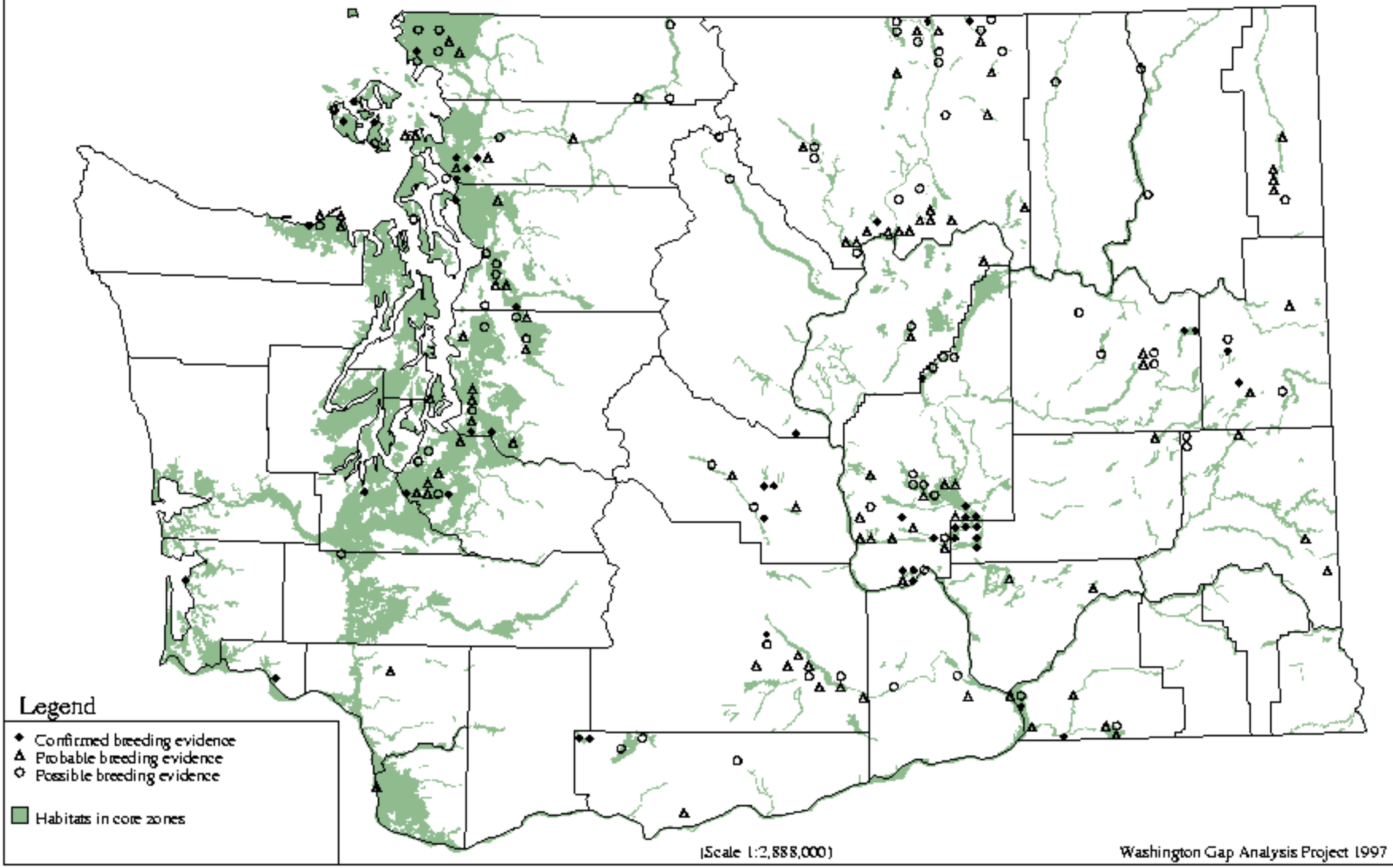
Northern Pintail - *Anas acuta*



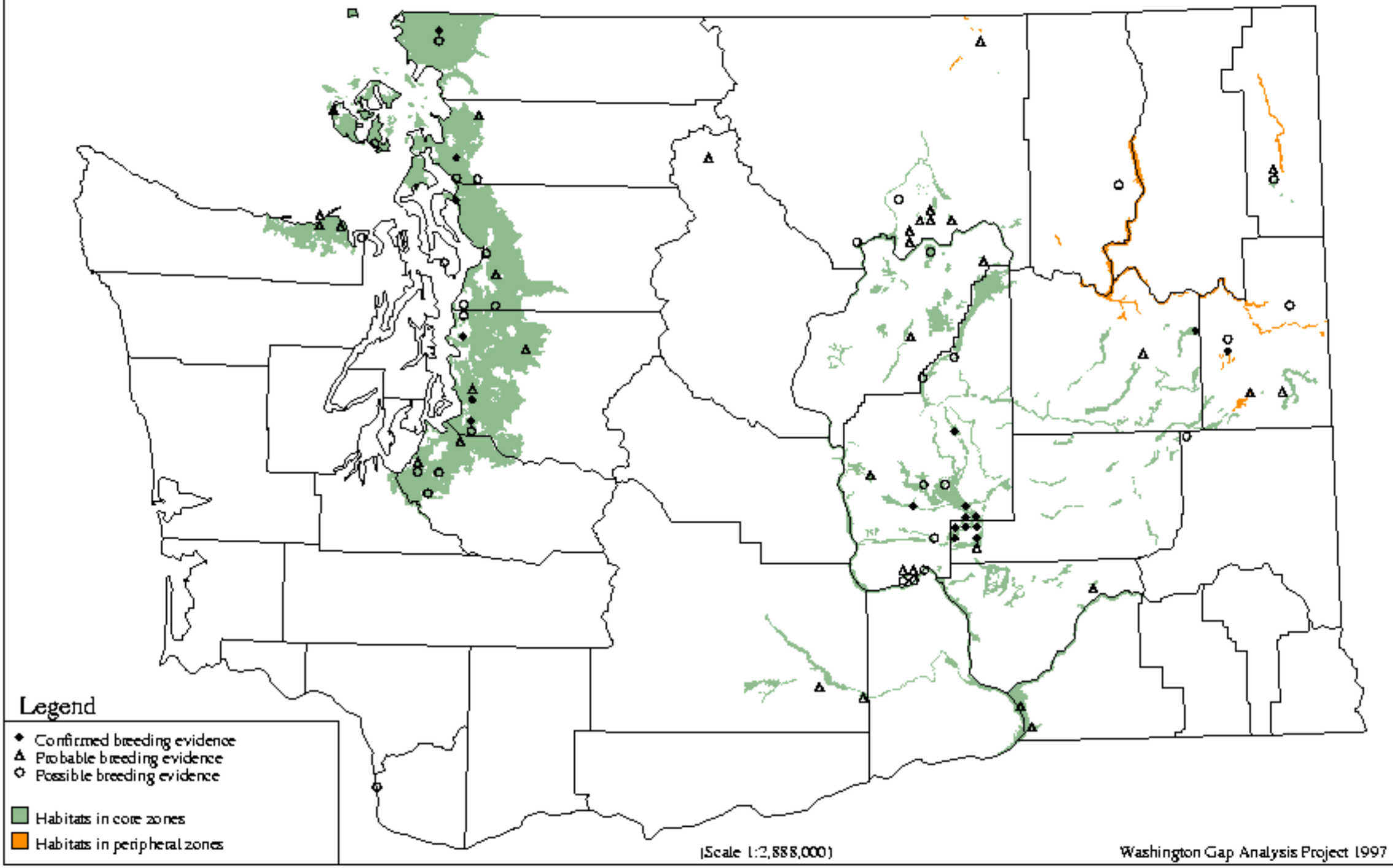
Blue-winged Teal - *Anas discors*



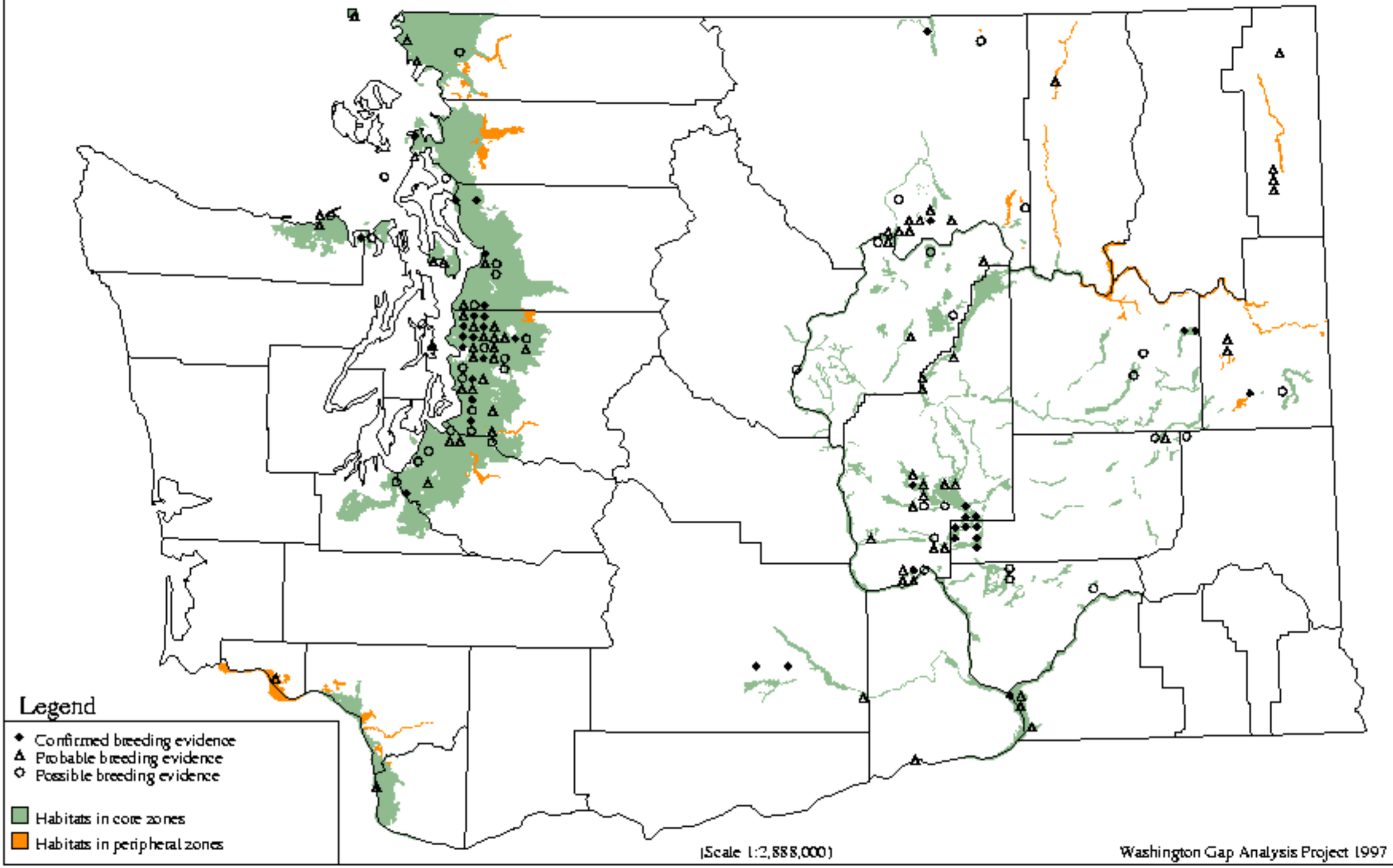
Cinnamon Teal - *Anas cyanoptera*



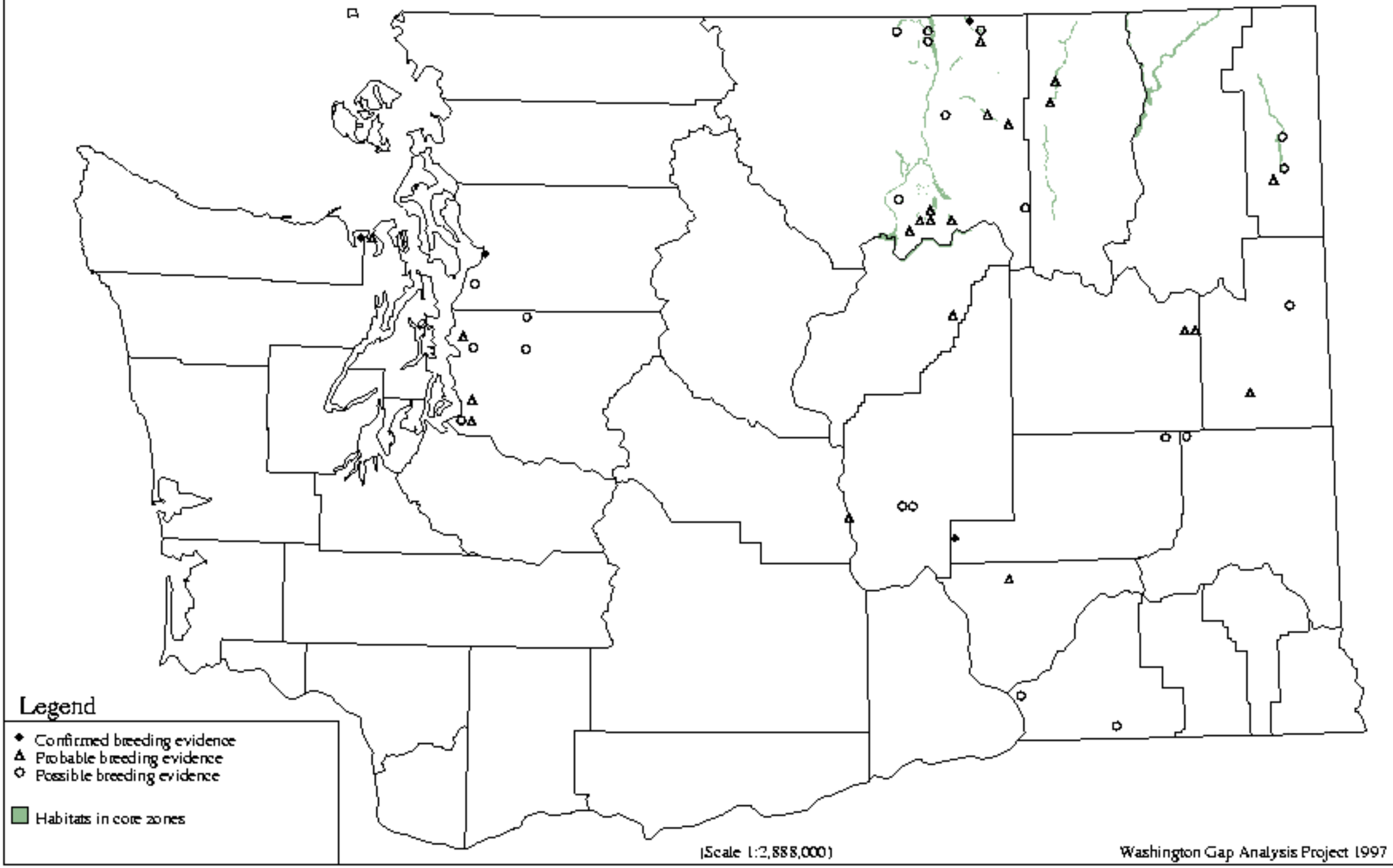
Northern Shoveler - *Anas clypeata*



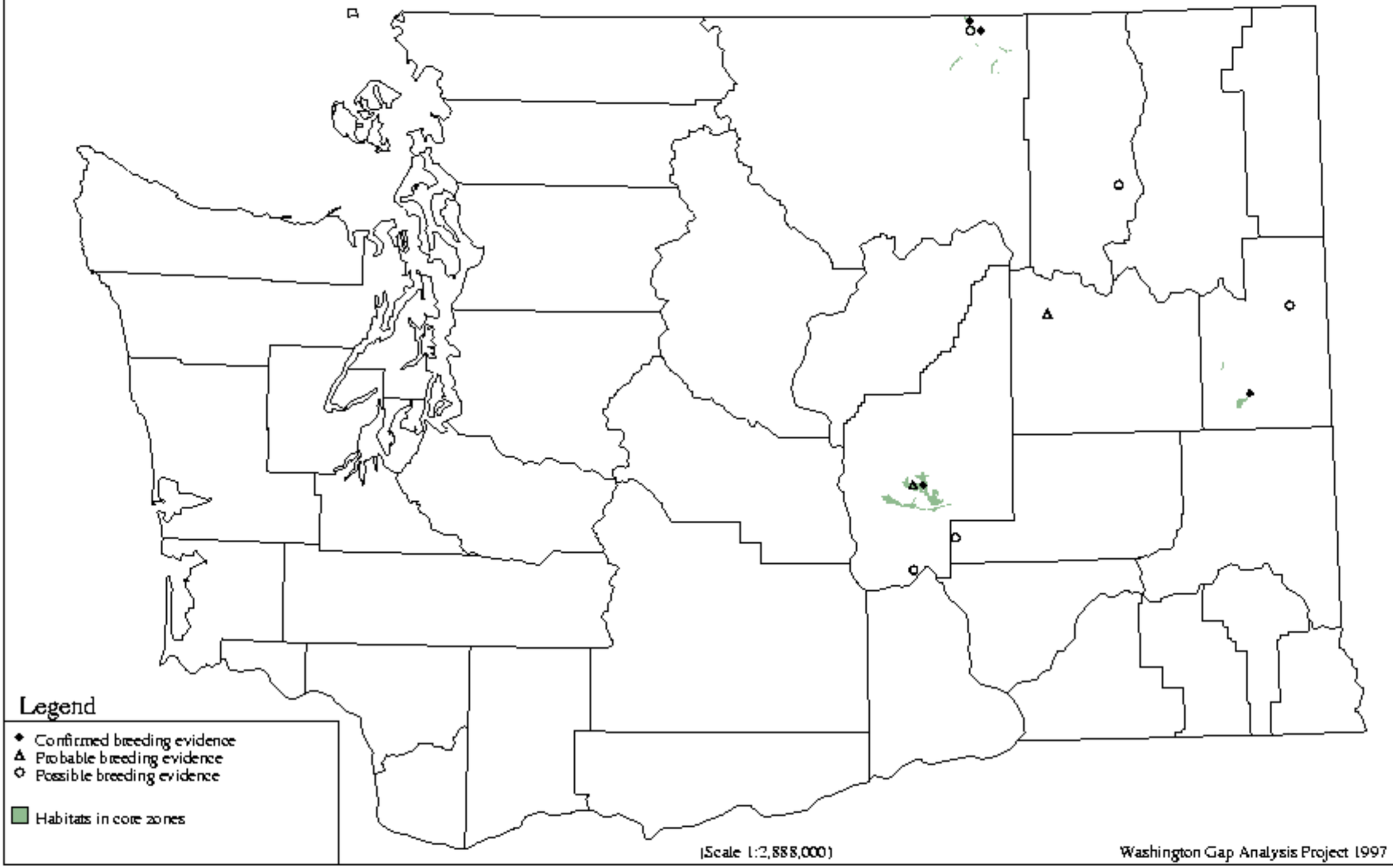
Gadwall - *Anas strepera*



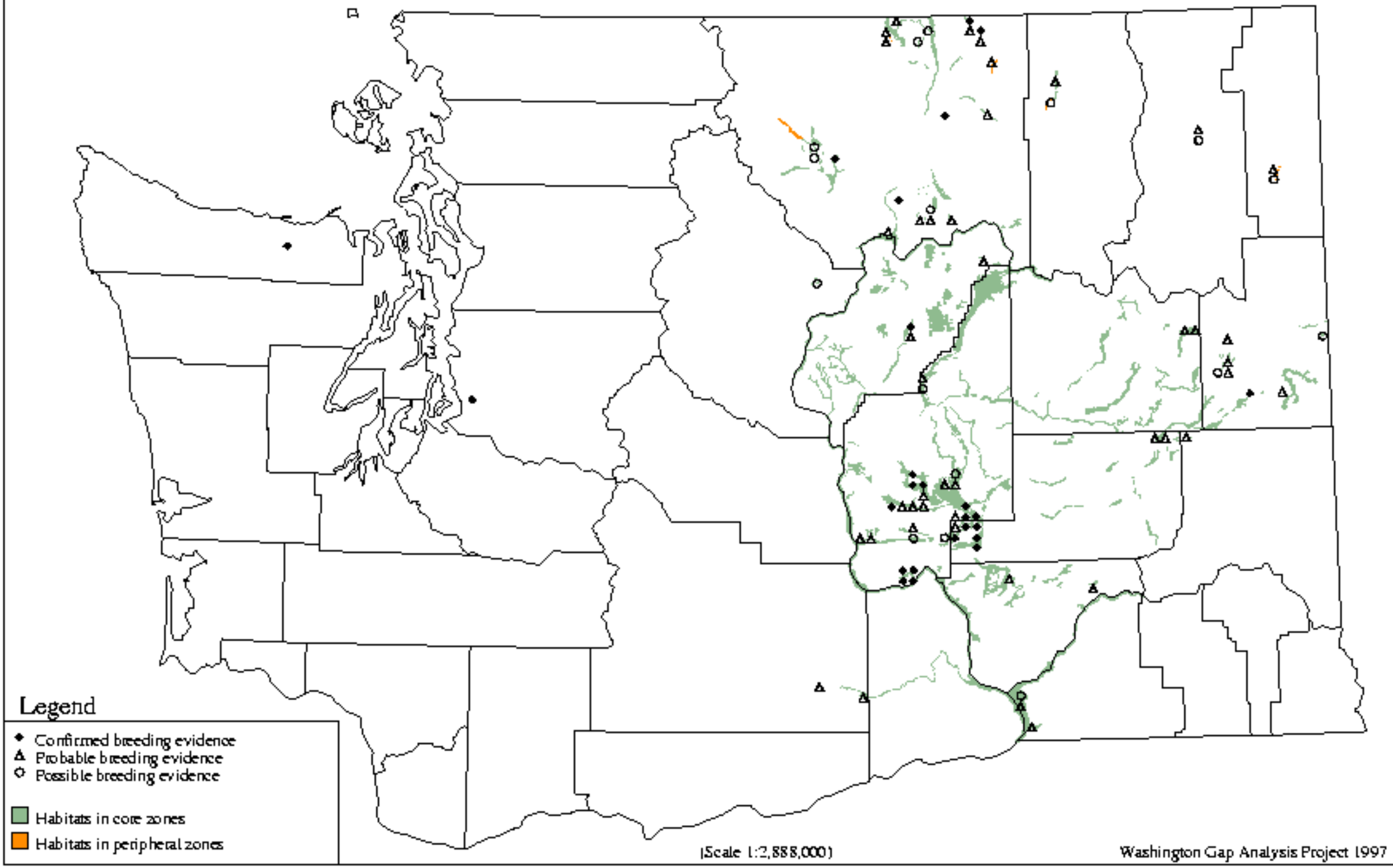
American Wigeon - *Anas americana*



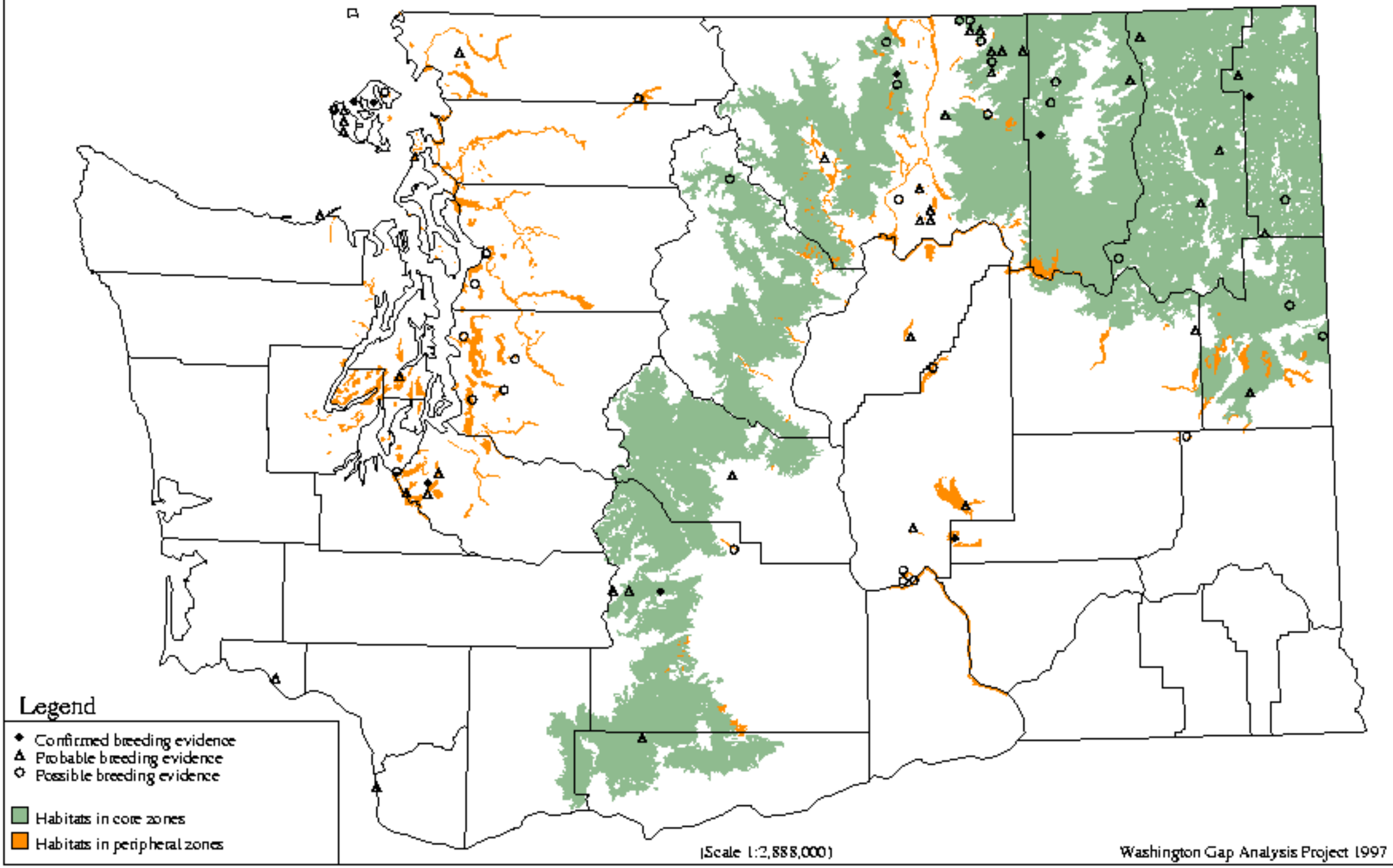
Canvasback - *Aythya valisineria*



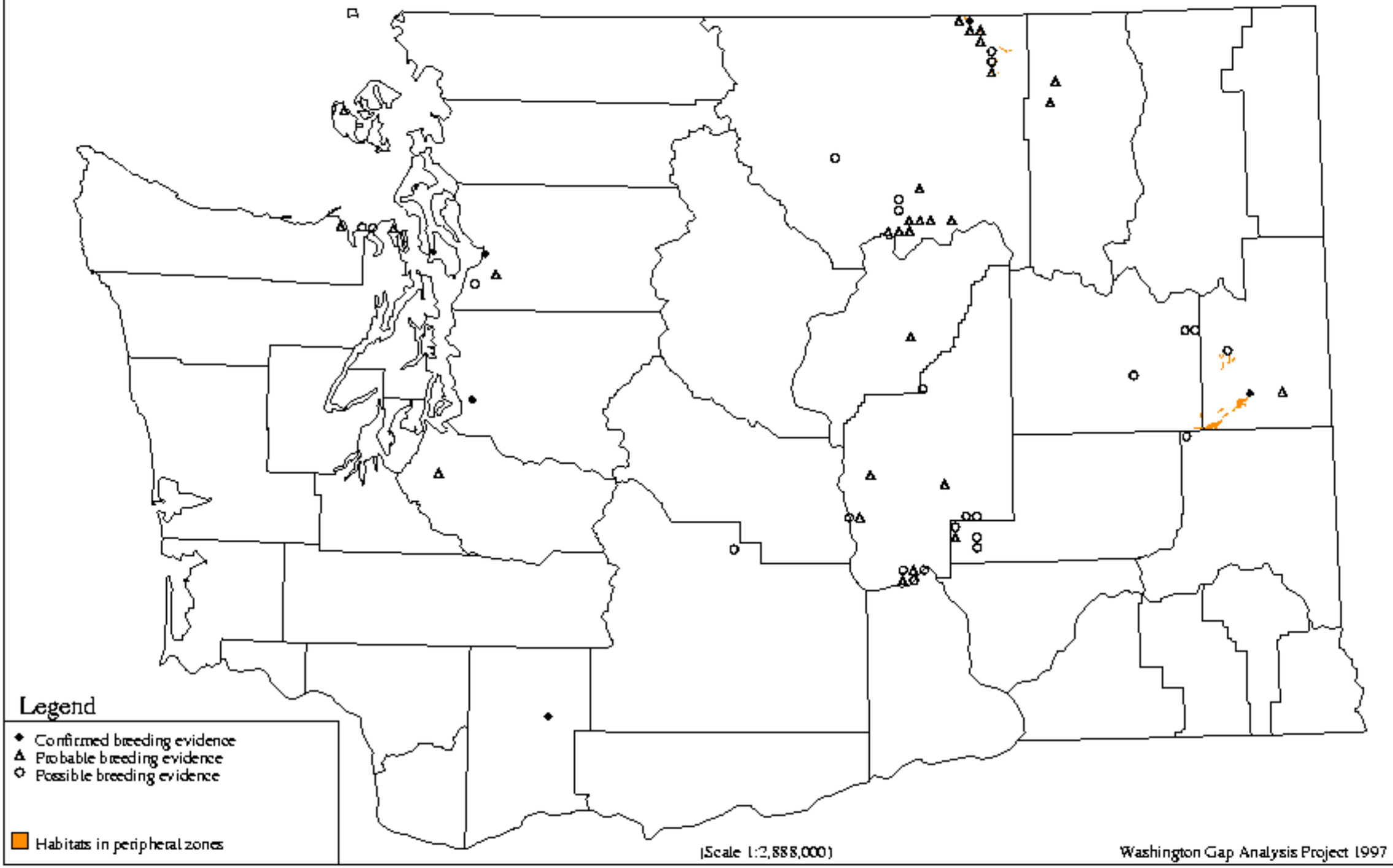
Redhead - *Aythya americana*



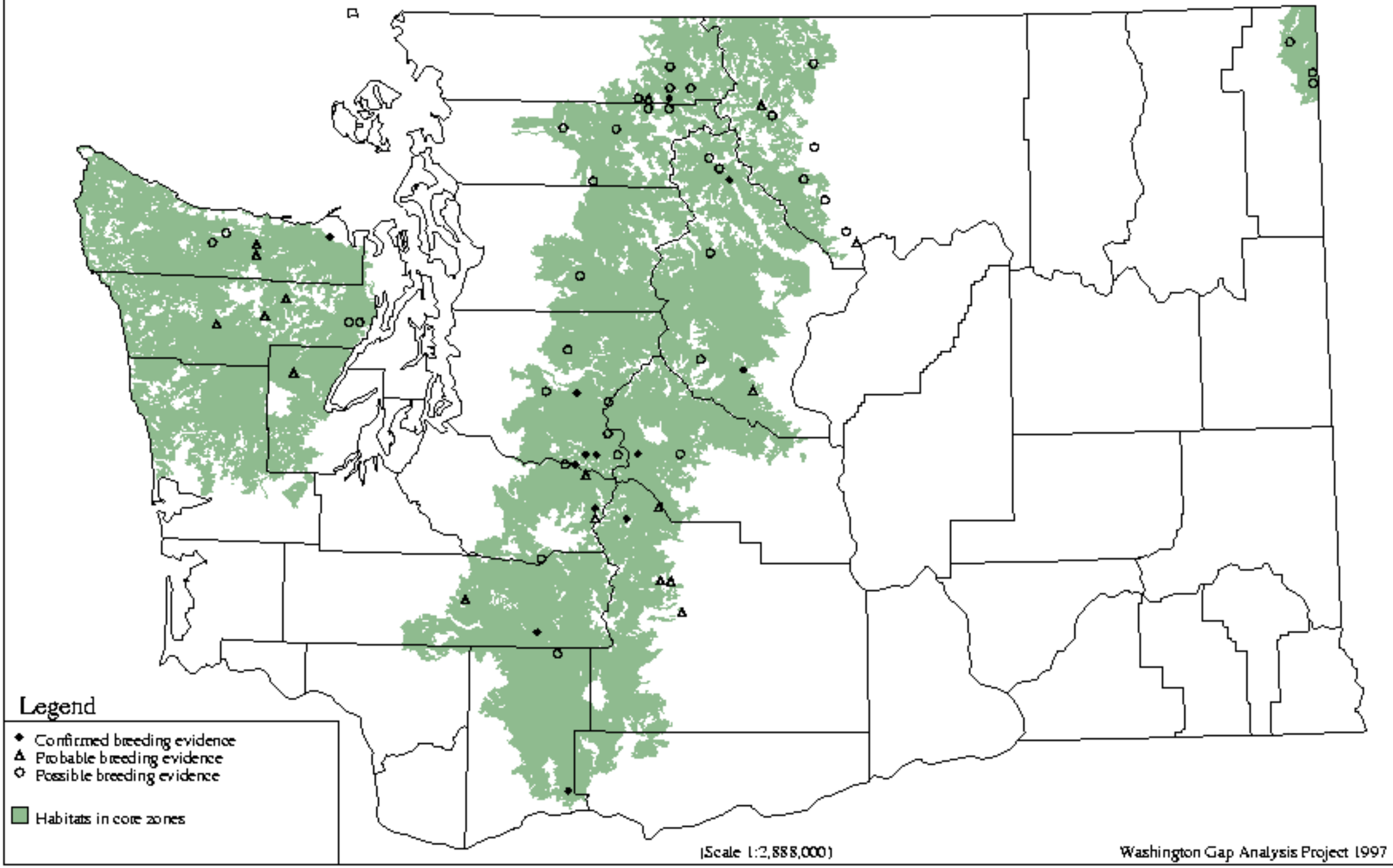
Ring-necked Duck - *Aythya collaris*



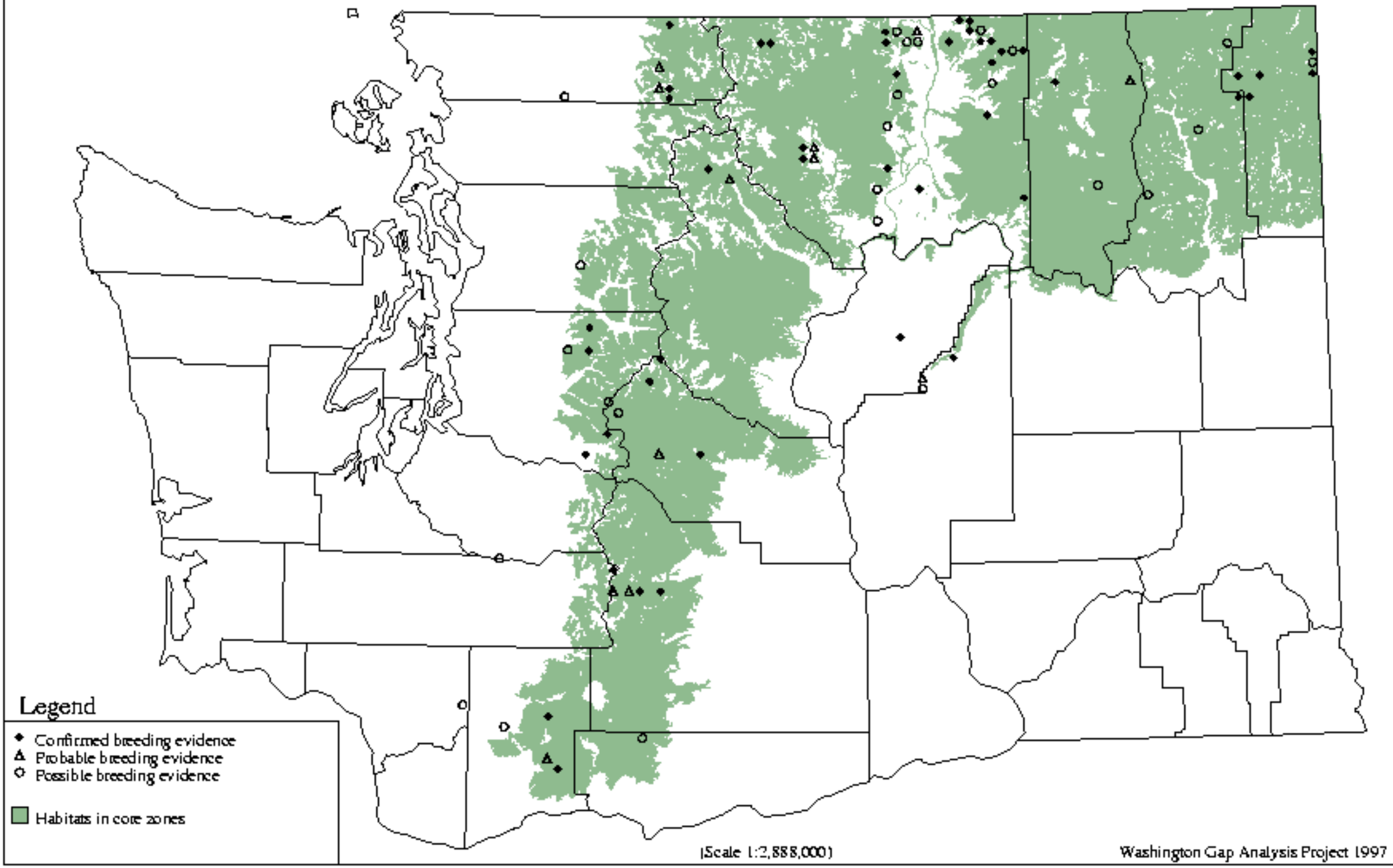
Lesser Scaup - *Aythya affinis*



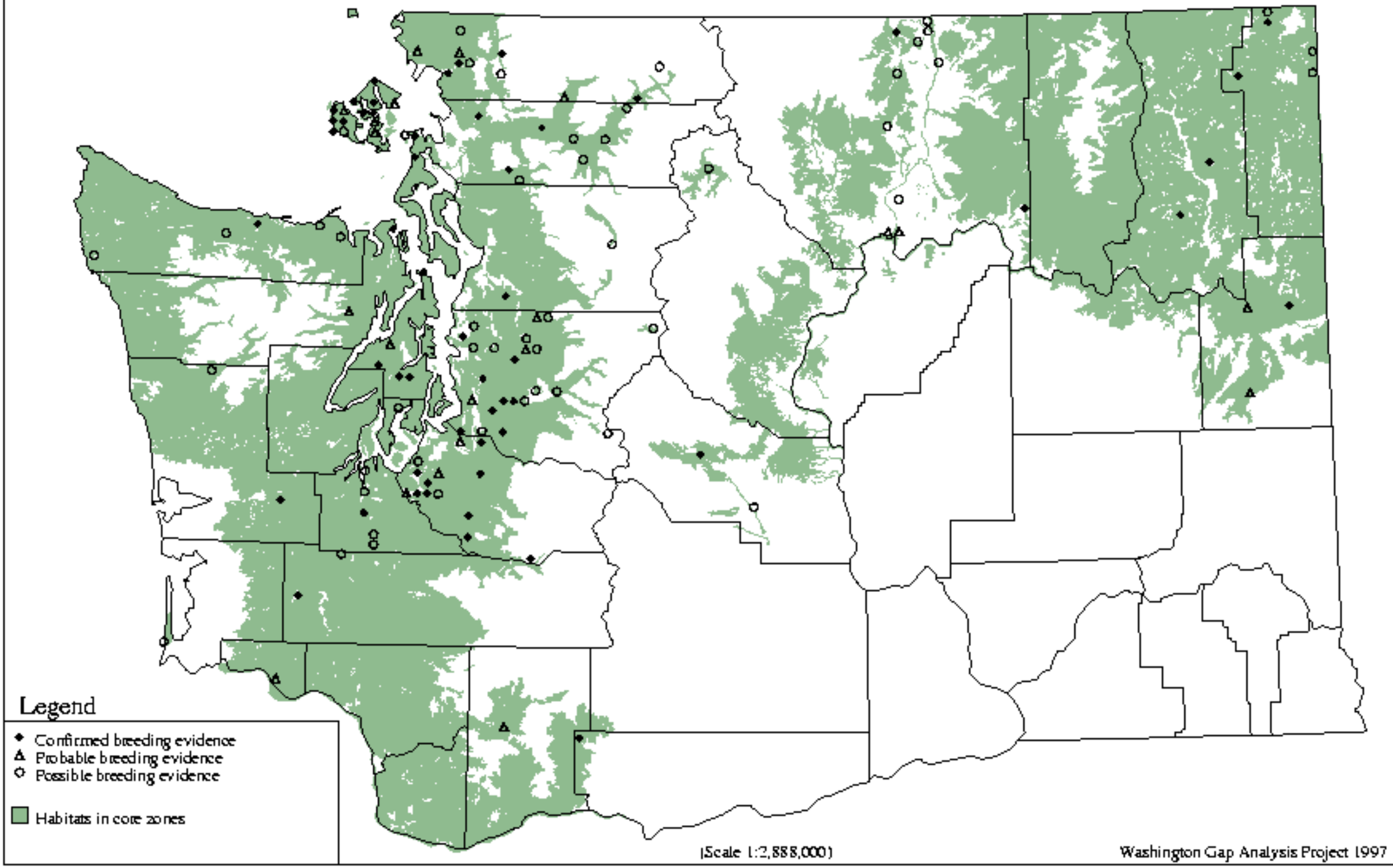
Harlequin Duck - *Histrionicus histrionicus*



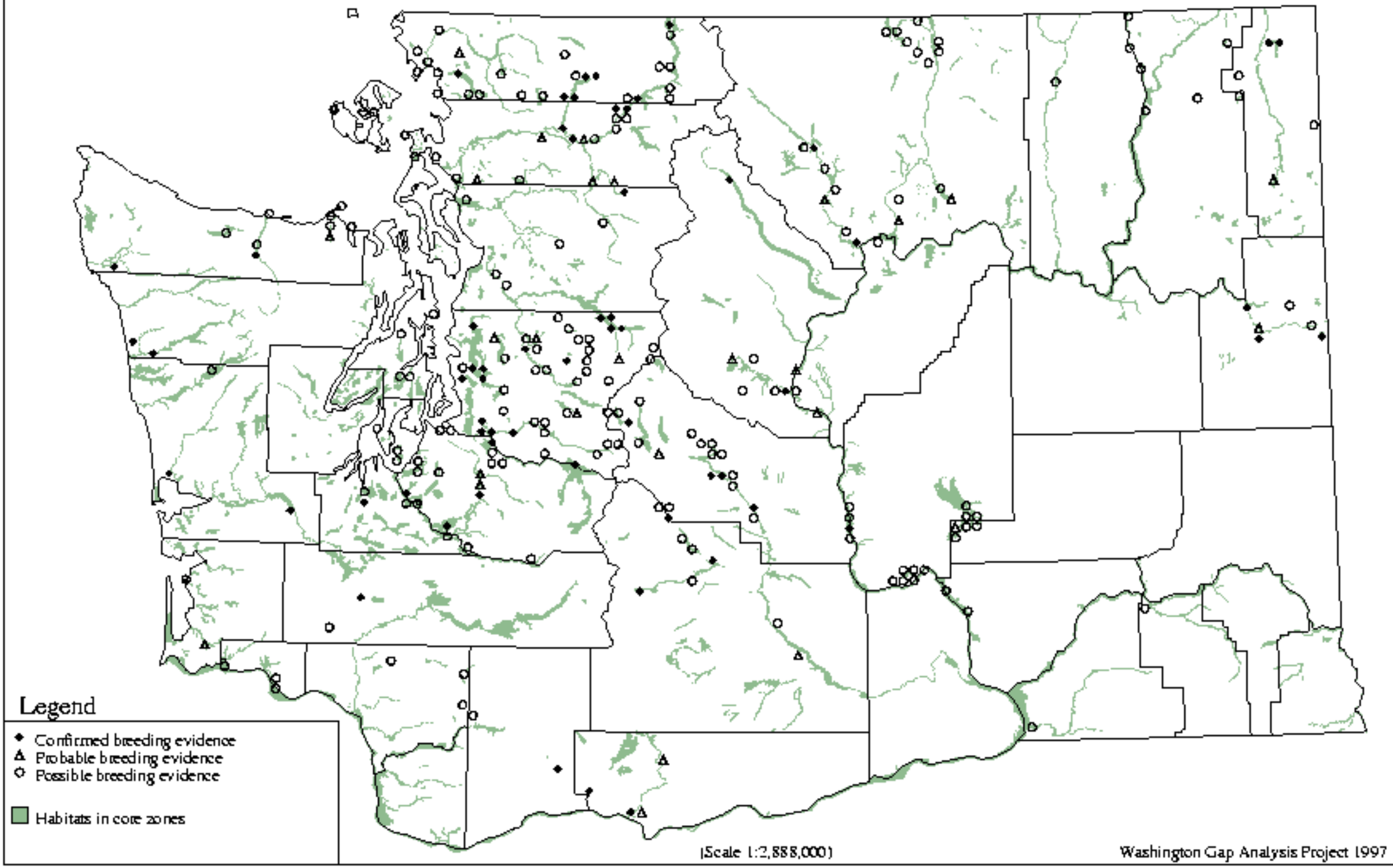
Barrow`s Goldeneye - *Bucephala islandica*



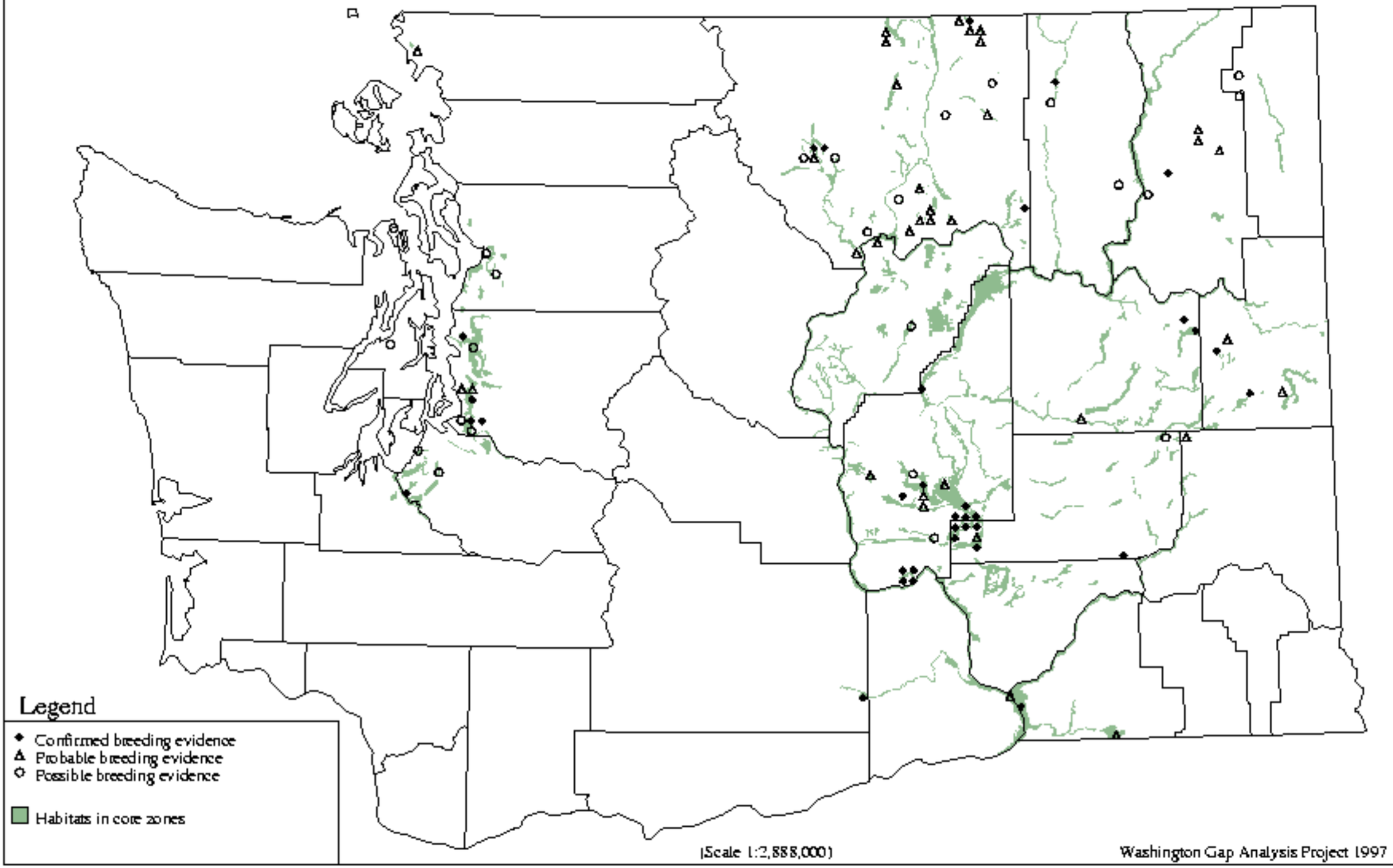
Hooded Merganser - *Lophodytes cucullatus*



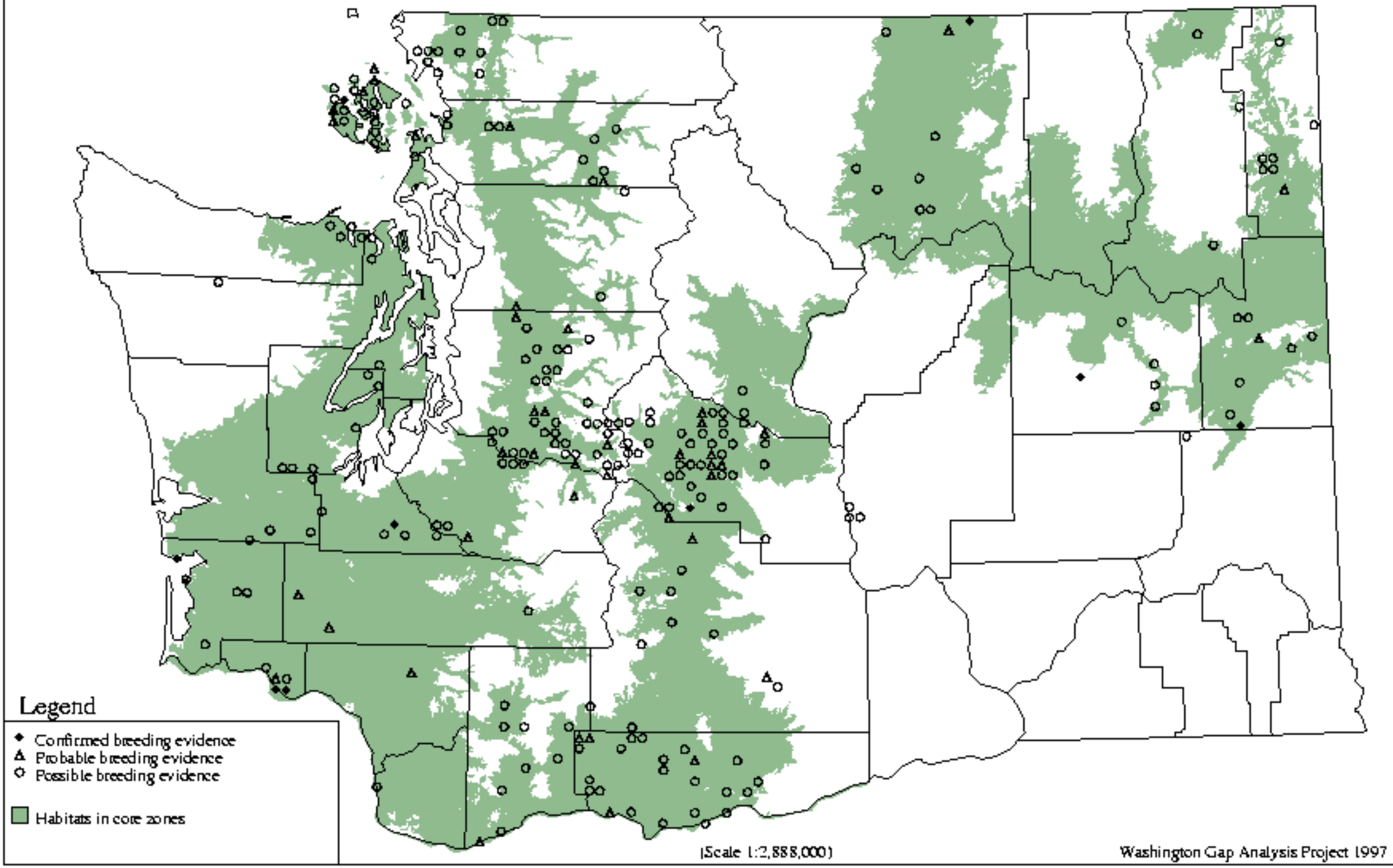
Common Merganser - *Mergus merganser*



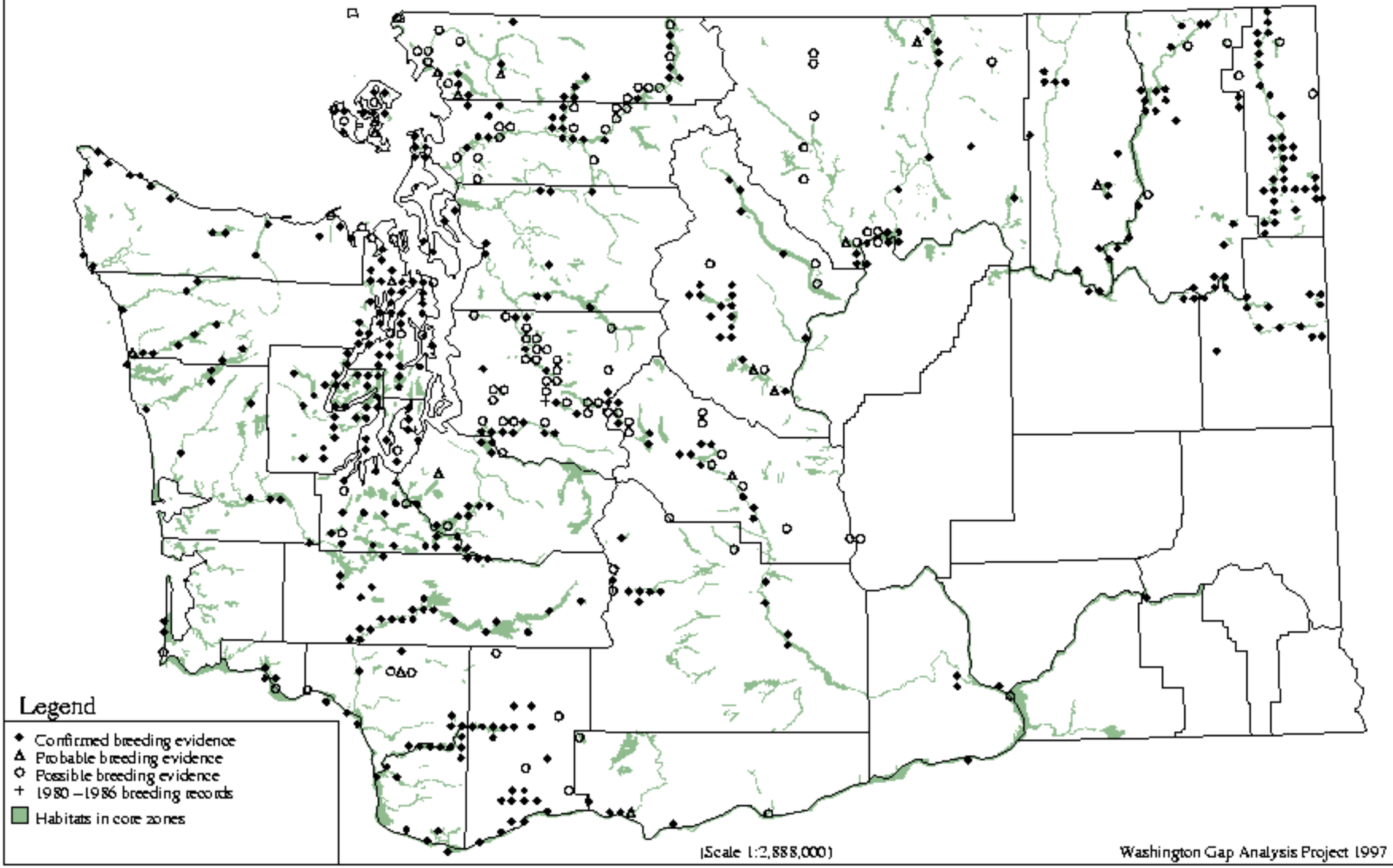
Ruddy Duck - *Oxyura jamaicensis*



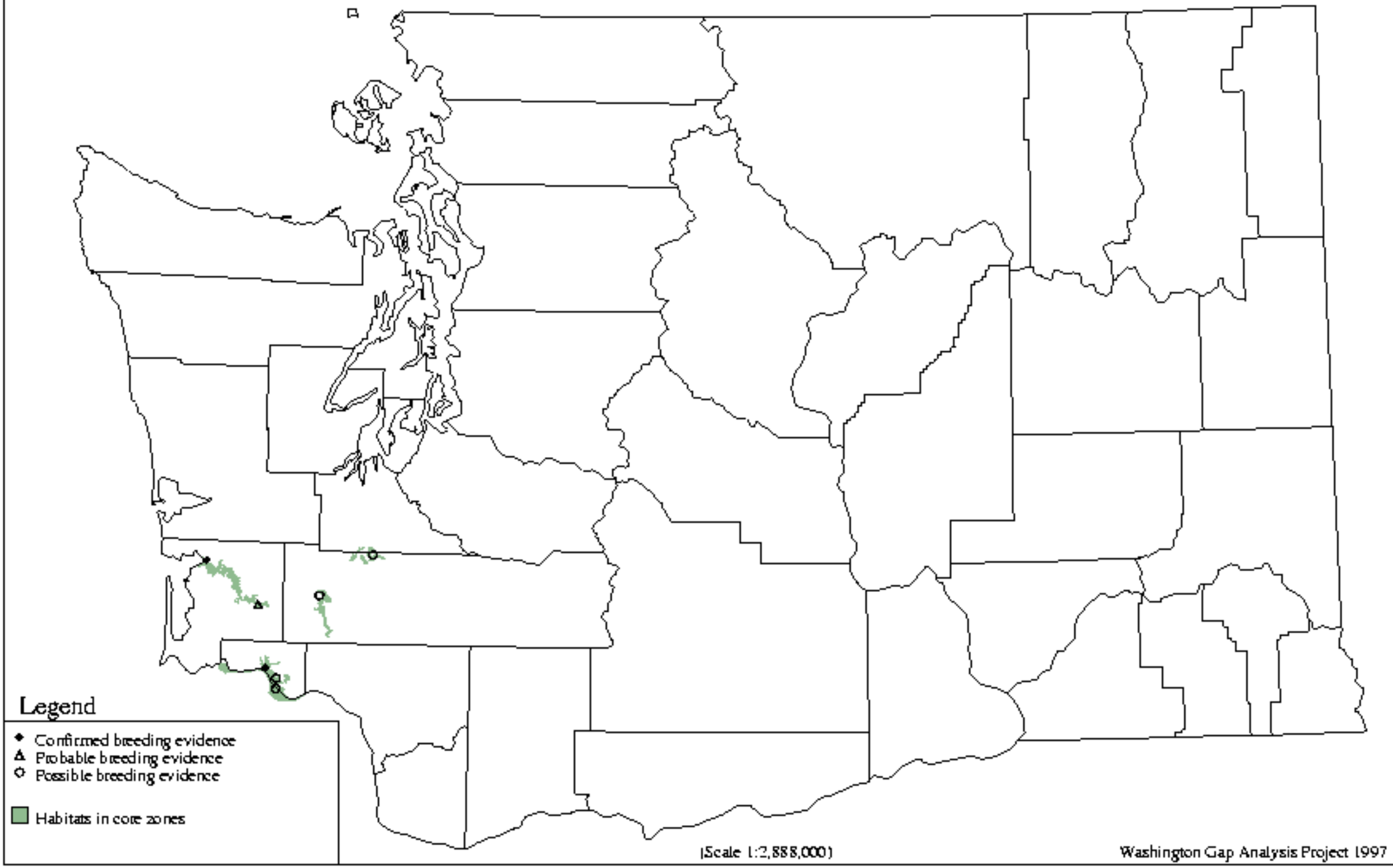
Turkey Vulture - *Cathartes aura*



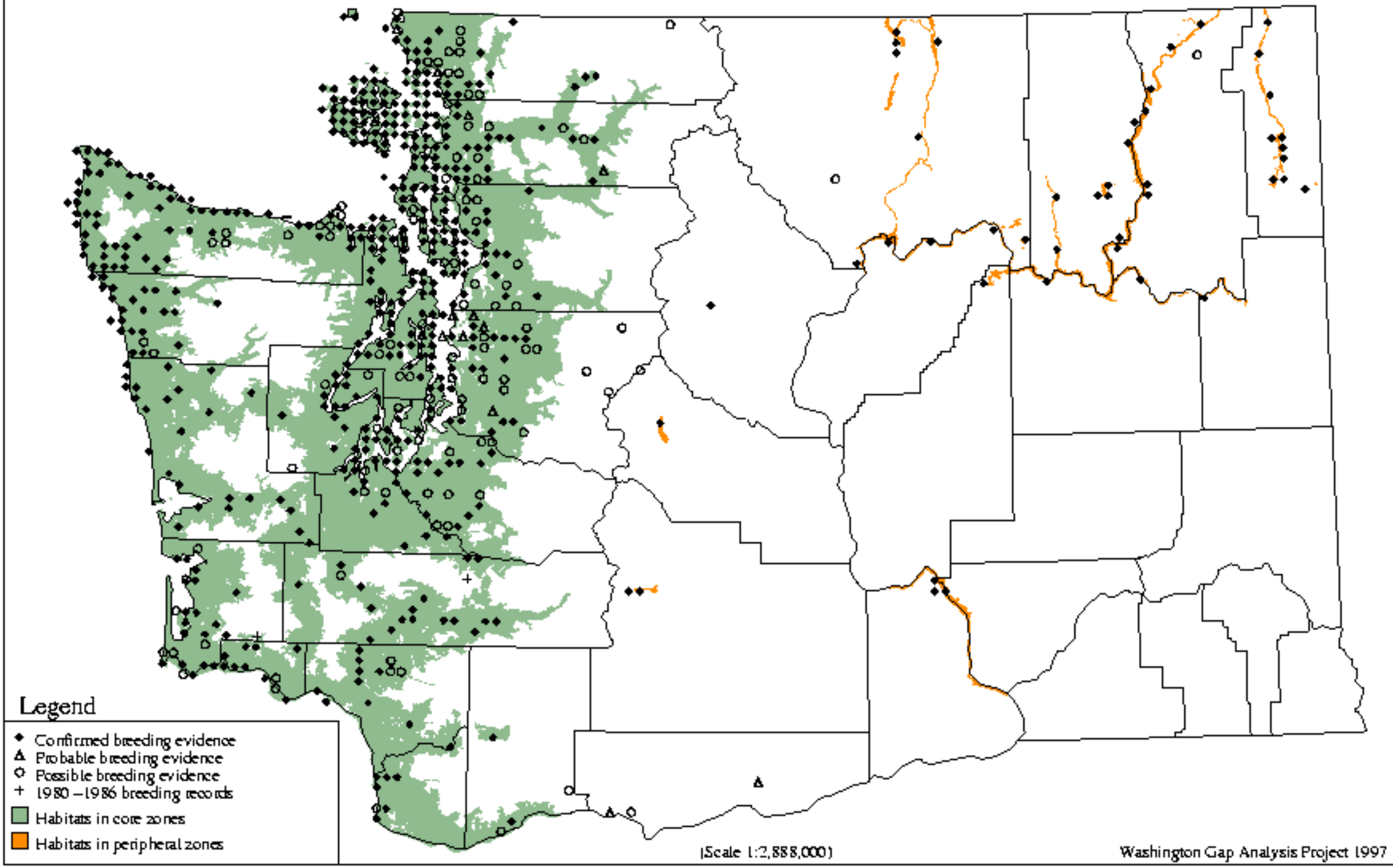
Osprey - *Pandion haliaetus*



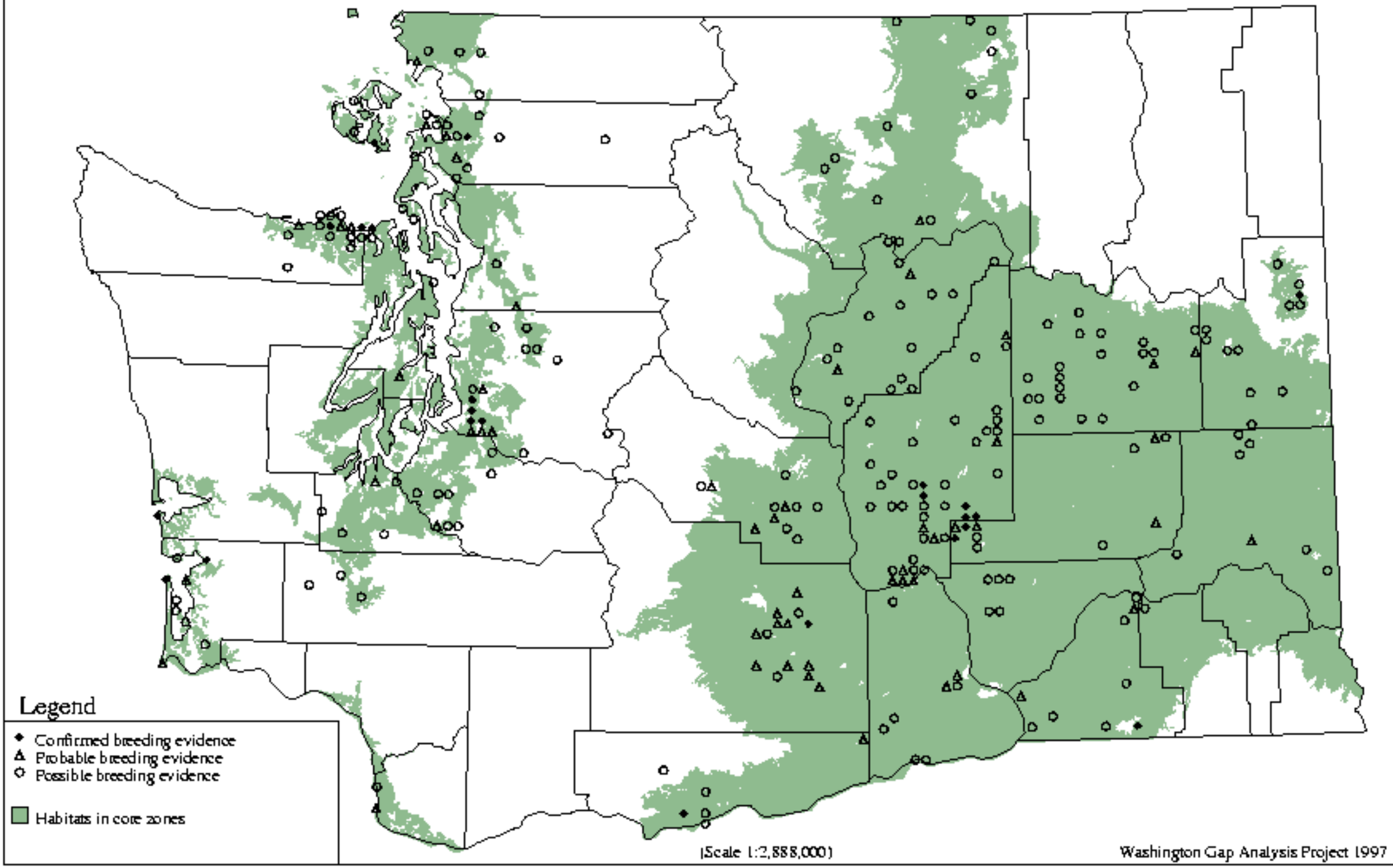
White-tailed Kite - *Elanus leucurus*



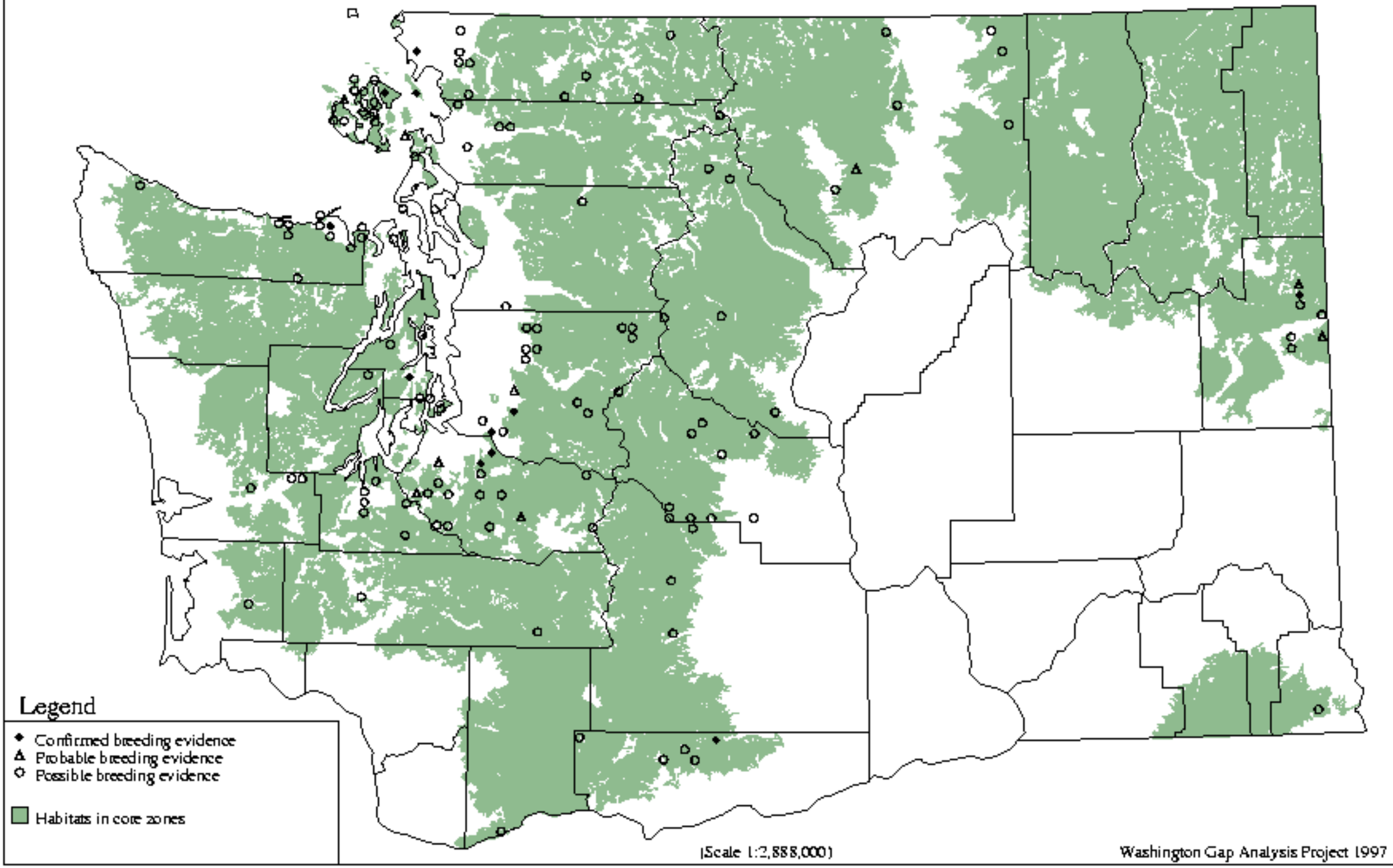
Bald Eagle - *Haliaeetus leucocephalus*



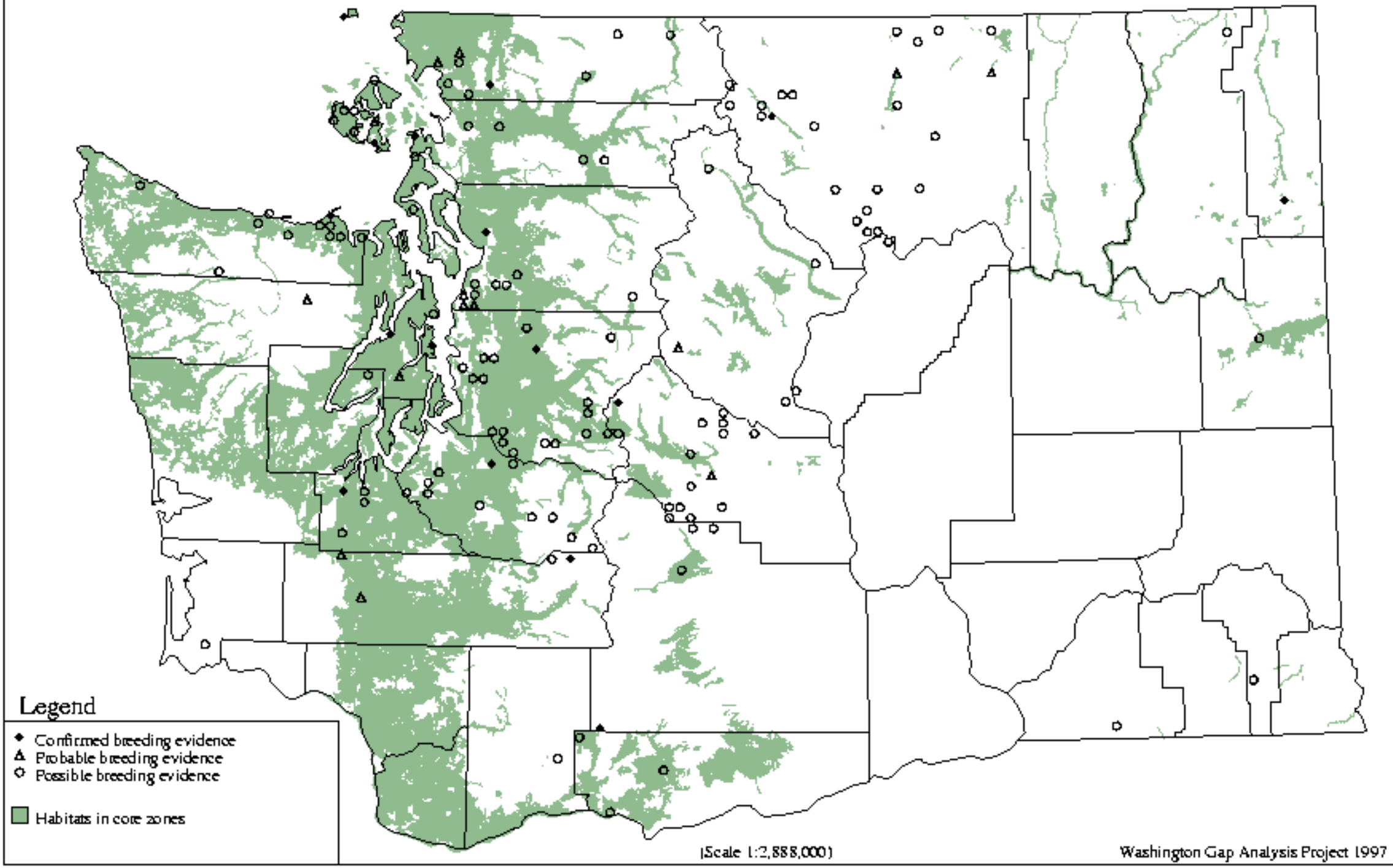
Northern Harrier - *Circus cyaneus*



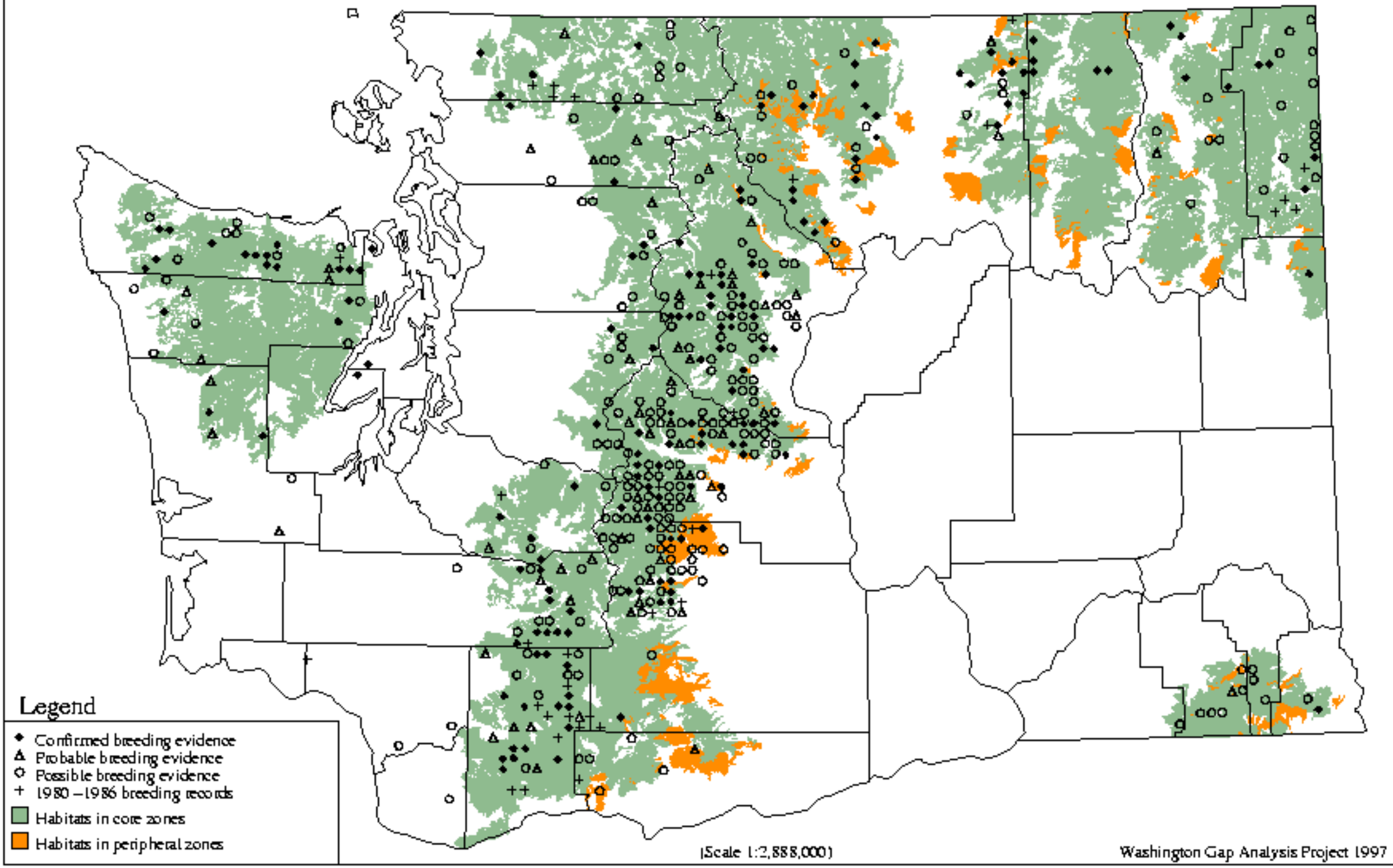
Sharp-shinned Hawk - *Accipiter striatus*



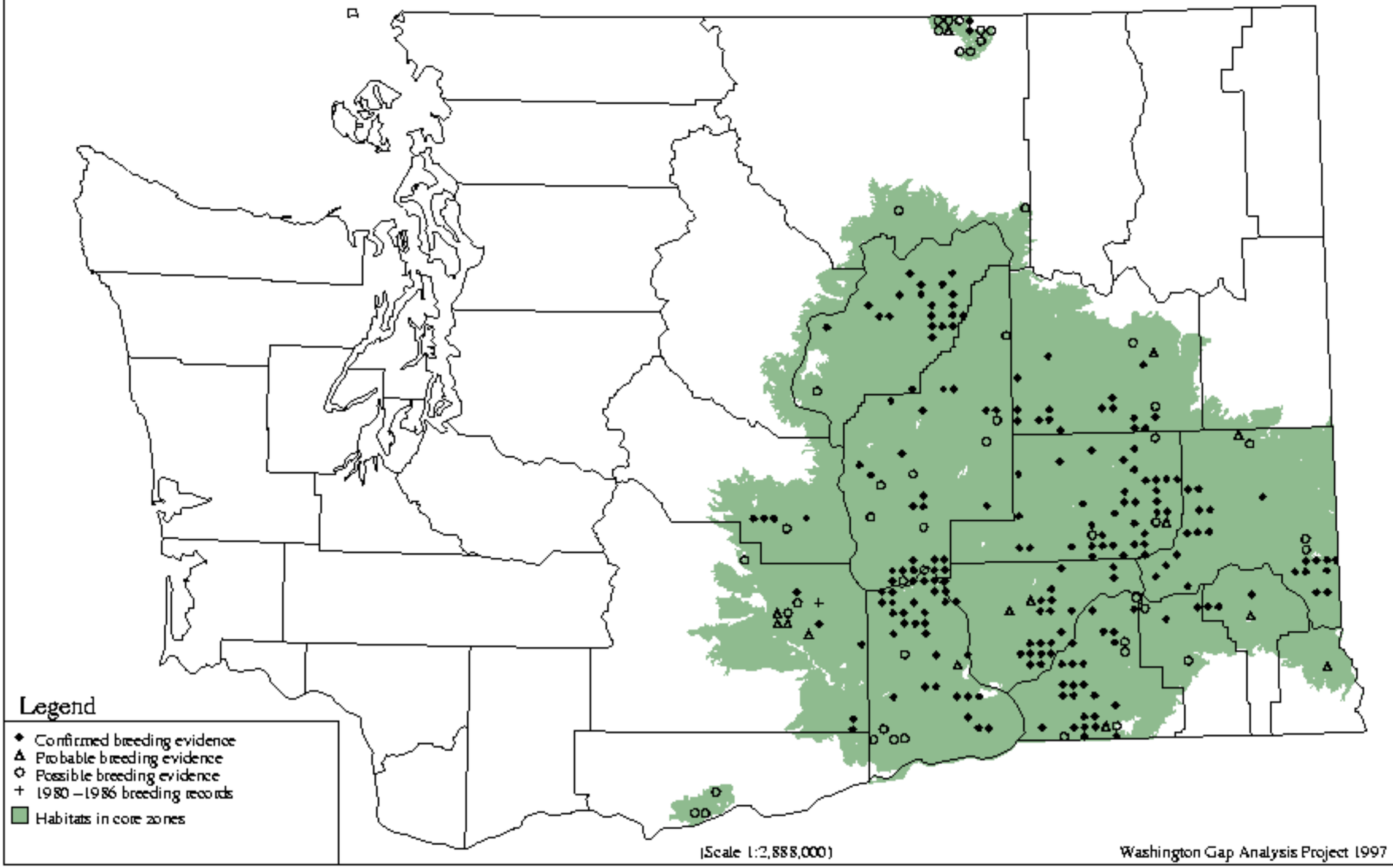
Cooper`s Hawk - *Accipiter cooperii*



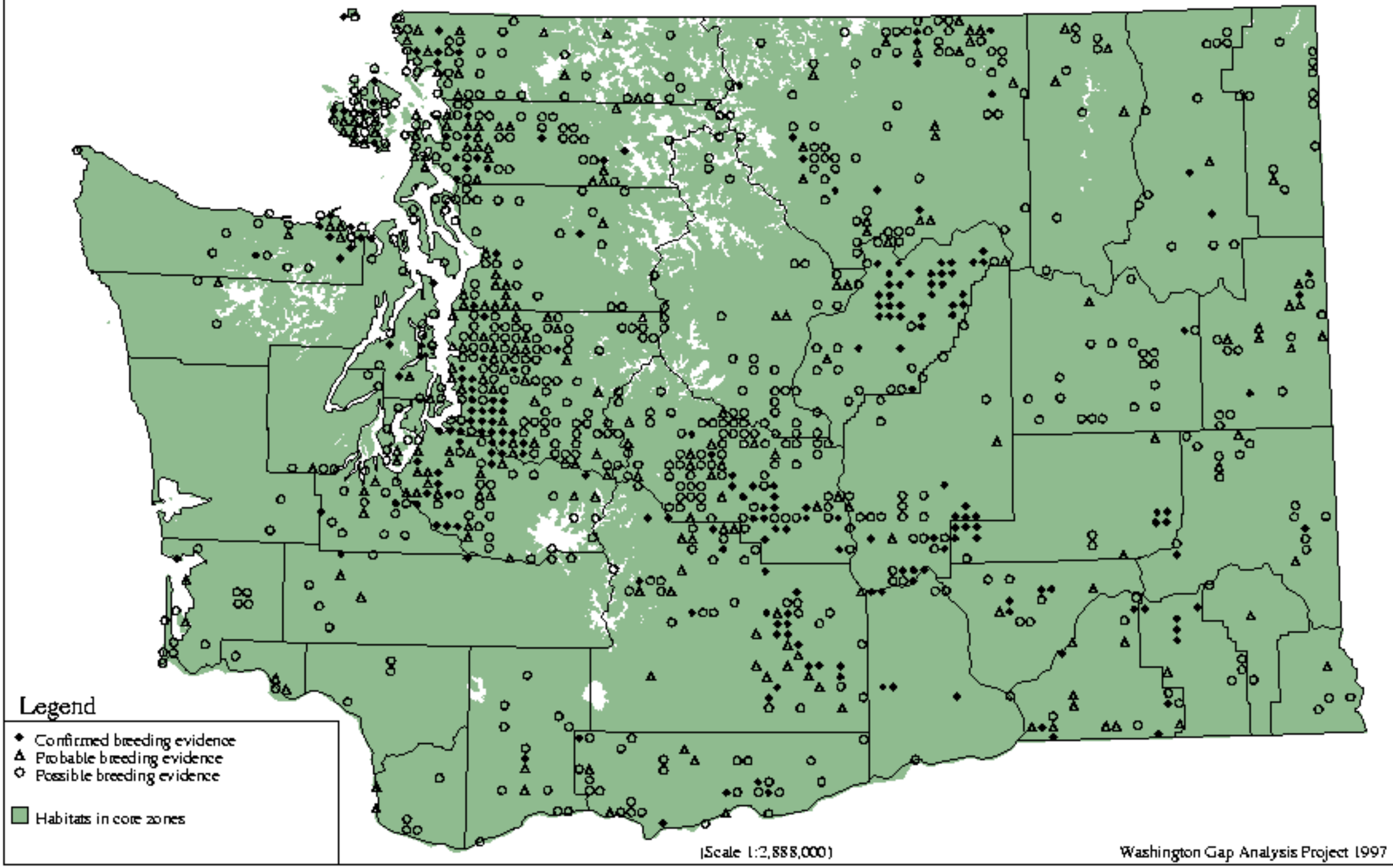
Northern Goshawk - *Accipiter gentilis*



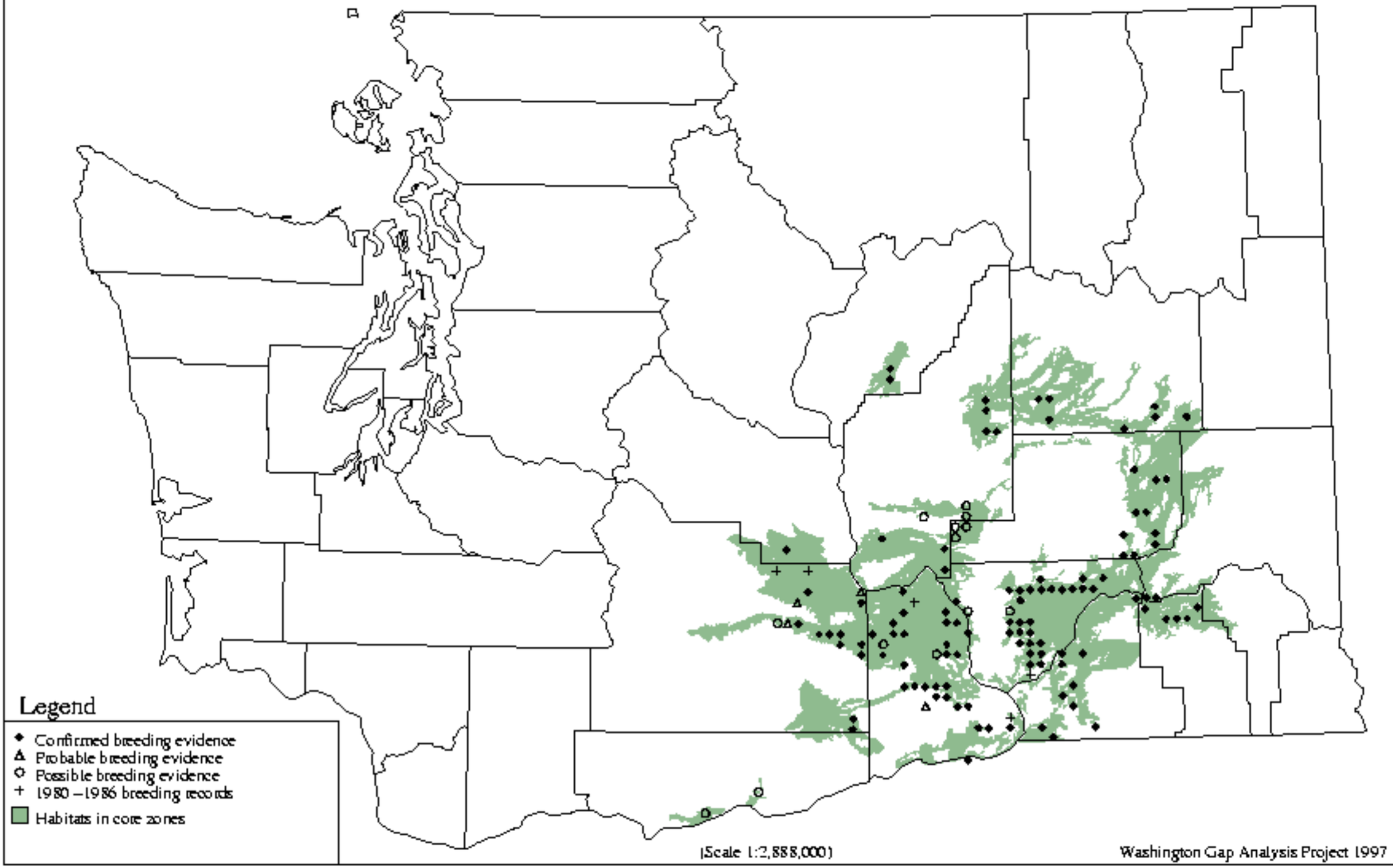
Swainson`s Hawk - *Buteo swainsoni*



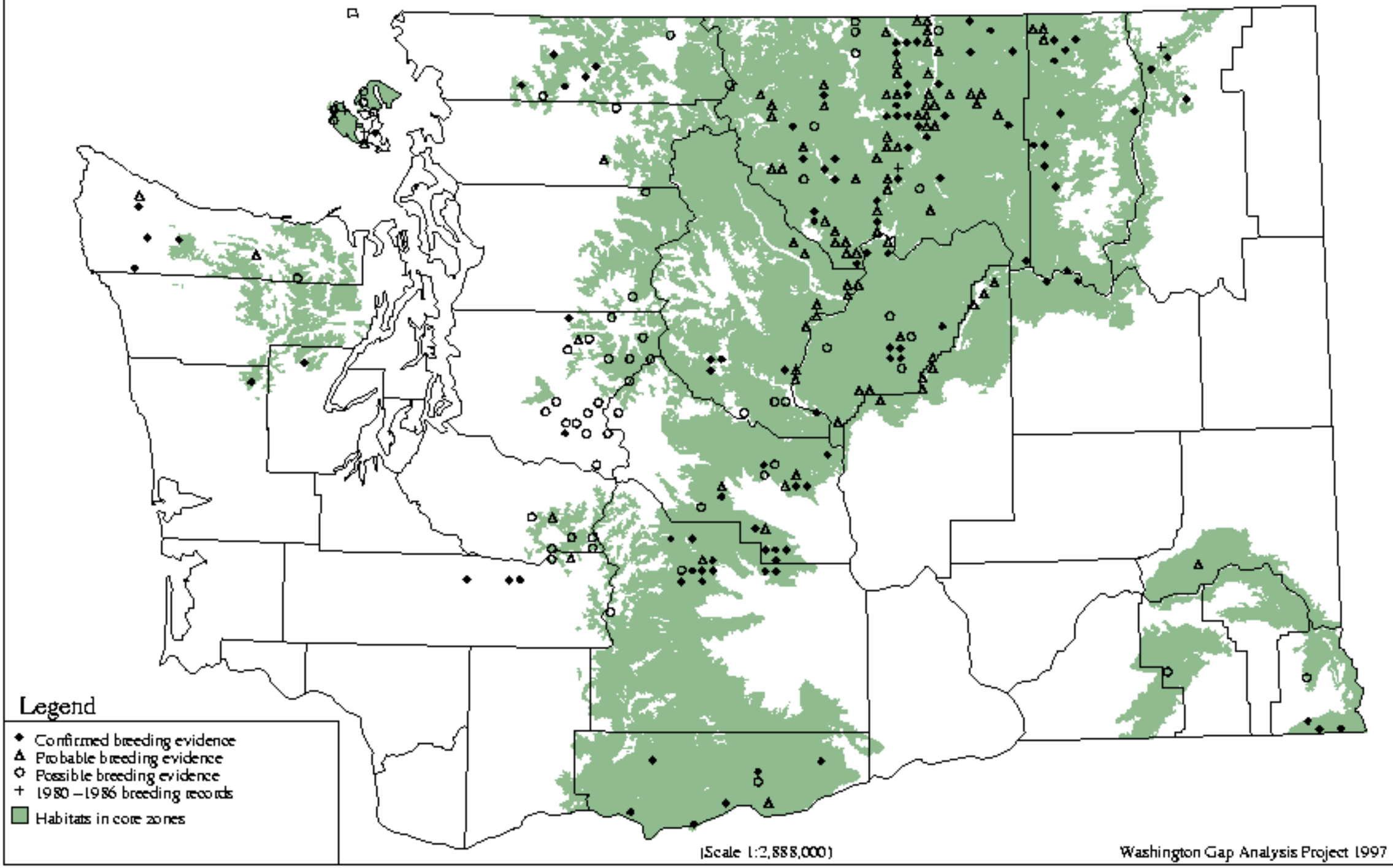
Red-tailed Hawk - *Buteo jamaicensis*



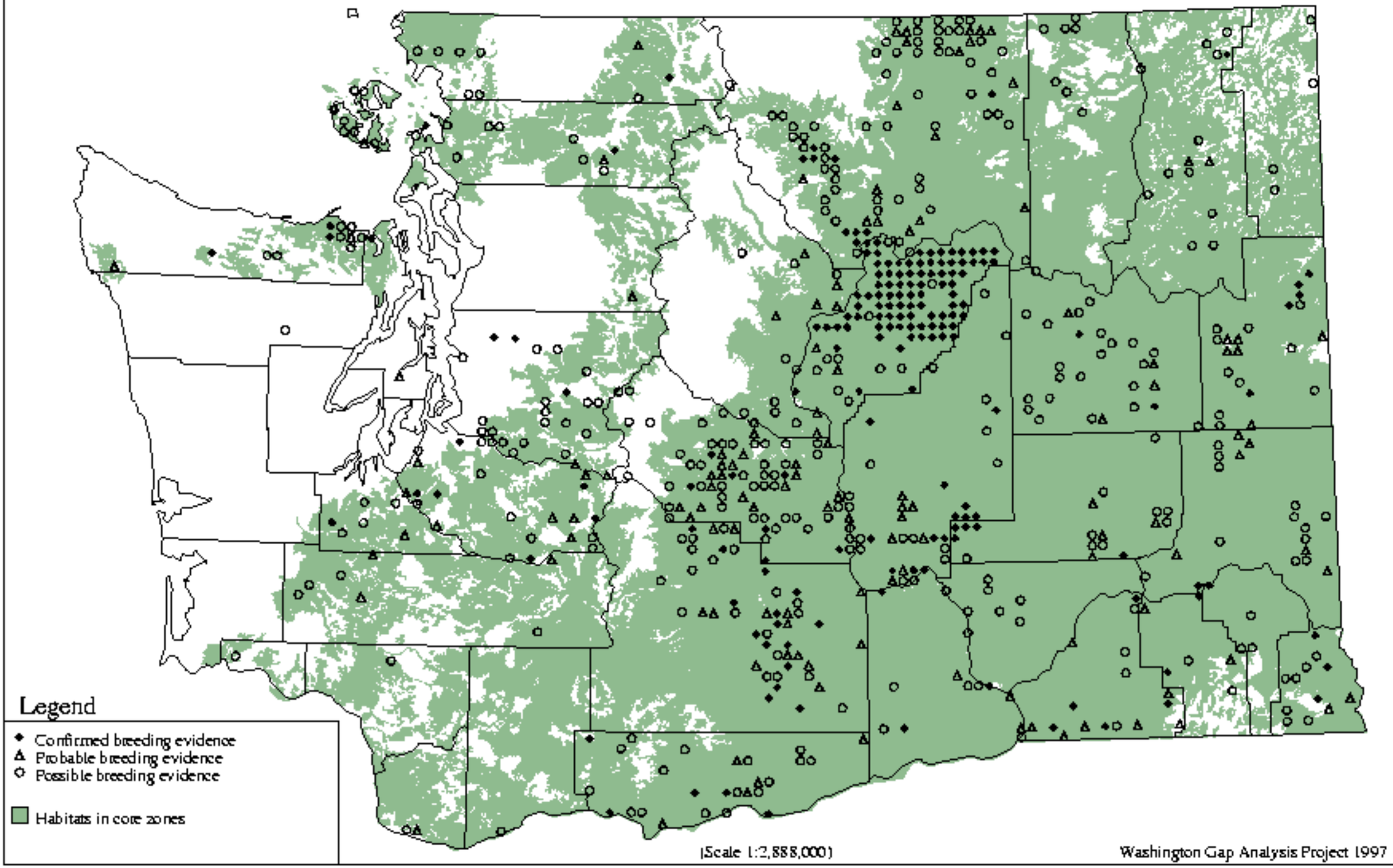
Ferruginous Hawk - *Buteo regalis*



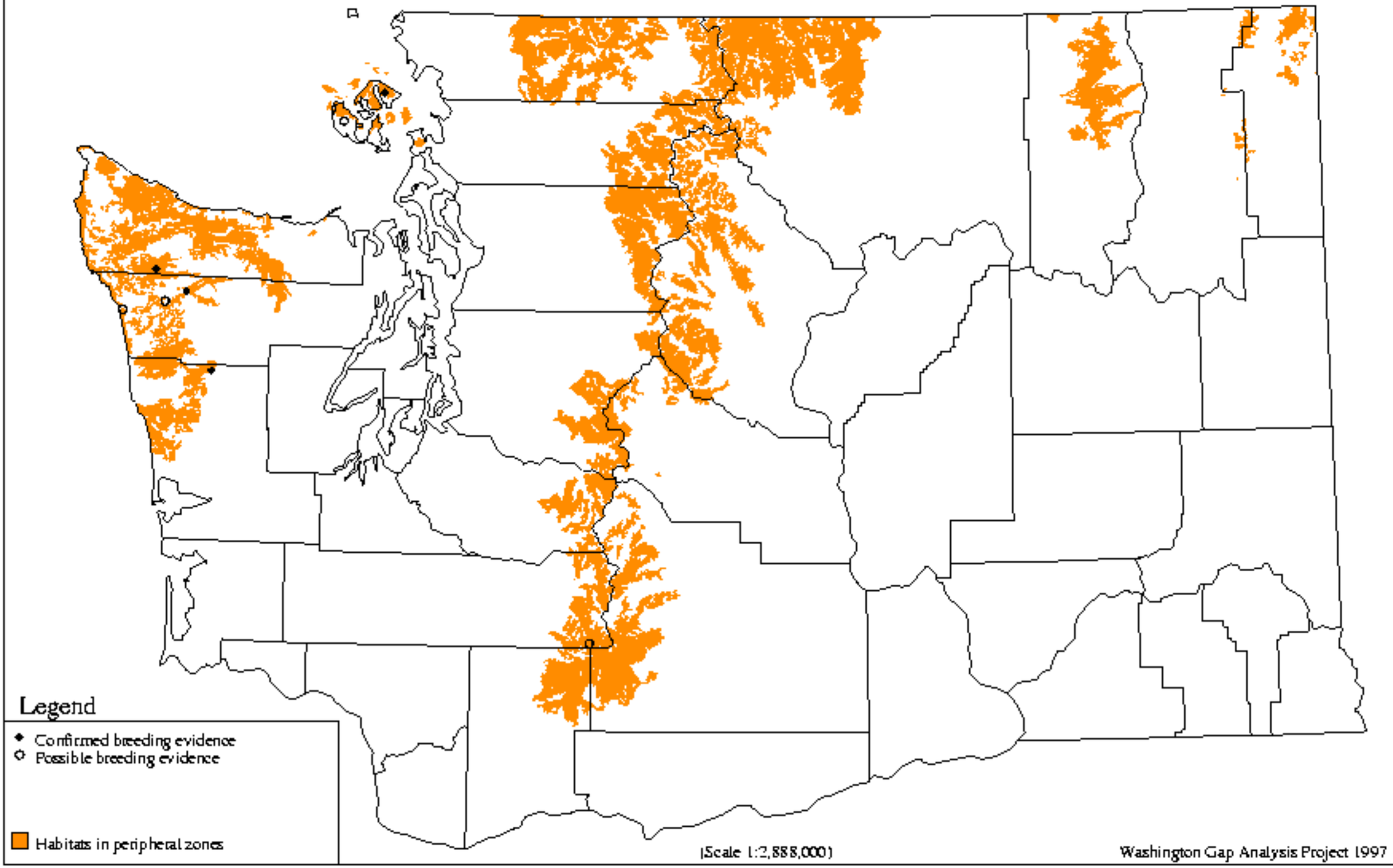
Golden Eagle - *Aquila chrysaetos*



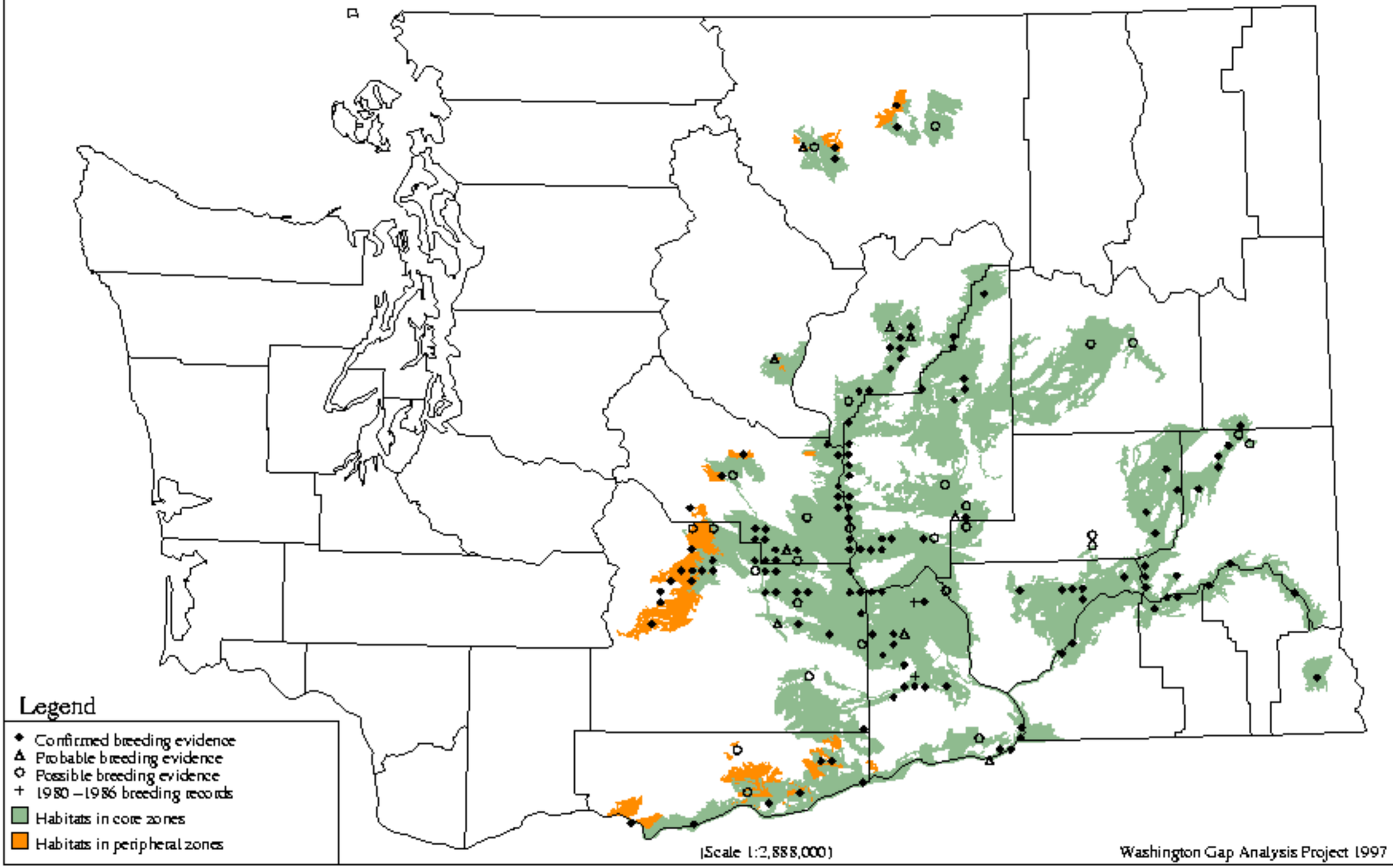
American Kestrel - *Falco sparverius*



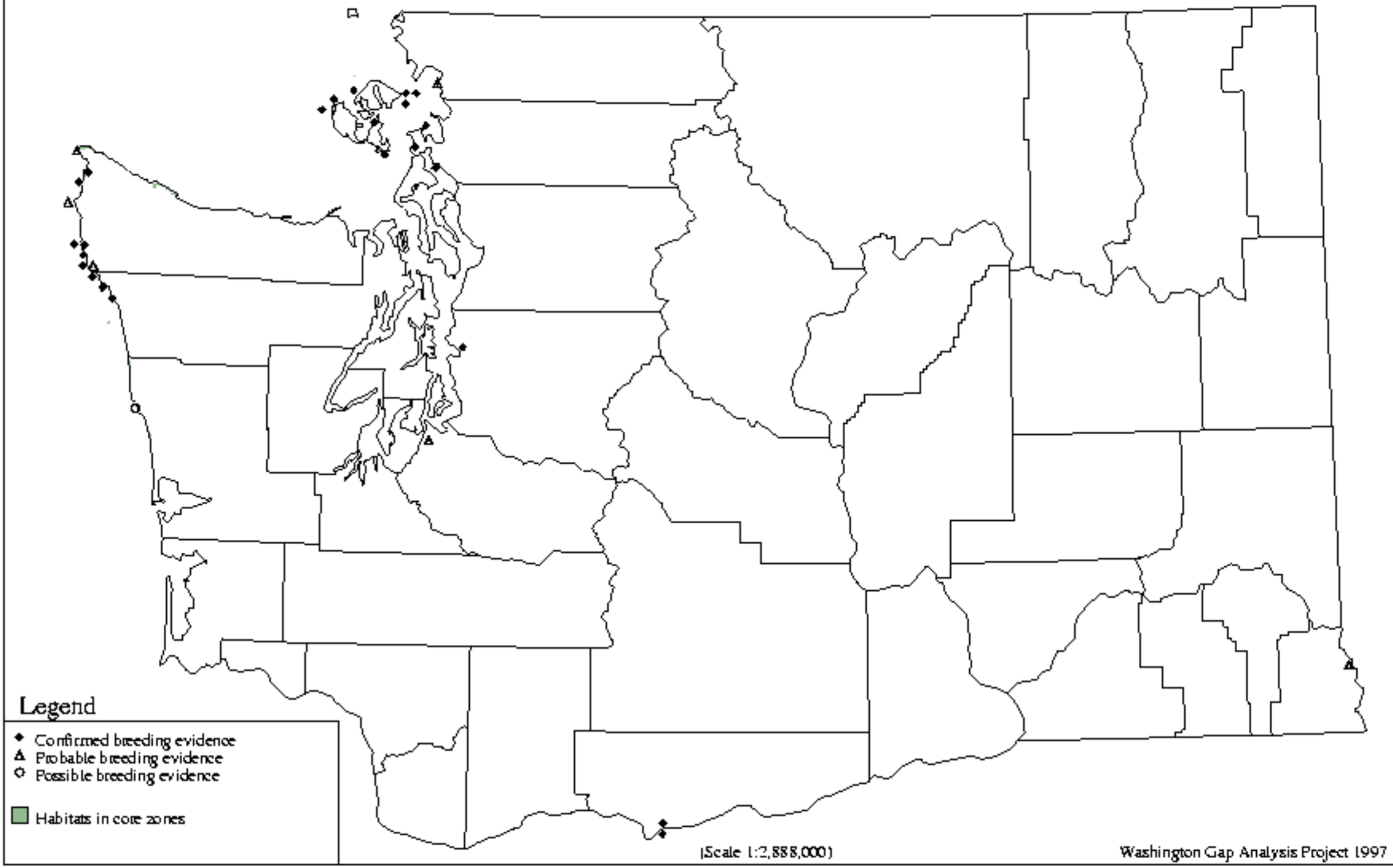
Merlin - *Falco columbarius*



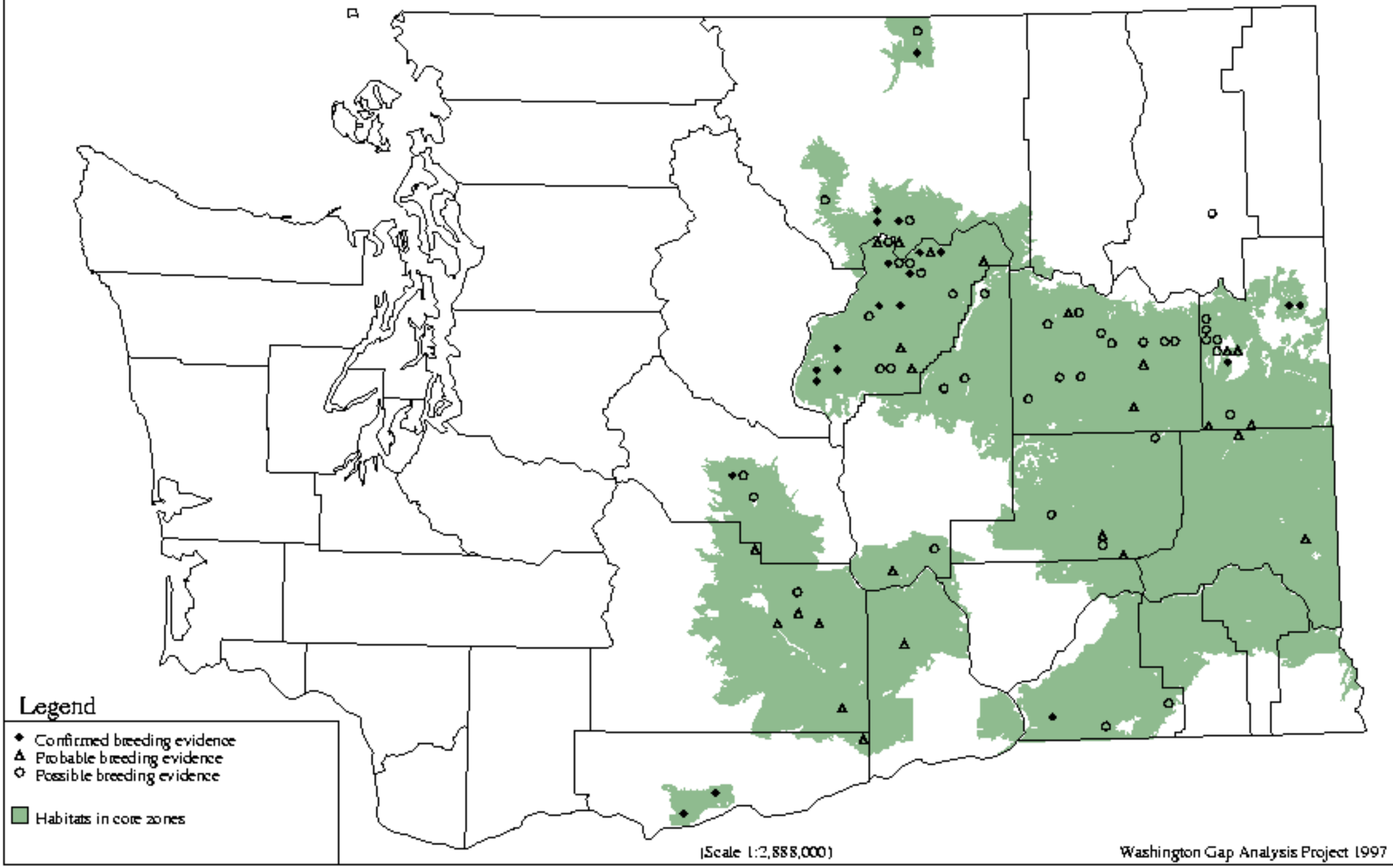
Prairie Falcon - *Falco mexicanus*



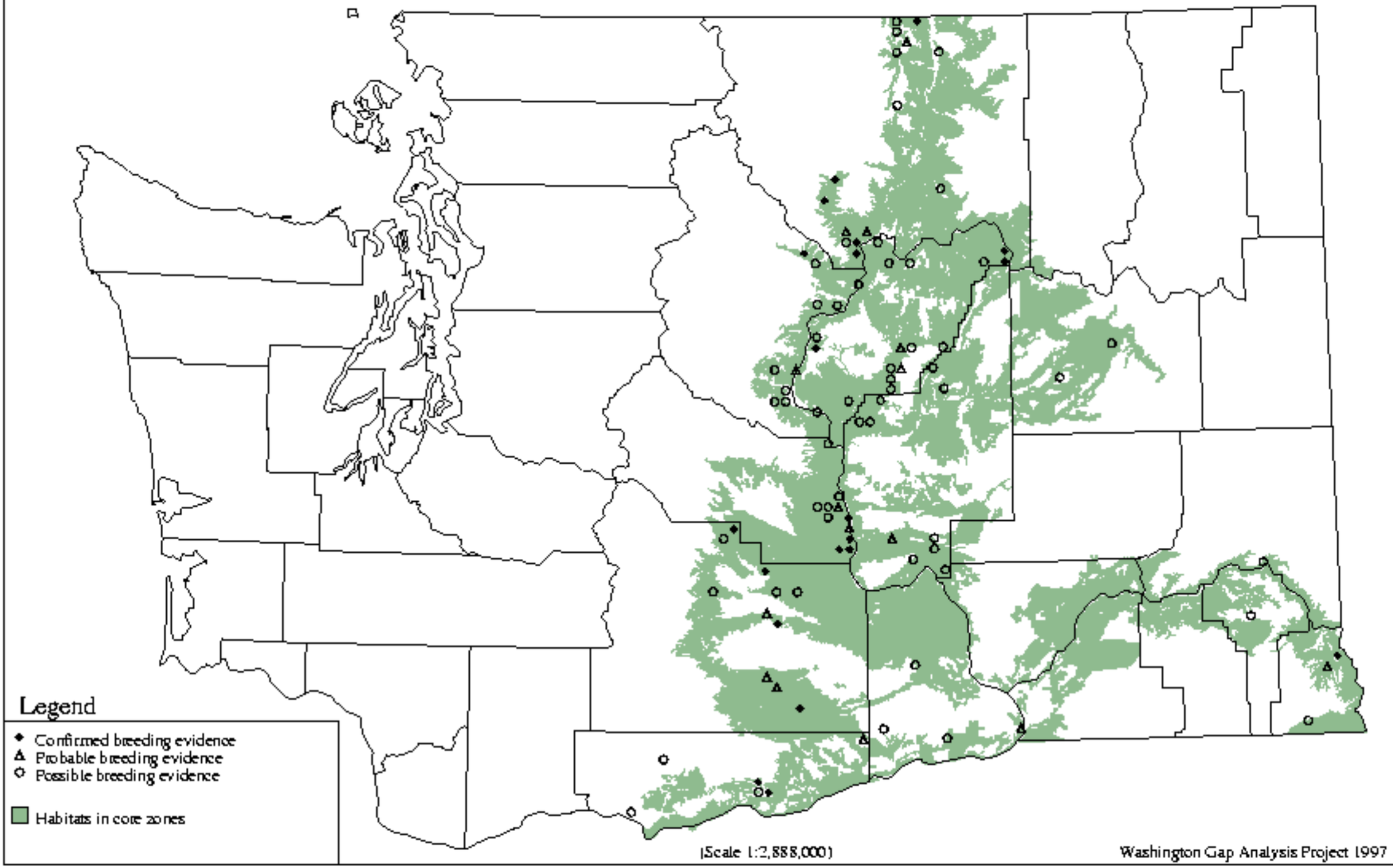
Peregrine Falcon - *Falco peregrinus*



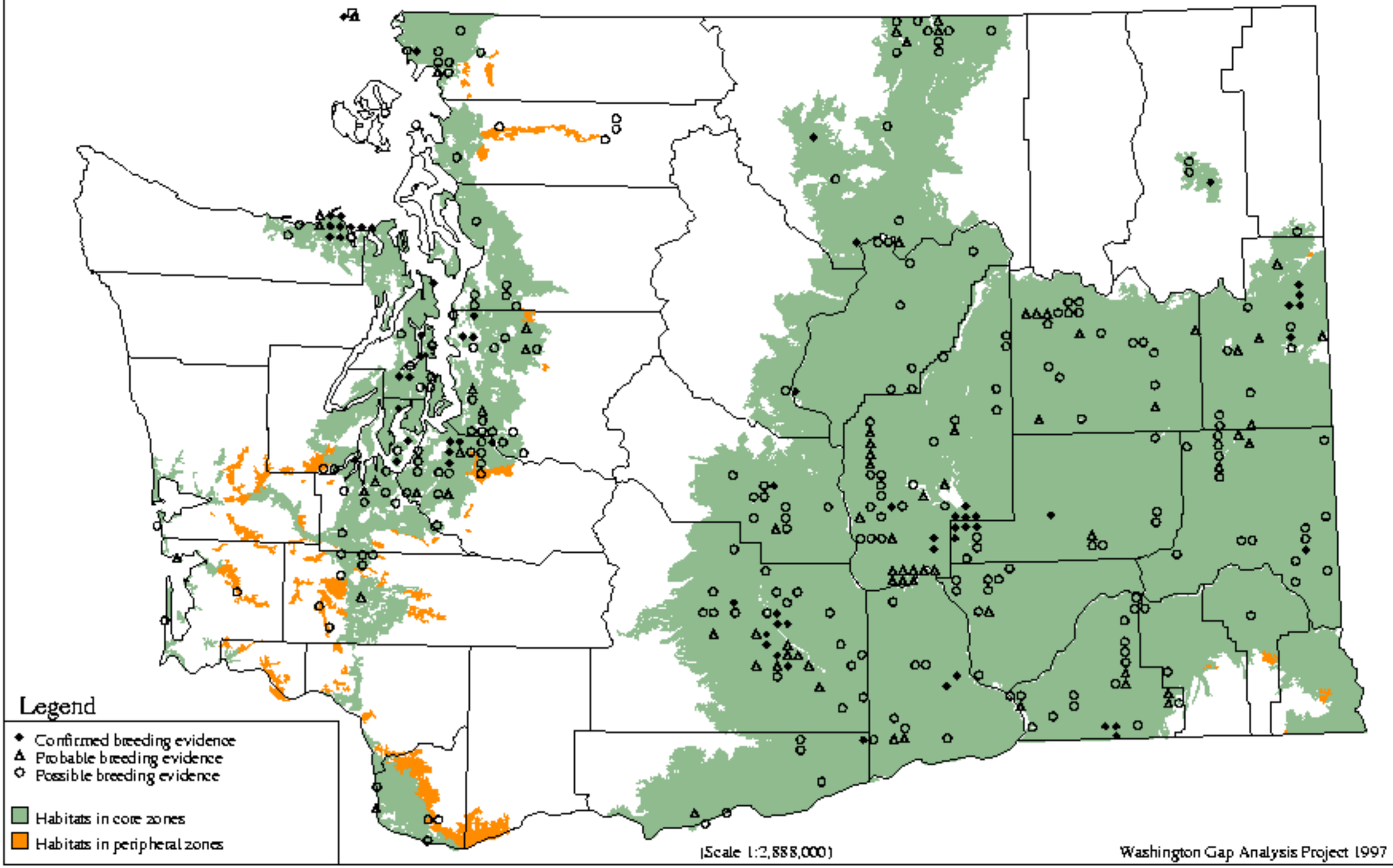
Gray Partridge - *Perdix perdix*



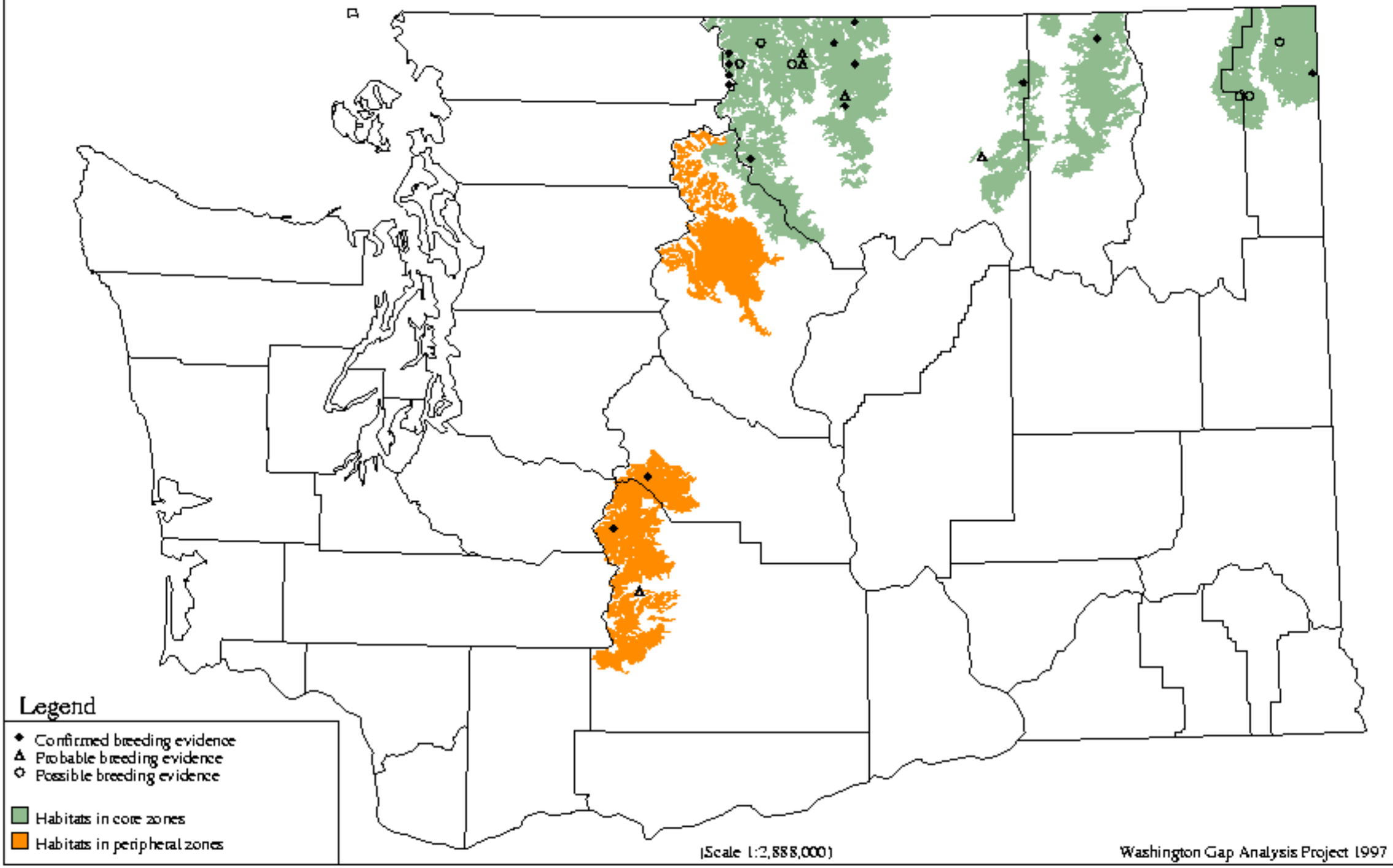
Chukar - *Alectoris chukar*



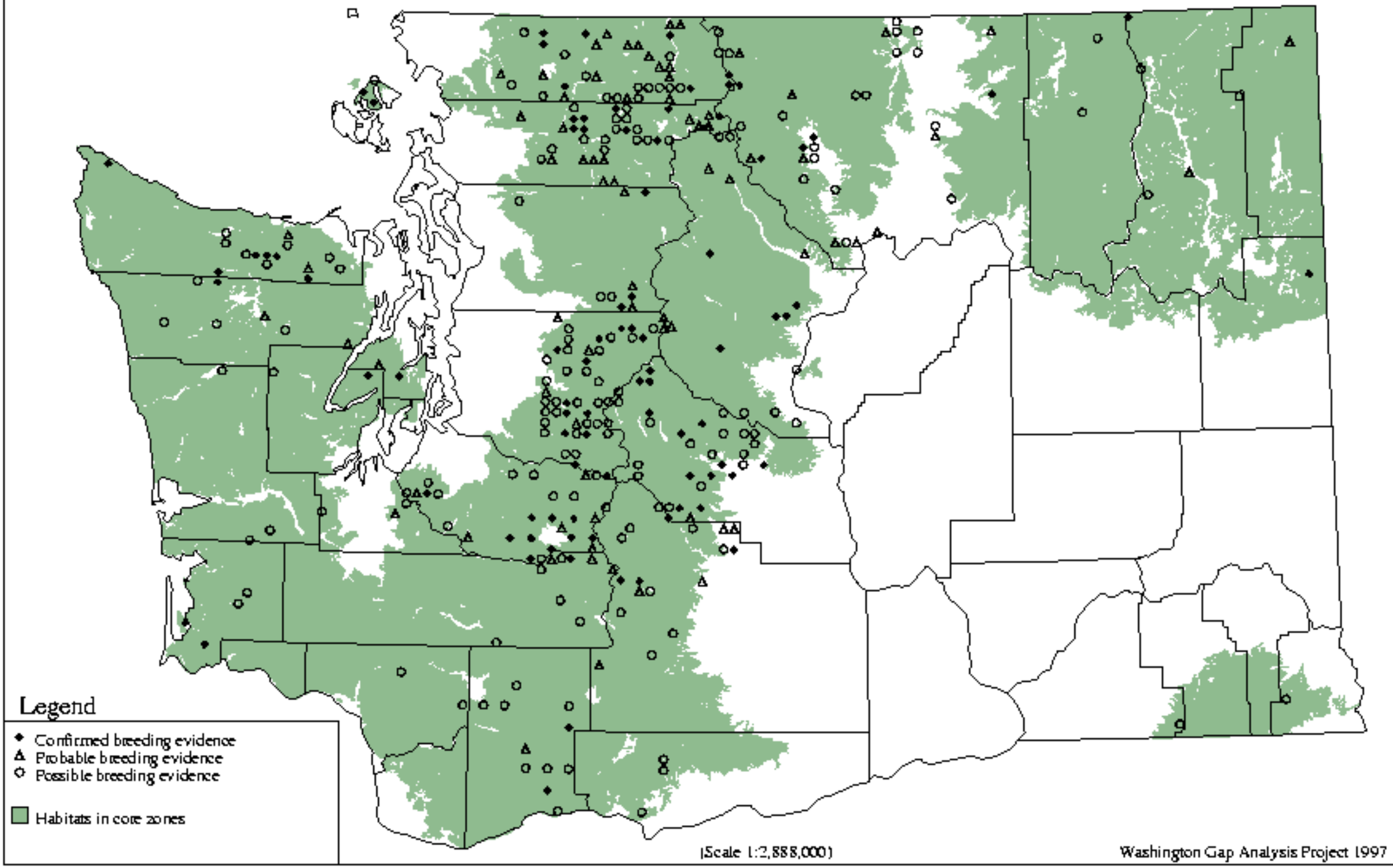
Ring-necked Pheasant - *Phasianus colchicus*



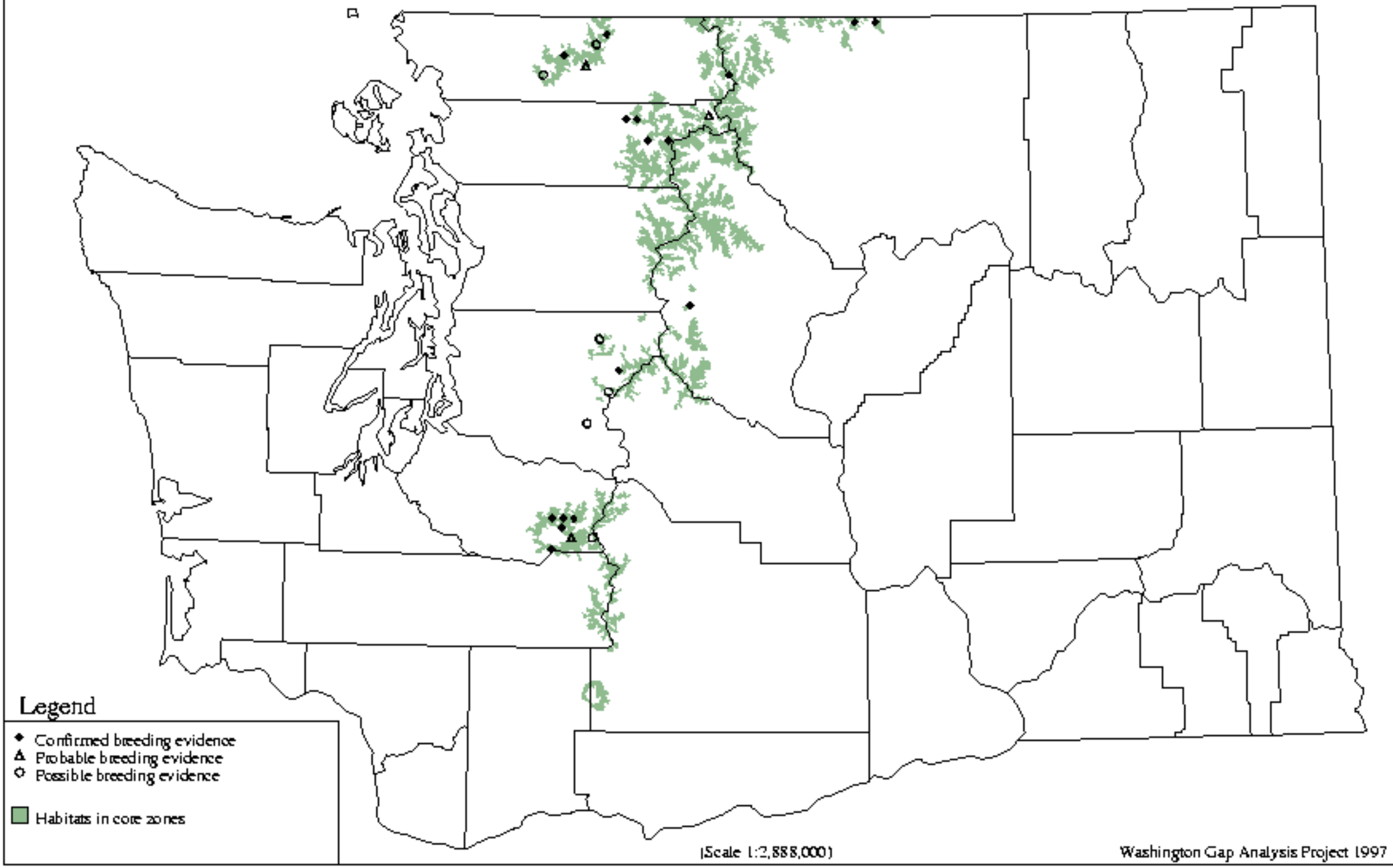
Spruce Grouse - *Dendragapus canadensis*



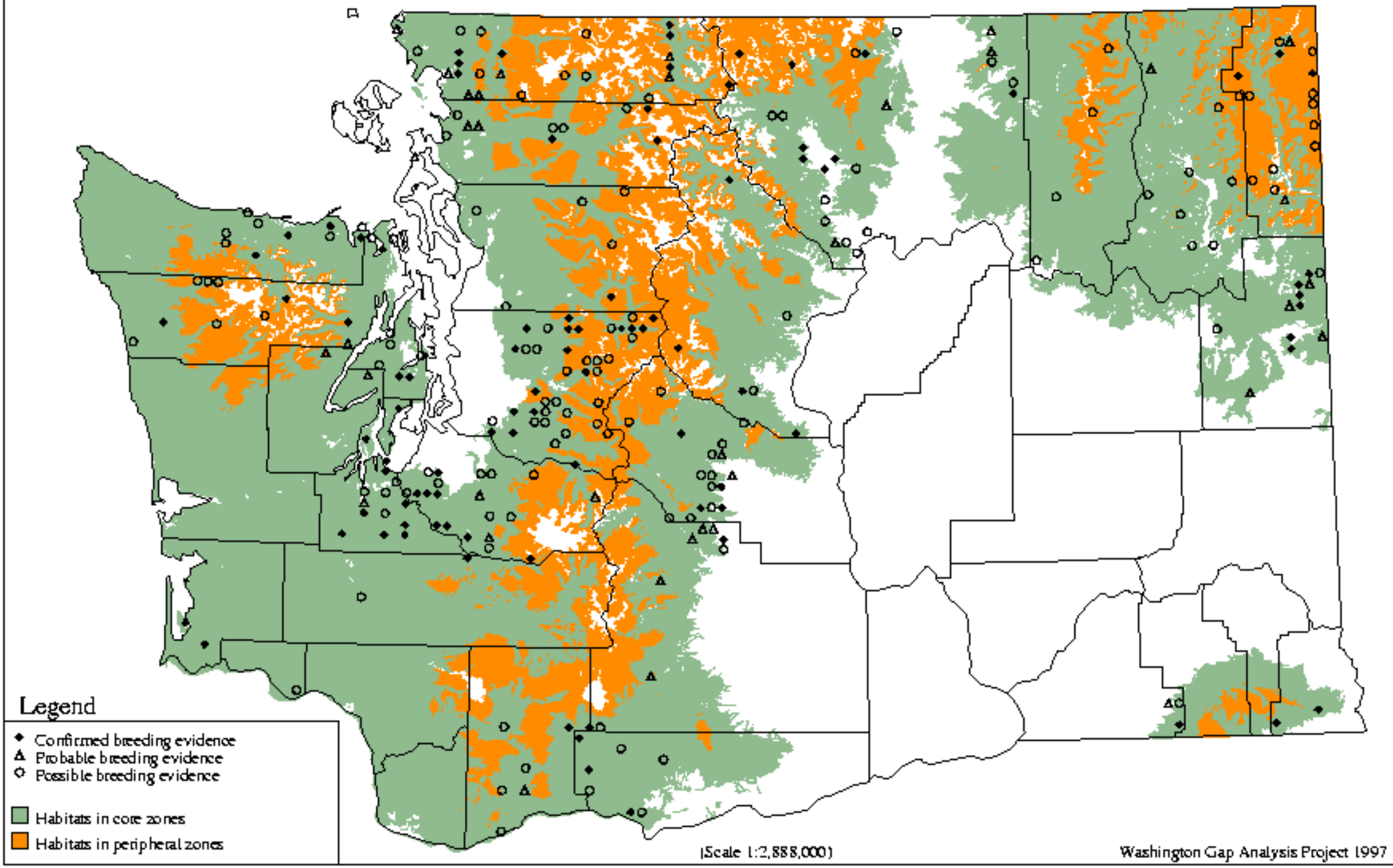
Blue Grouse - *Dendragapus obscurus*



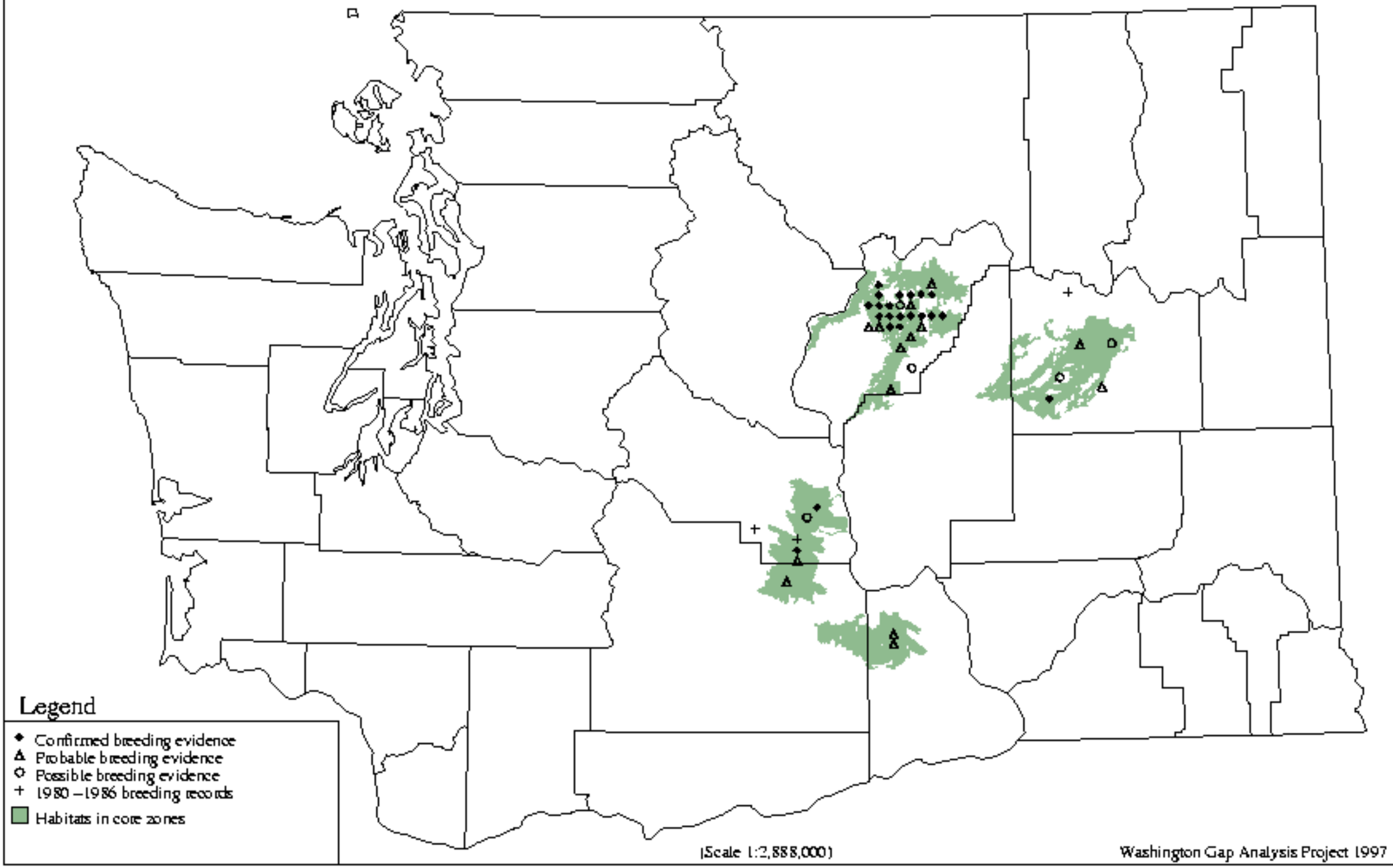
White-tailed Ptarmigan - *Lagopus leucurus*



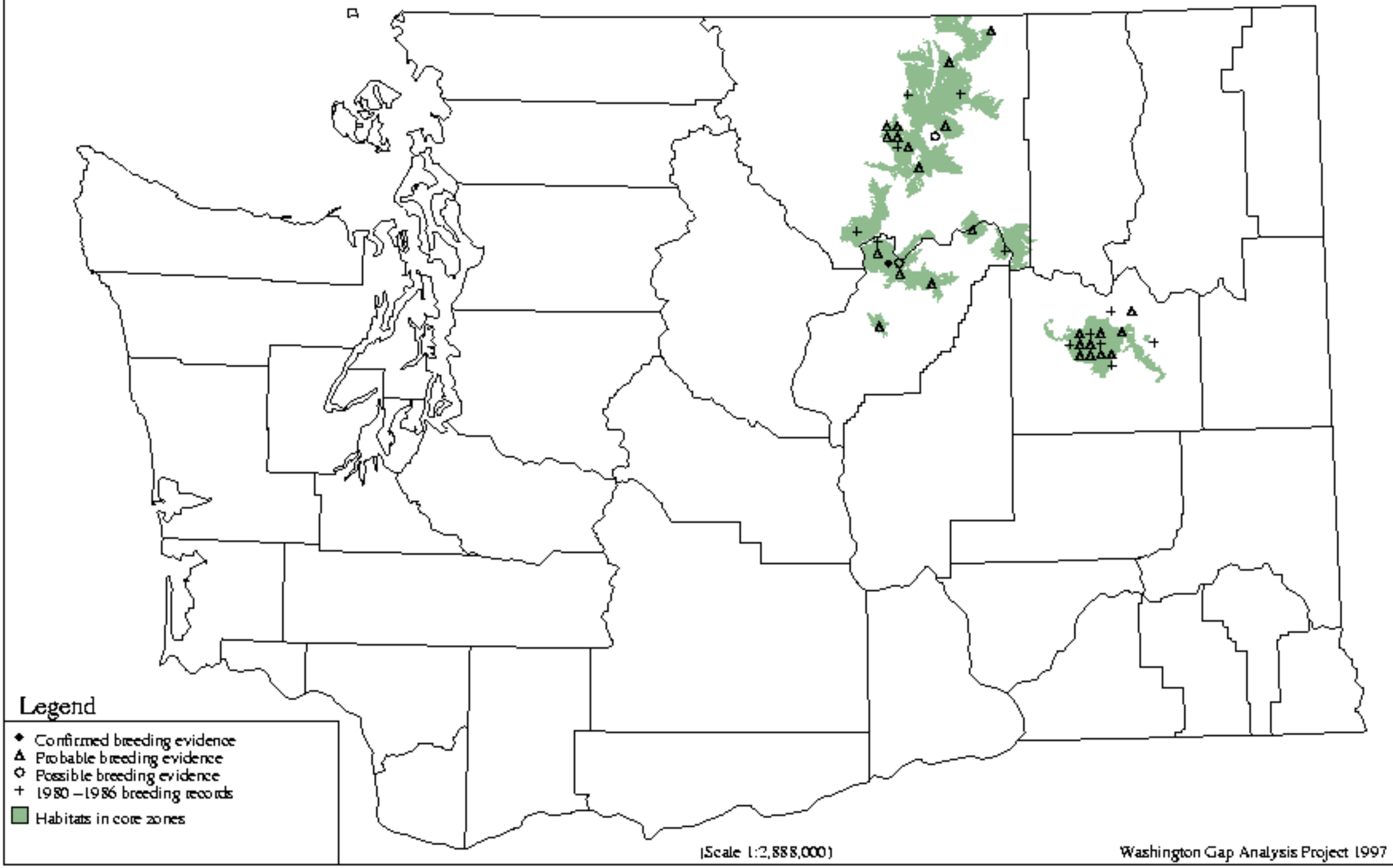
Ruffed Grouse - *Bonasa umbellus*



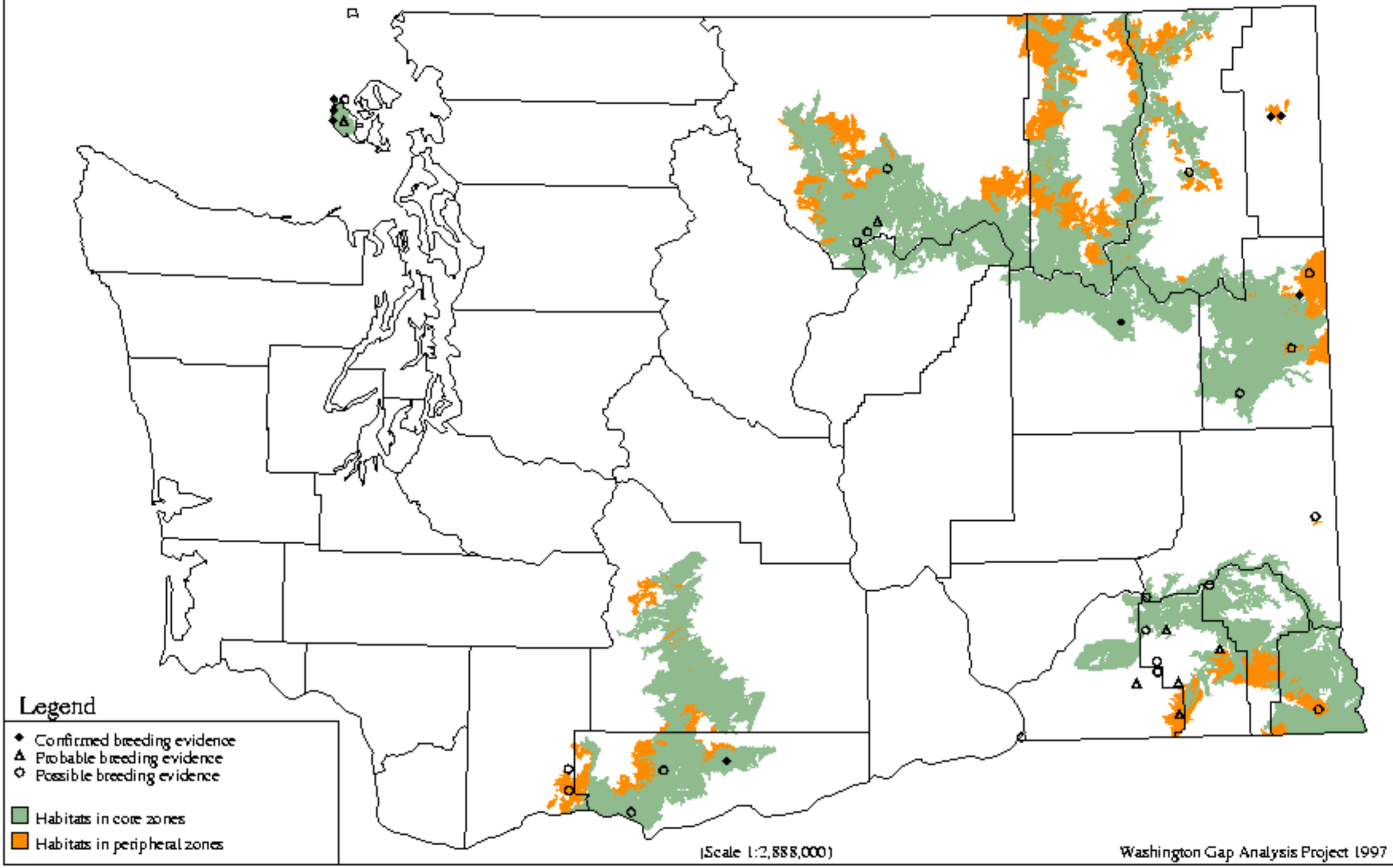
Sage Grouse - *Centrocercus urophasianus*



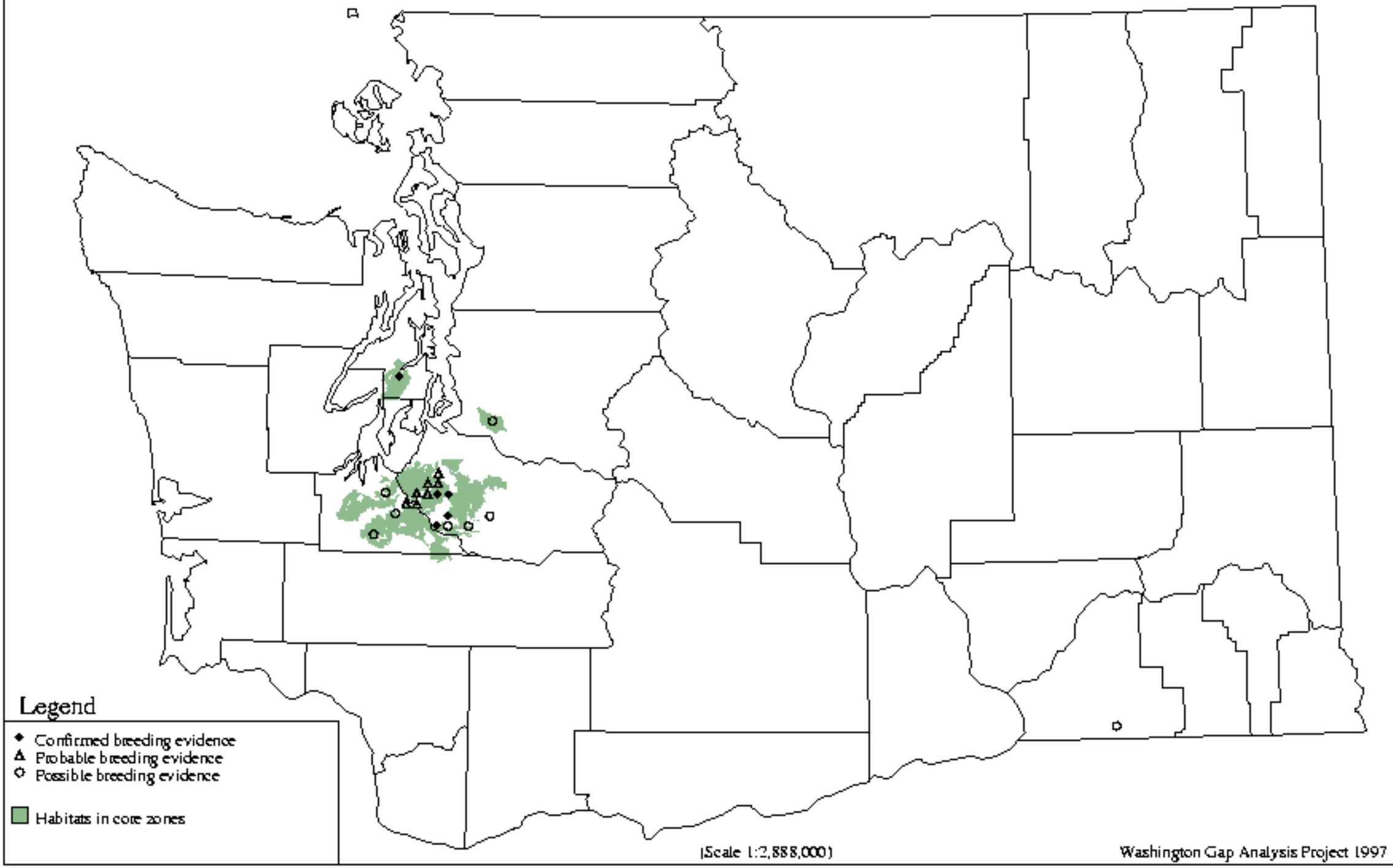
Sharp-tailed Grouse - *Tympanuchus phasianellus*



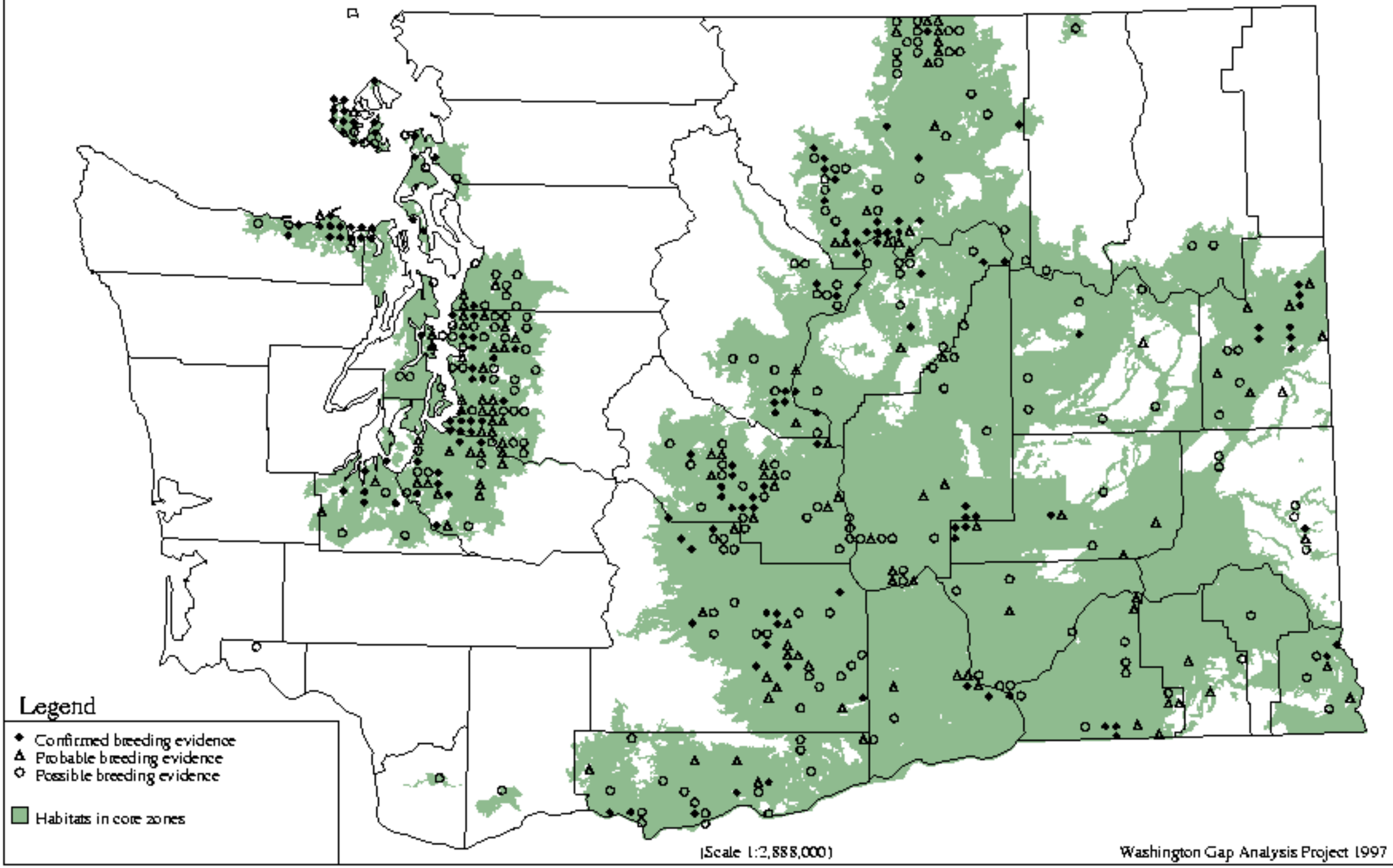
Wild Turkey - *Meleagris gallopavo*



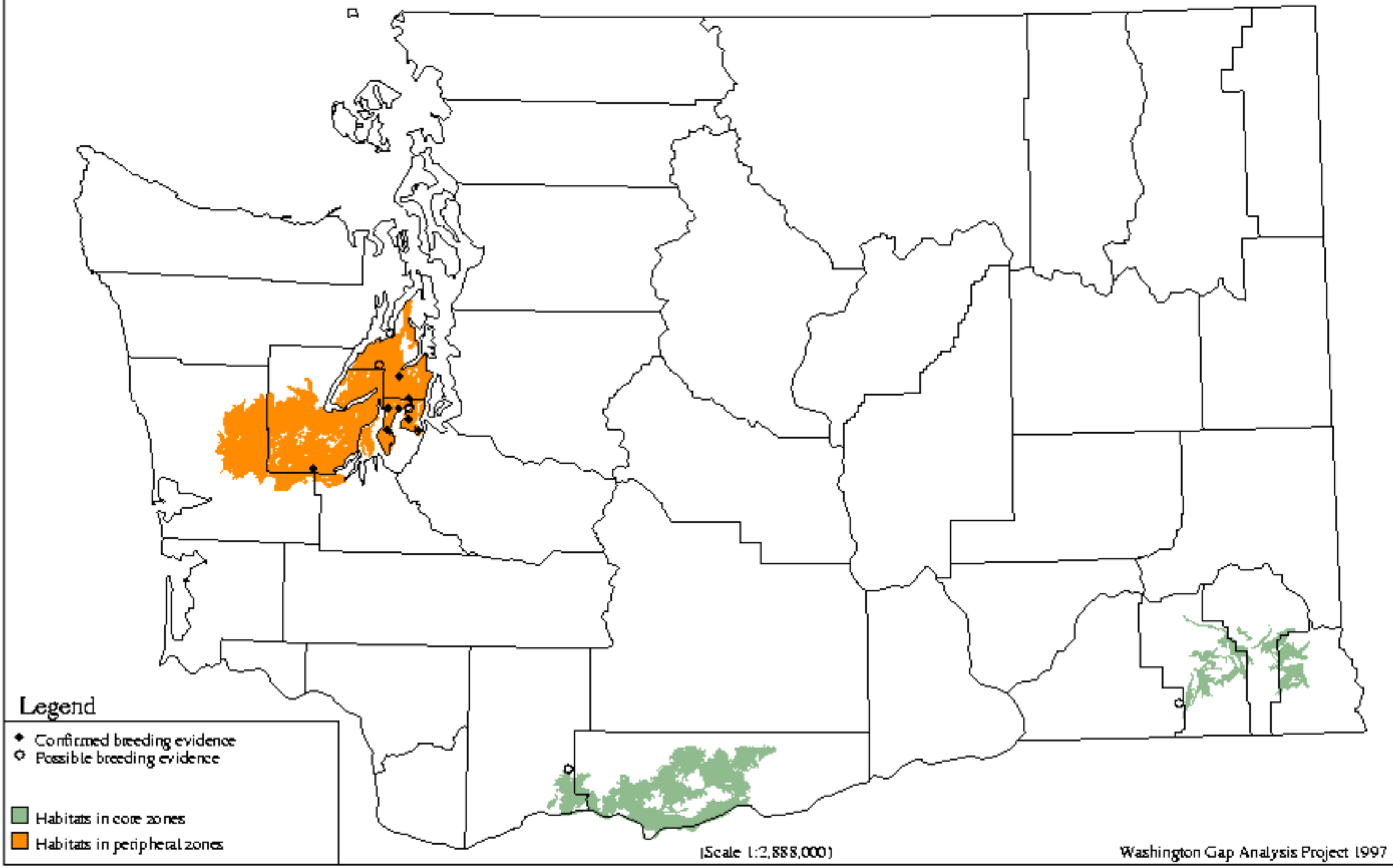
Northern Bobwhite - *Colinus virginianus*



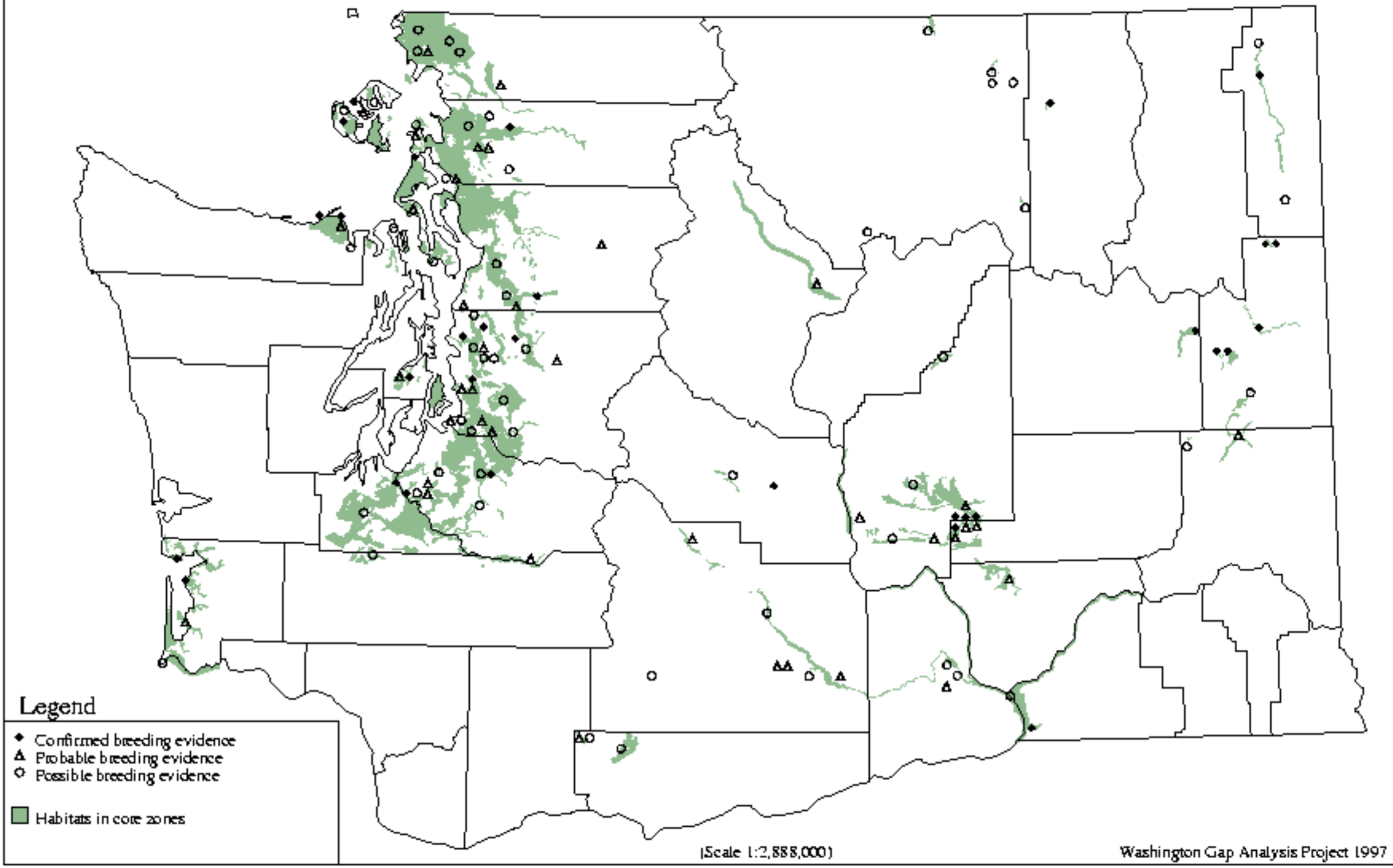
California Quail - *Callipepla californica*



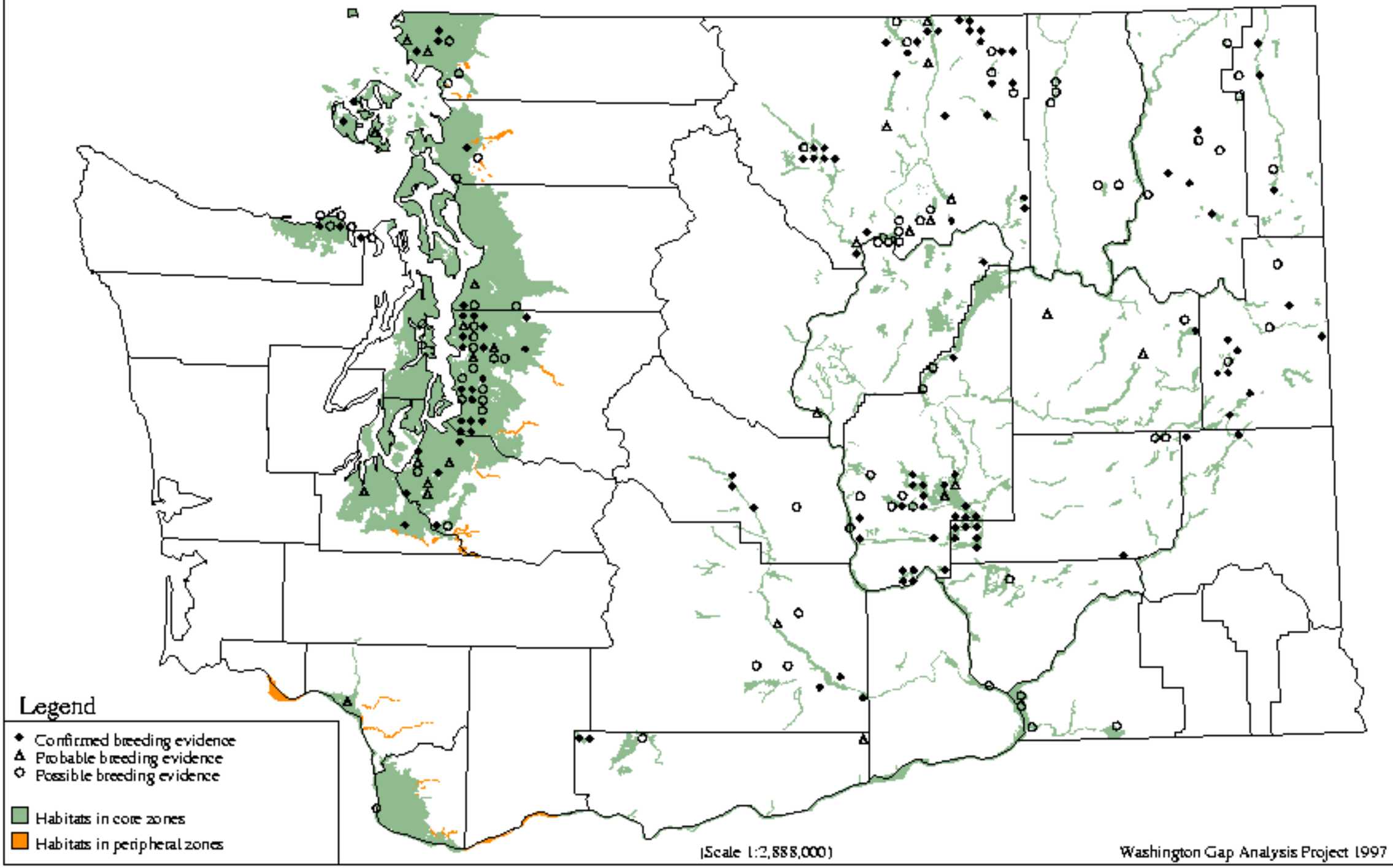
Mountain Quail - *Oreortyx pictus*



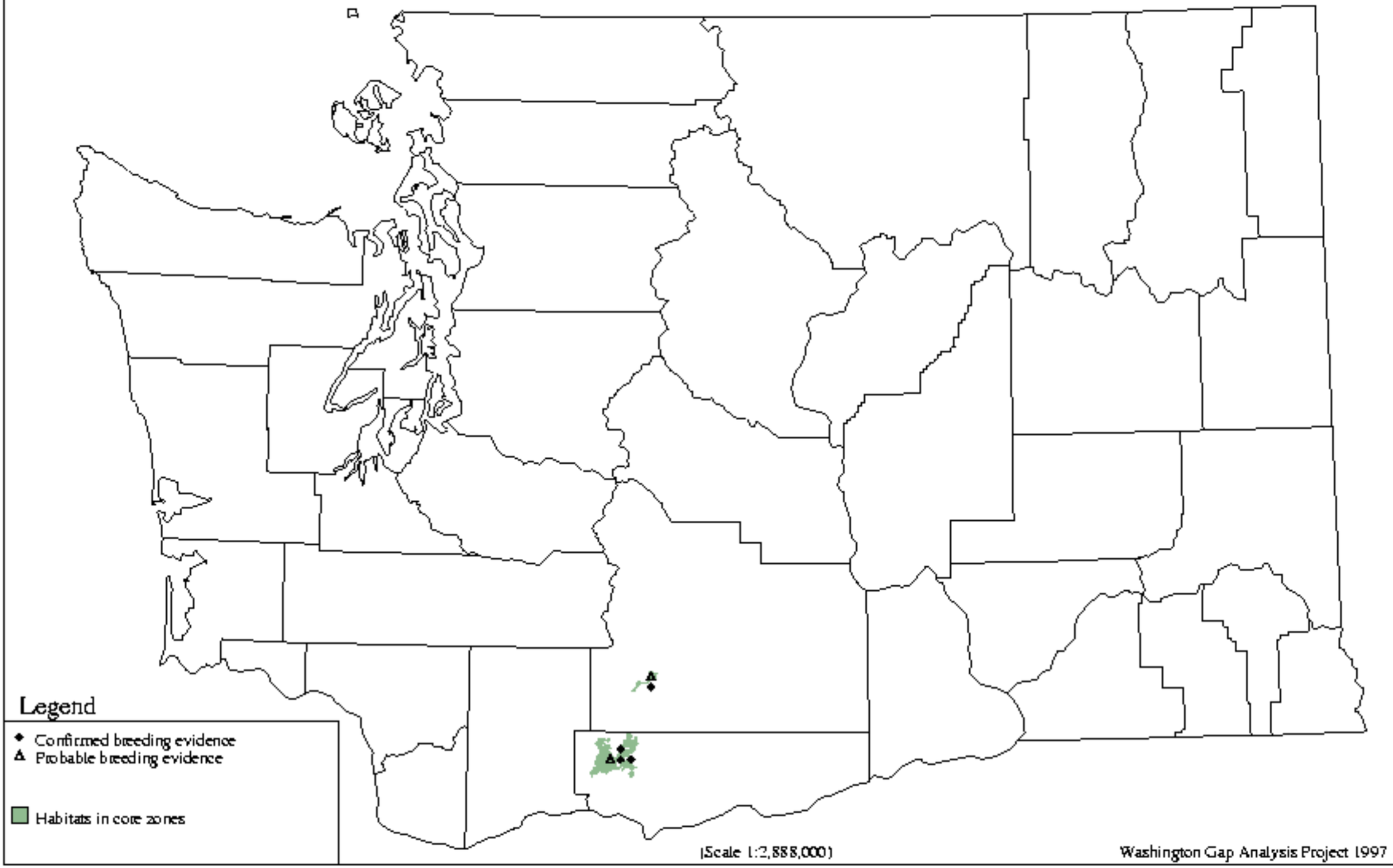
Virginia Rail - *Rallus limicola*



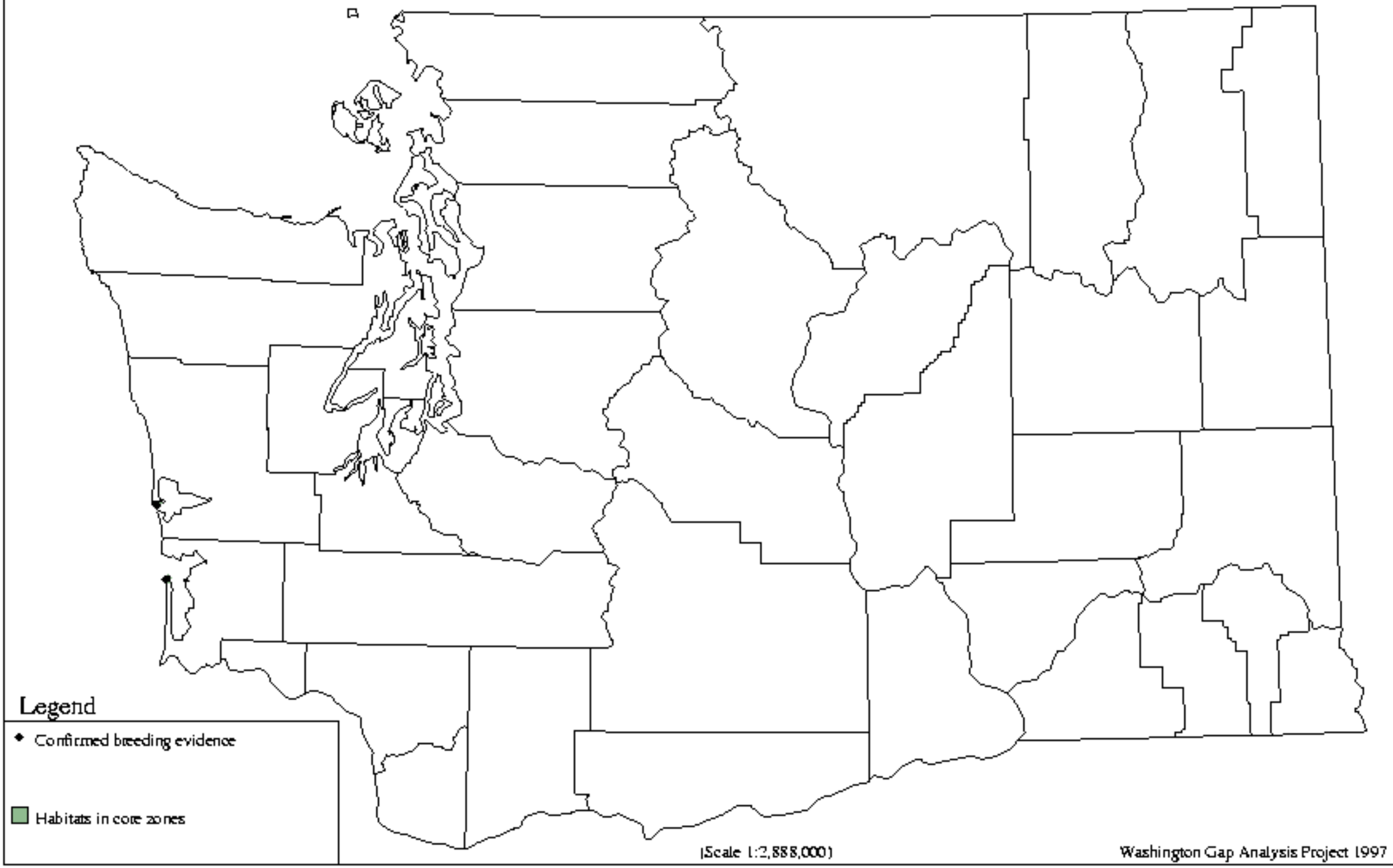
American Coot - *Fulica americana*



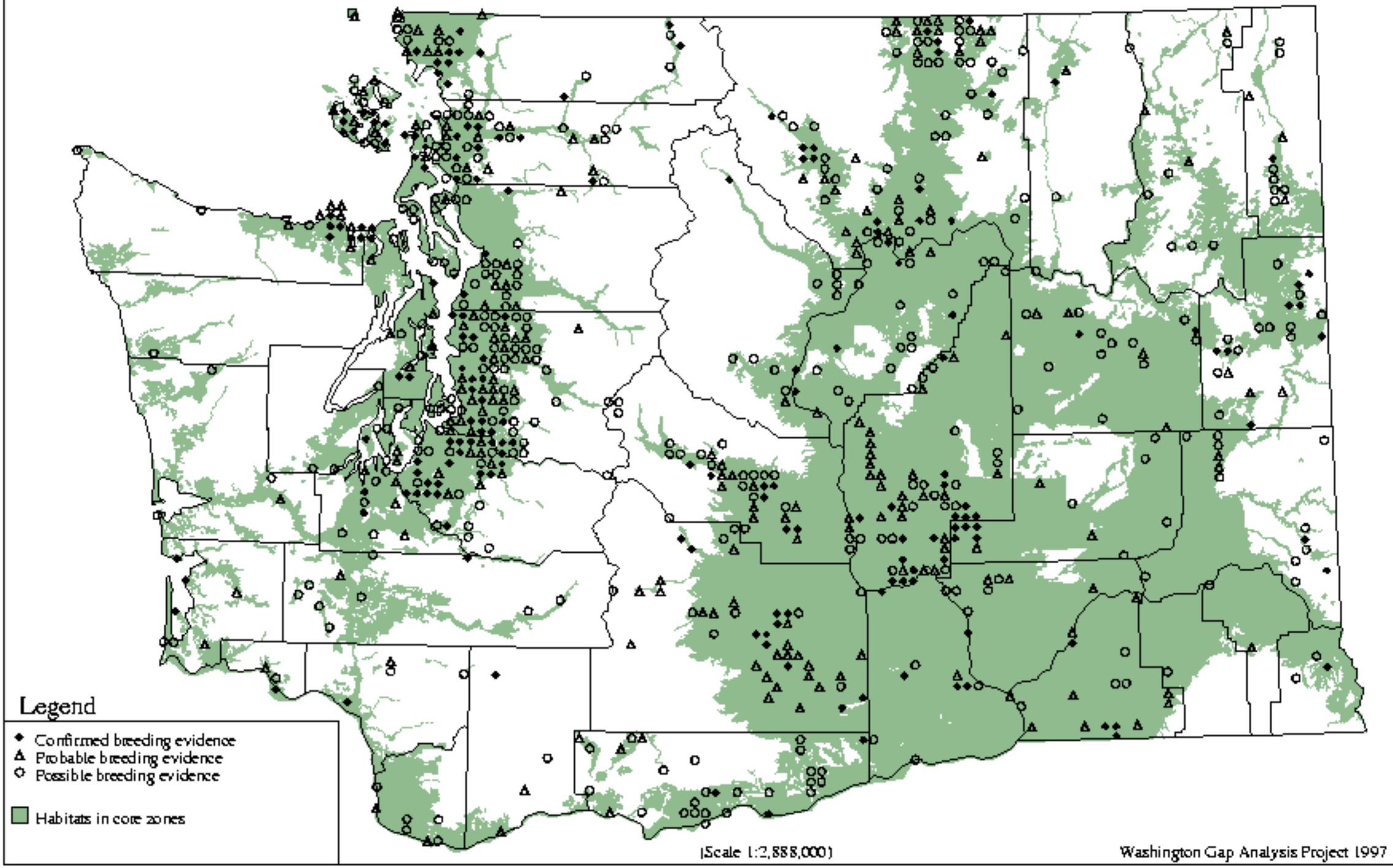
Sandhill Crane - *Grus canadensis*



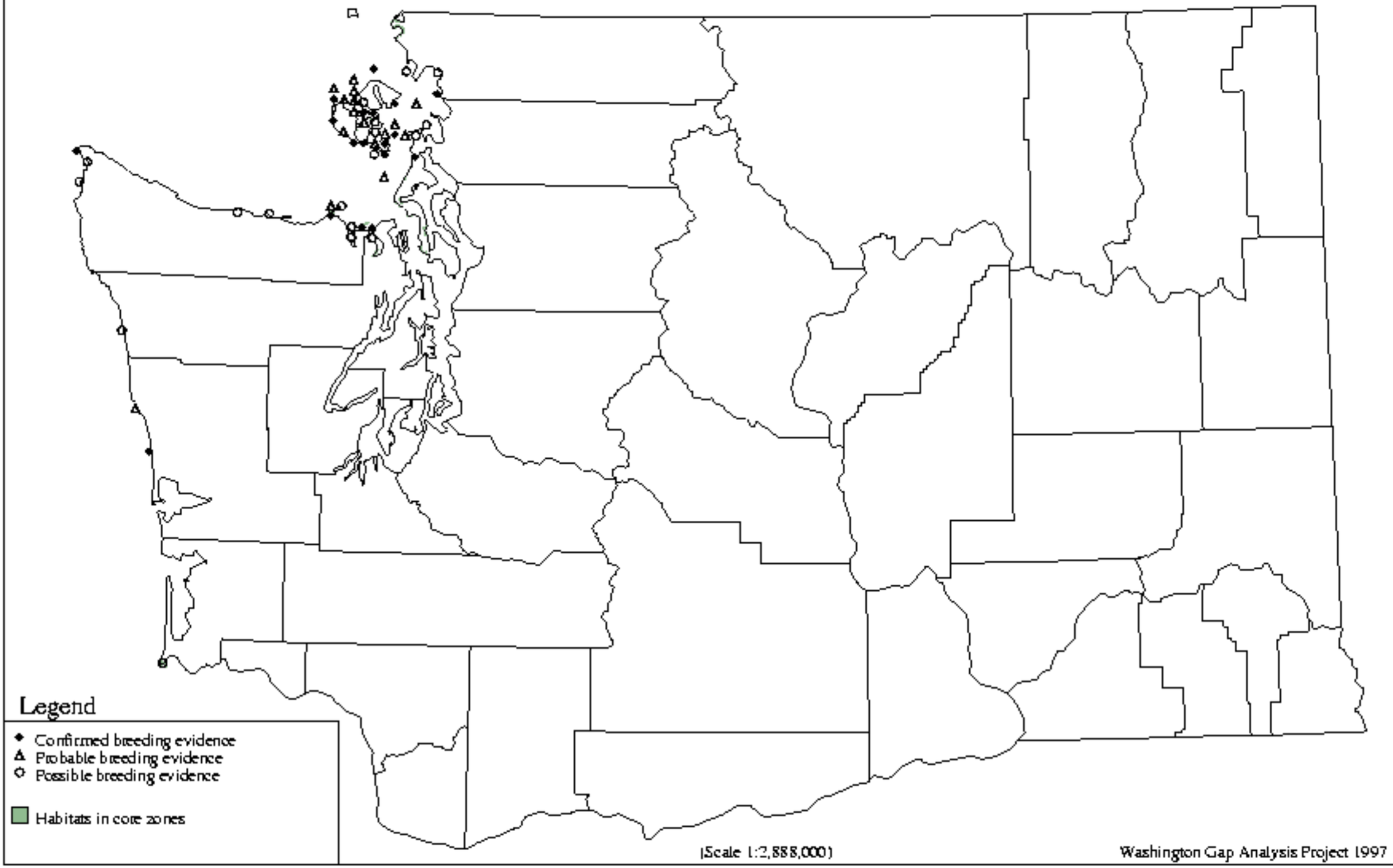
Snowy Plover - *Charadrius alexandrinus*



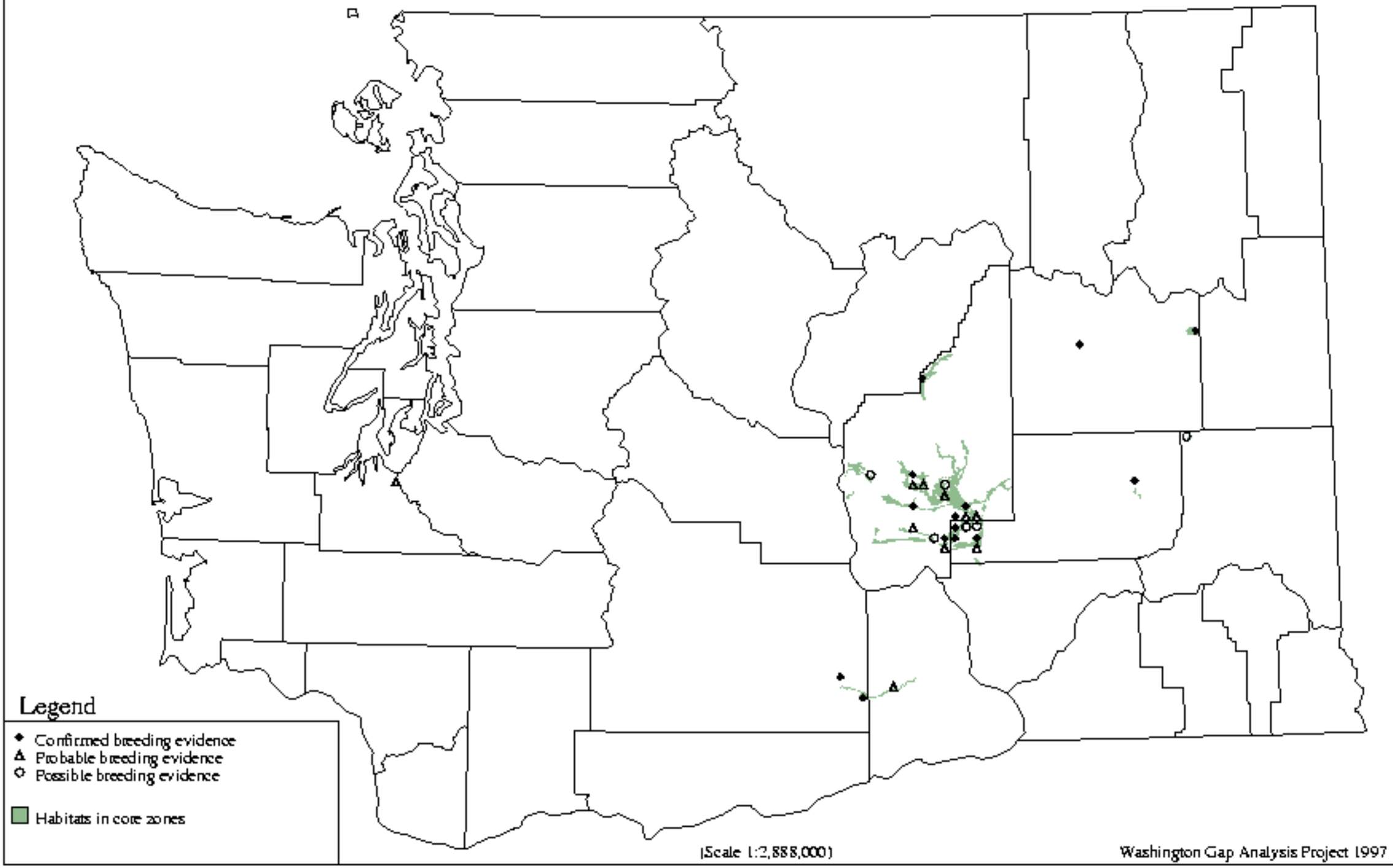
Killdeer - *Charadrius vociferus*



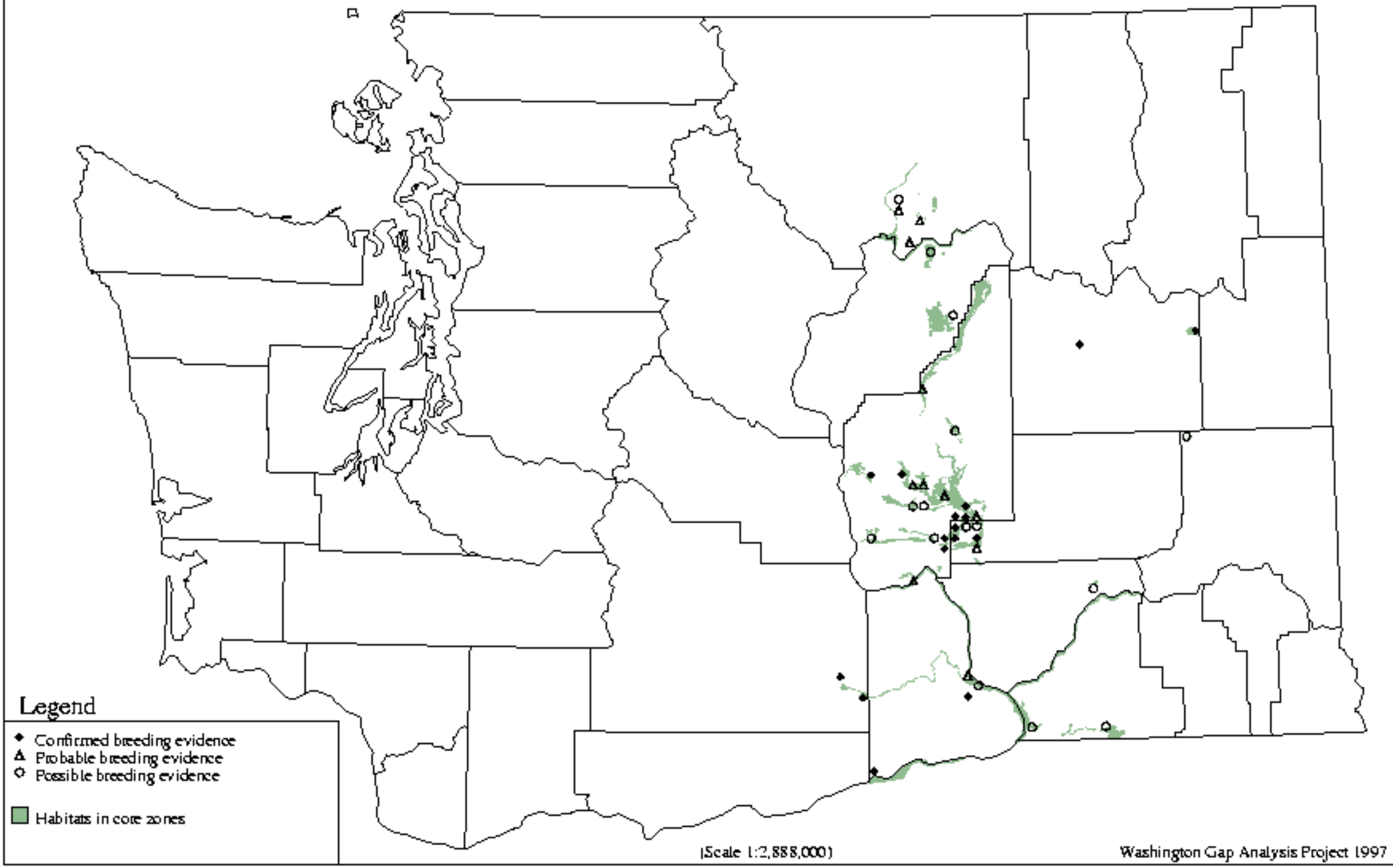
Black Oystercatcher - *Haematopus bachmani*



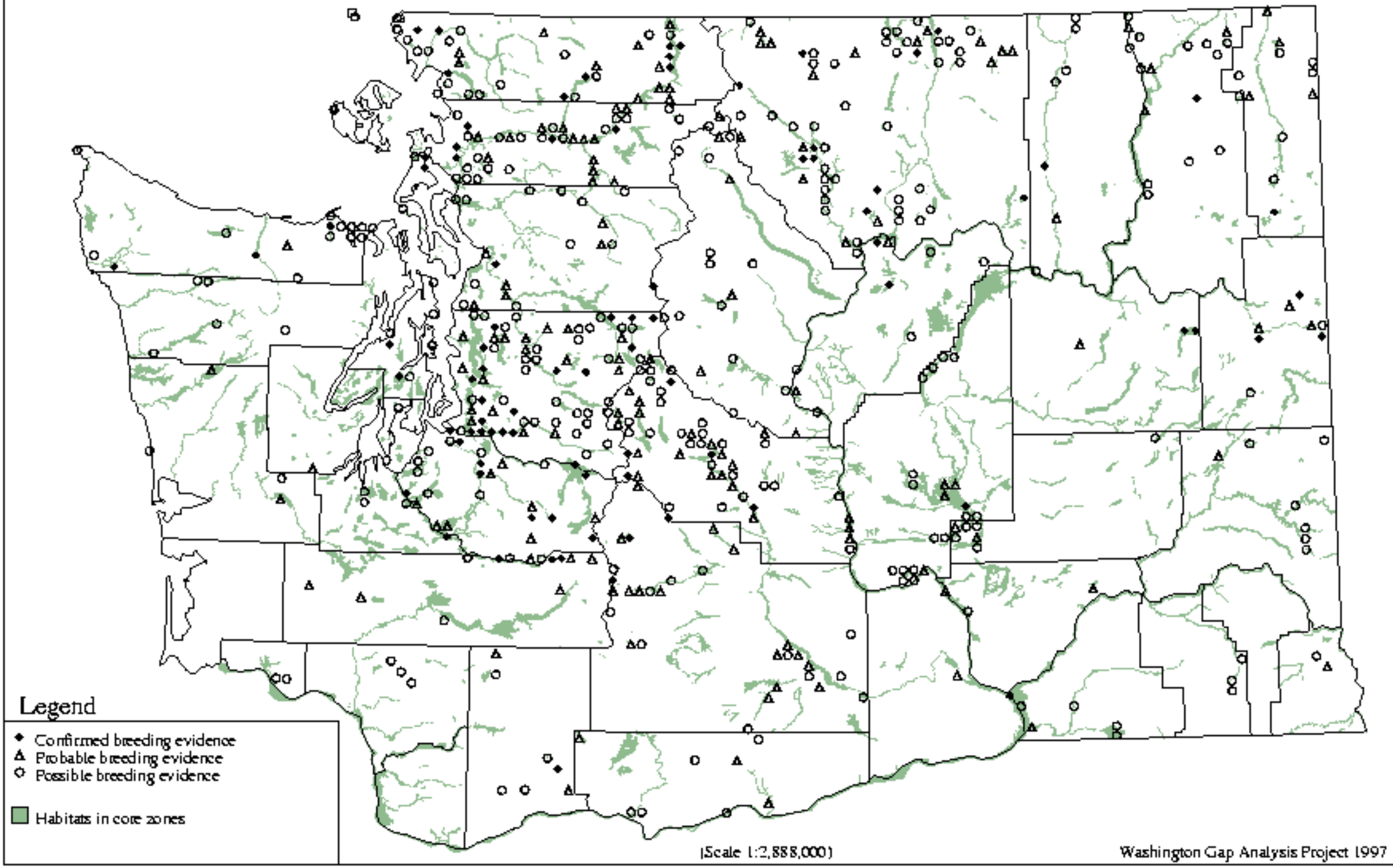
Black-necked Stilt - *Himantopus mexicanus*



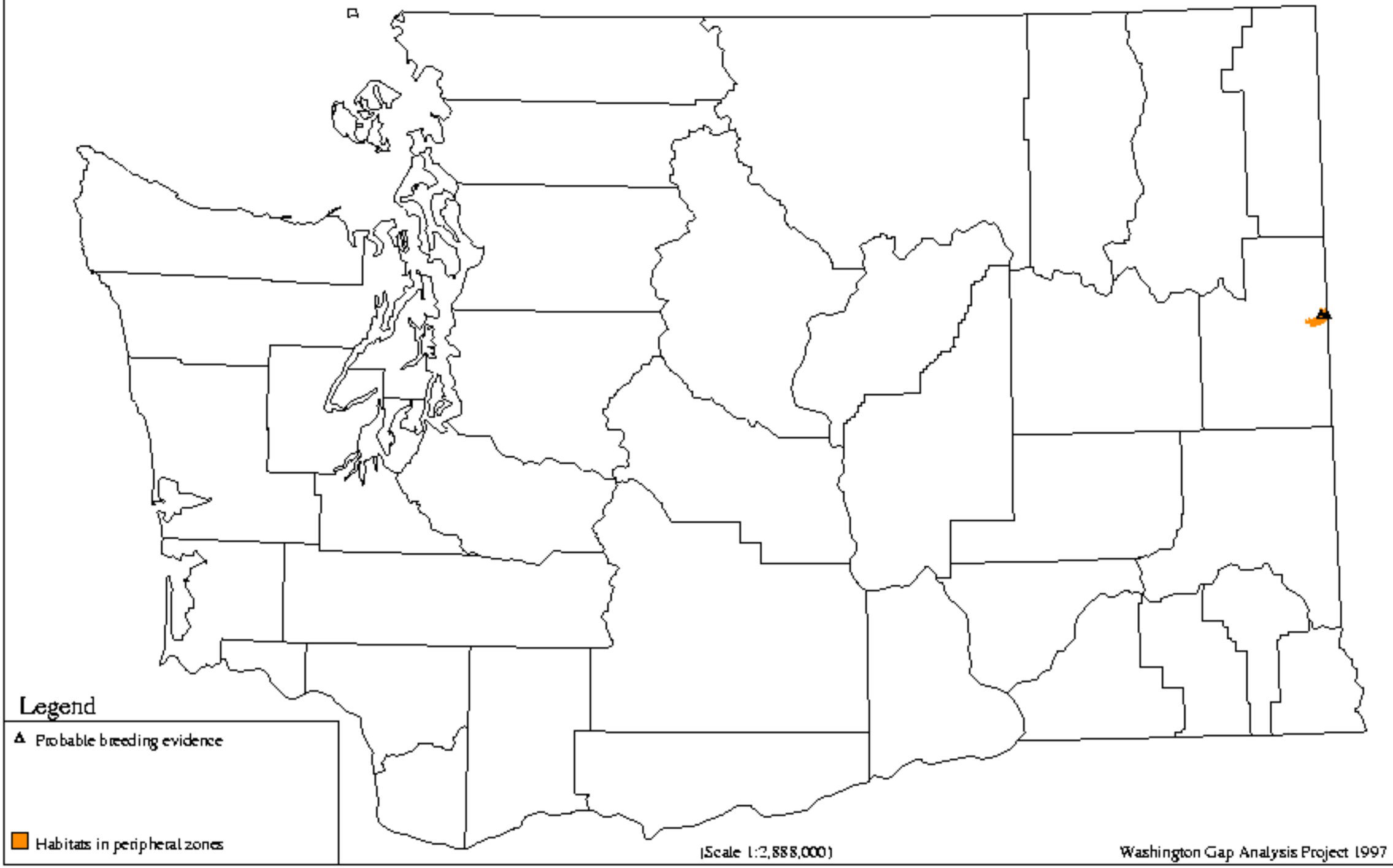
American Avocet - *Recurvirostra americana*



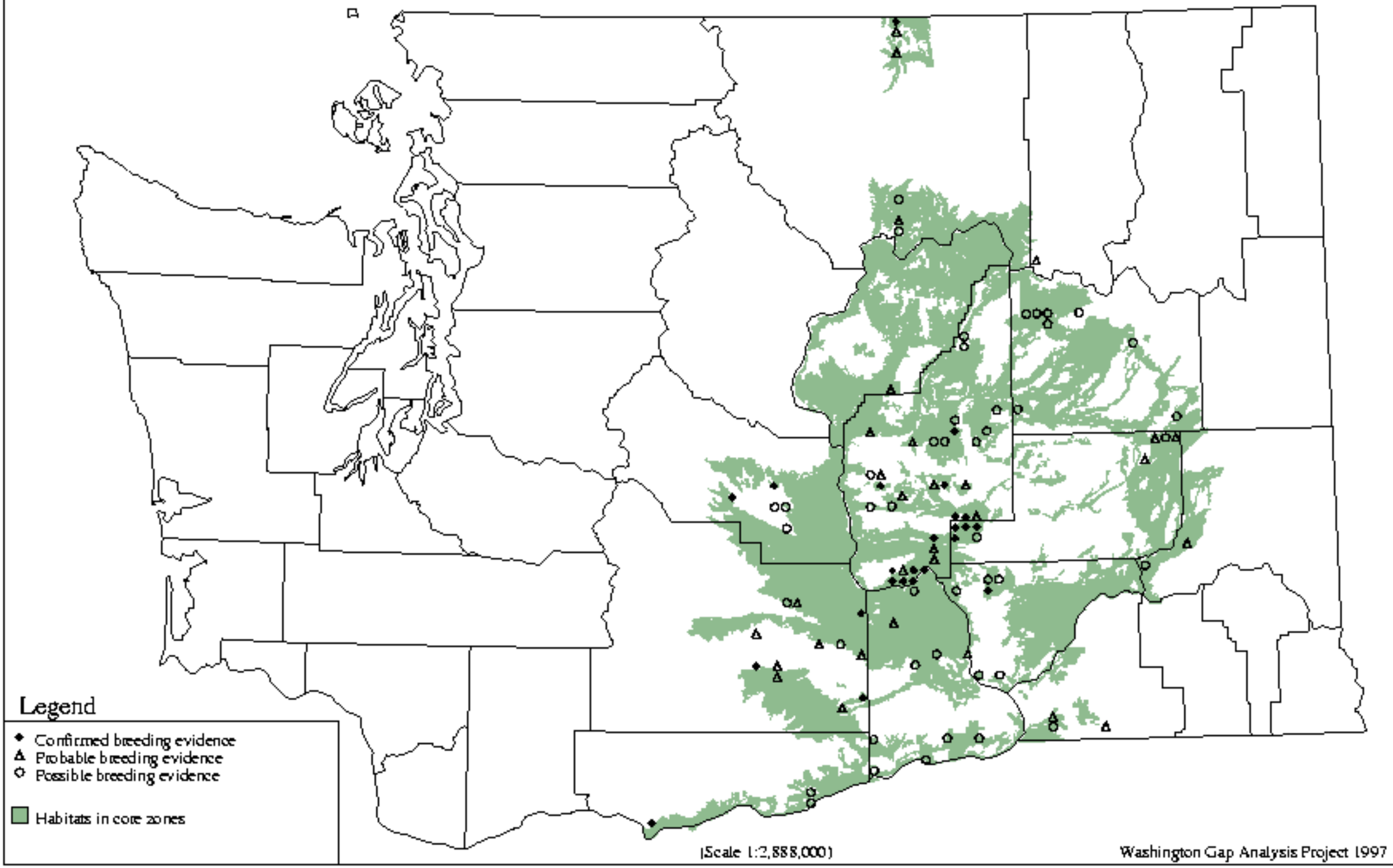
Spotted Sandpiper - *Actitis macularia*



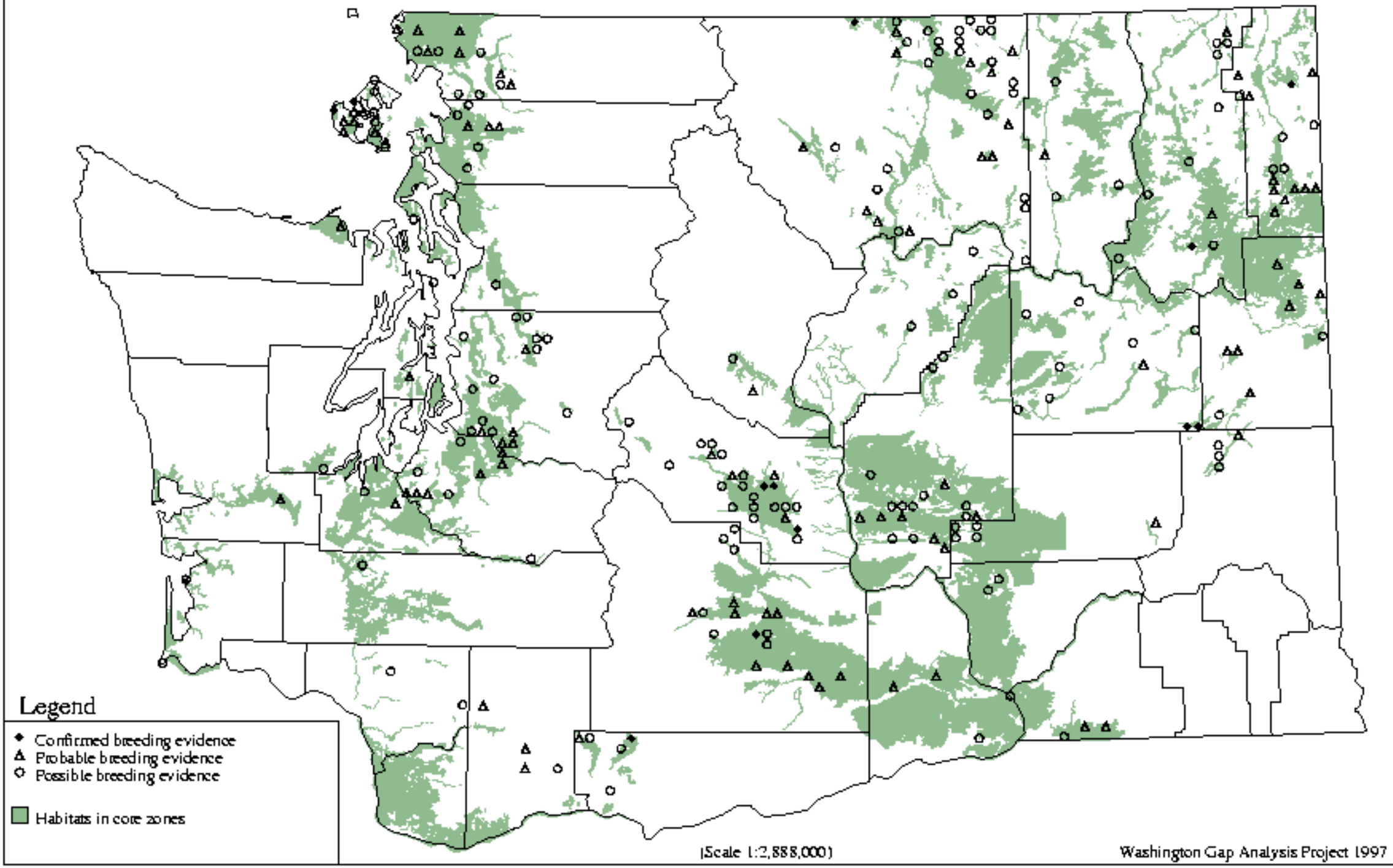
Upland Sandpiper - *Bartramia longicauda*



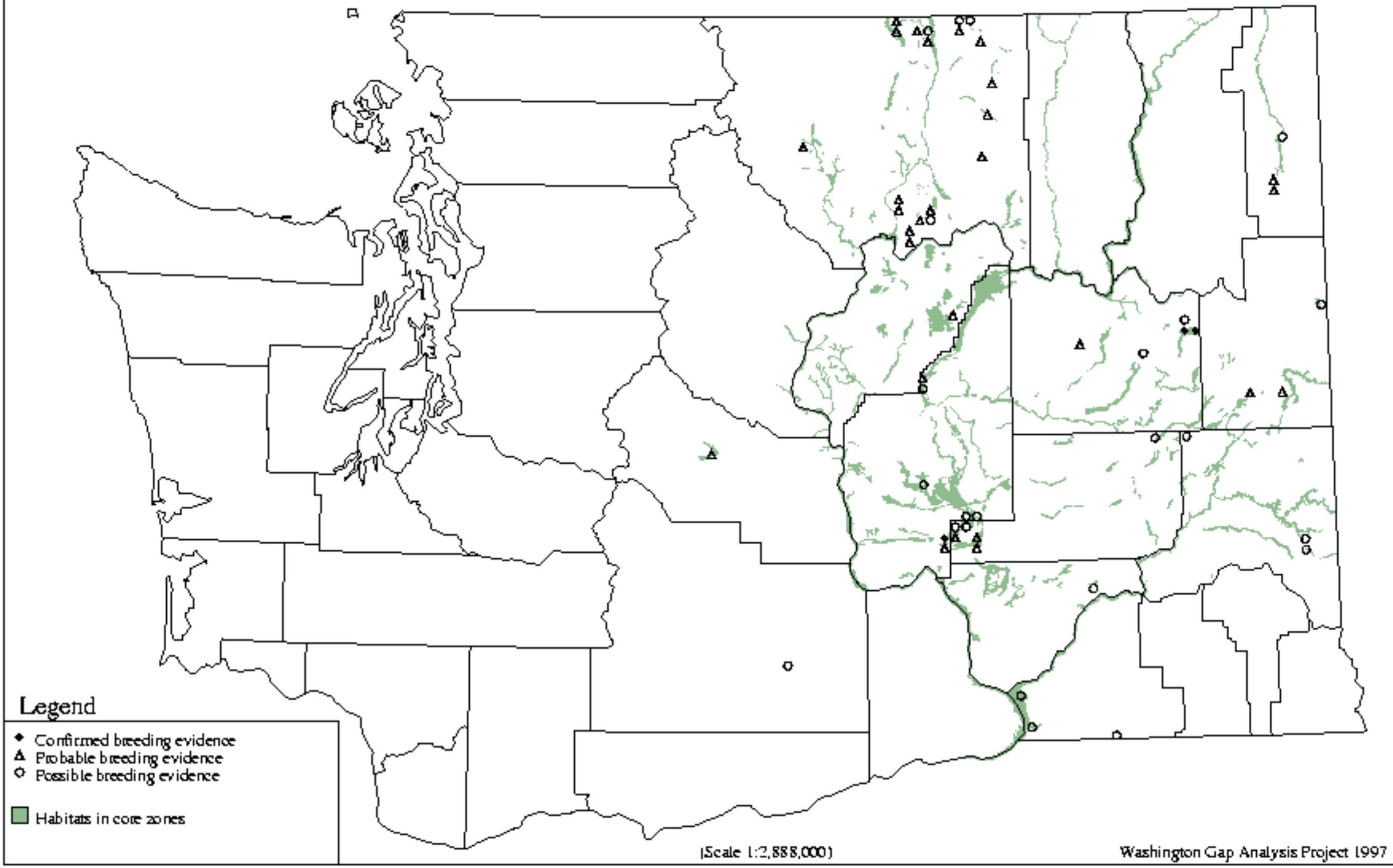
Long-billed Curlew - *Numenius americanus*



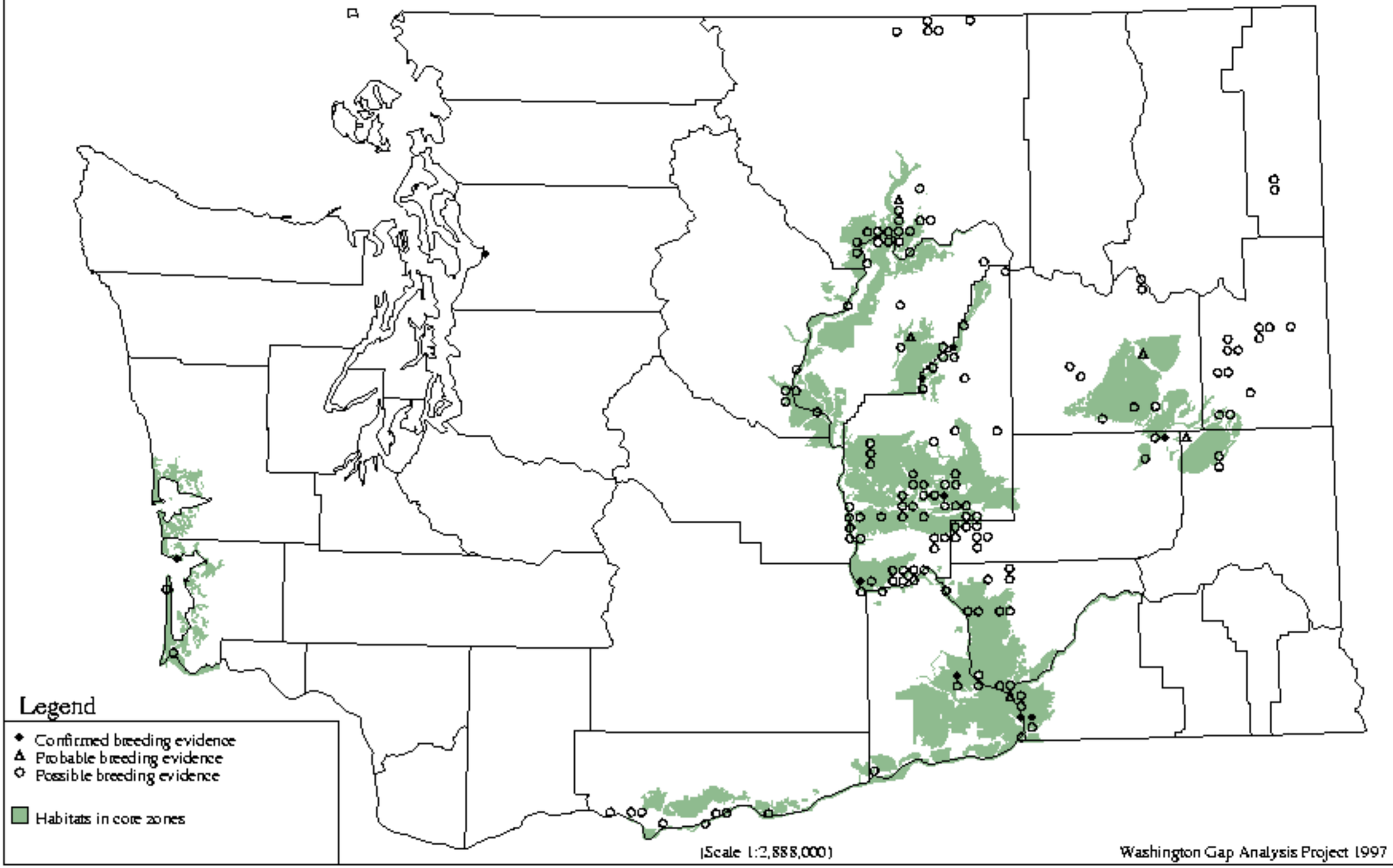
Common Snipe - *Gallinago gallinago*



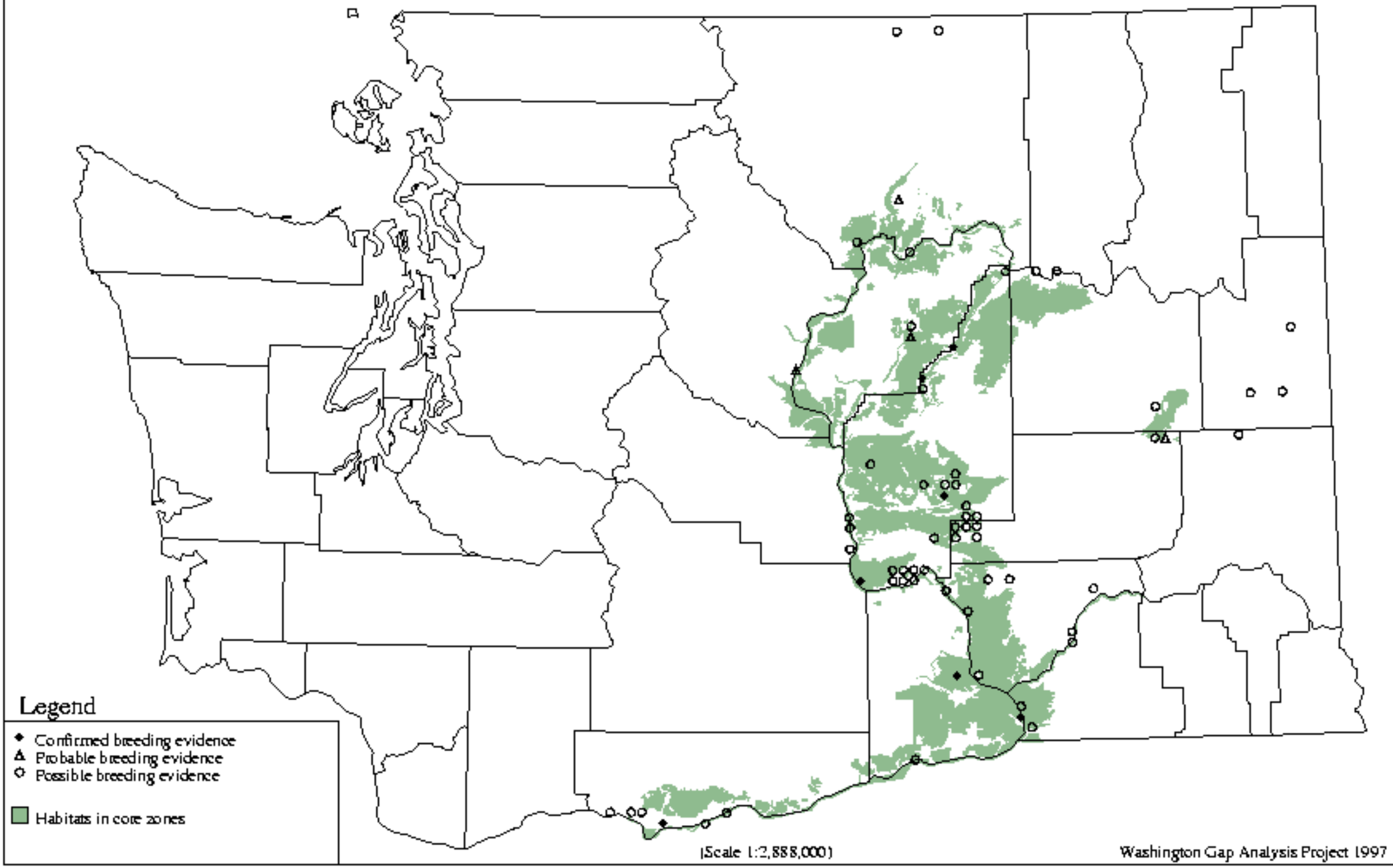
Wilson`s Phalarope - *Phalaropus tricolor*



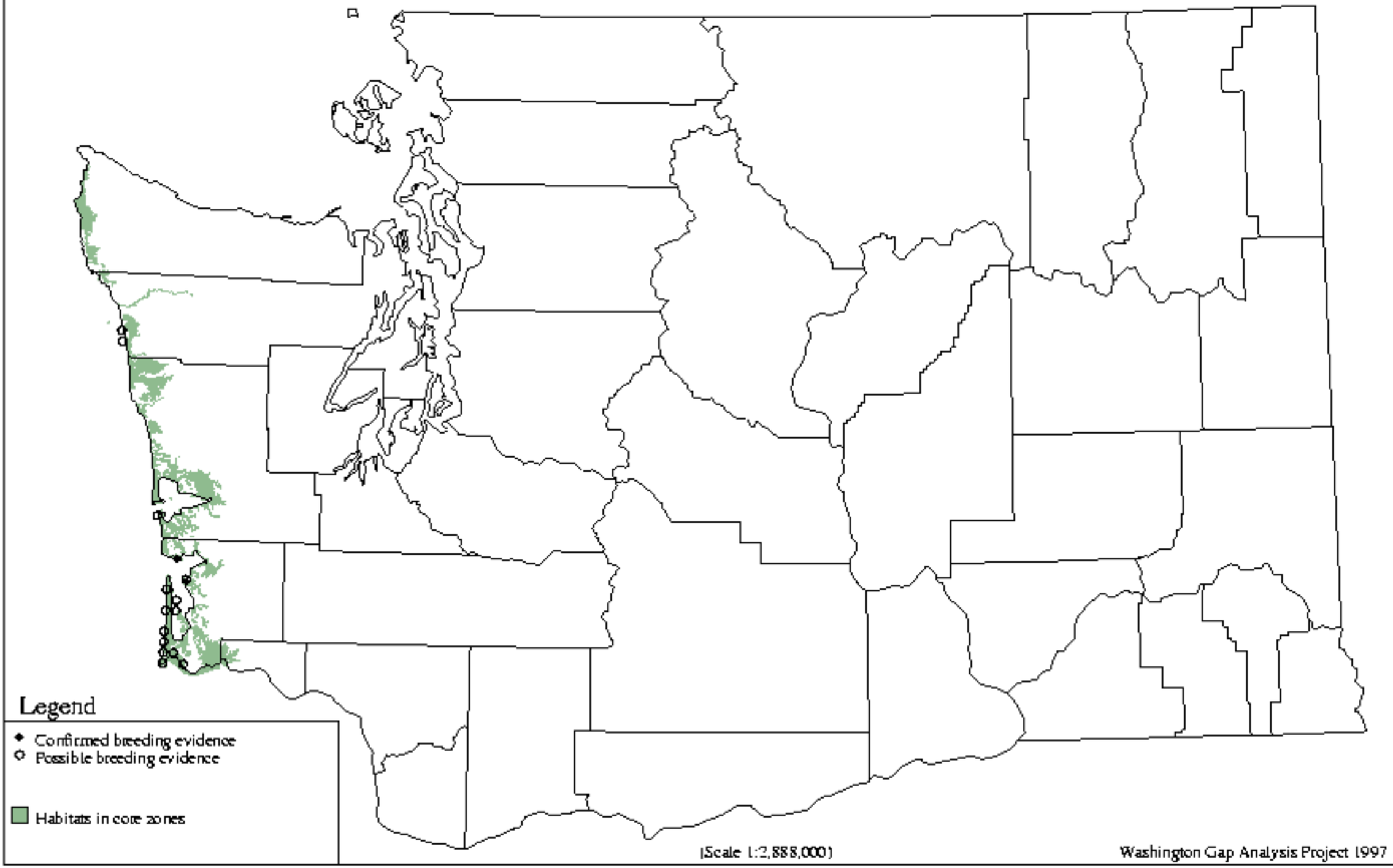
Ring-billed Gull - *Larus delawarensis*



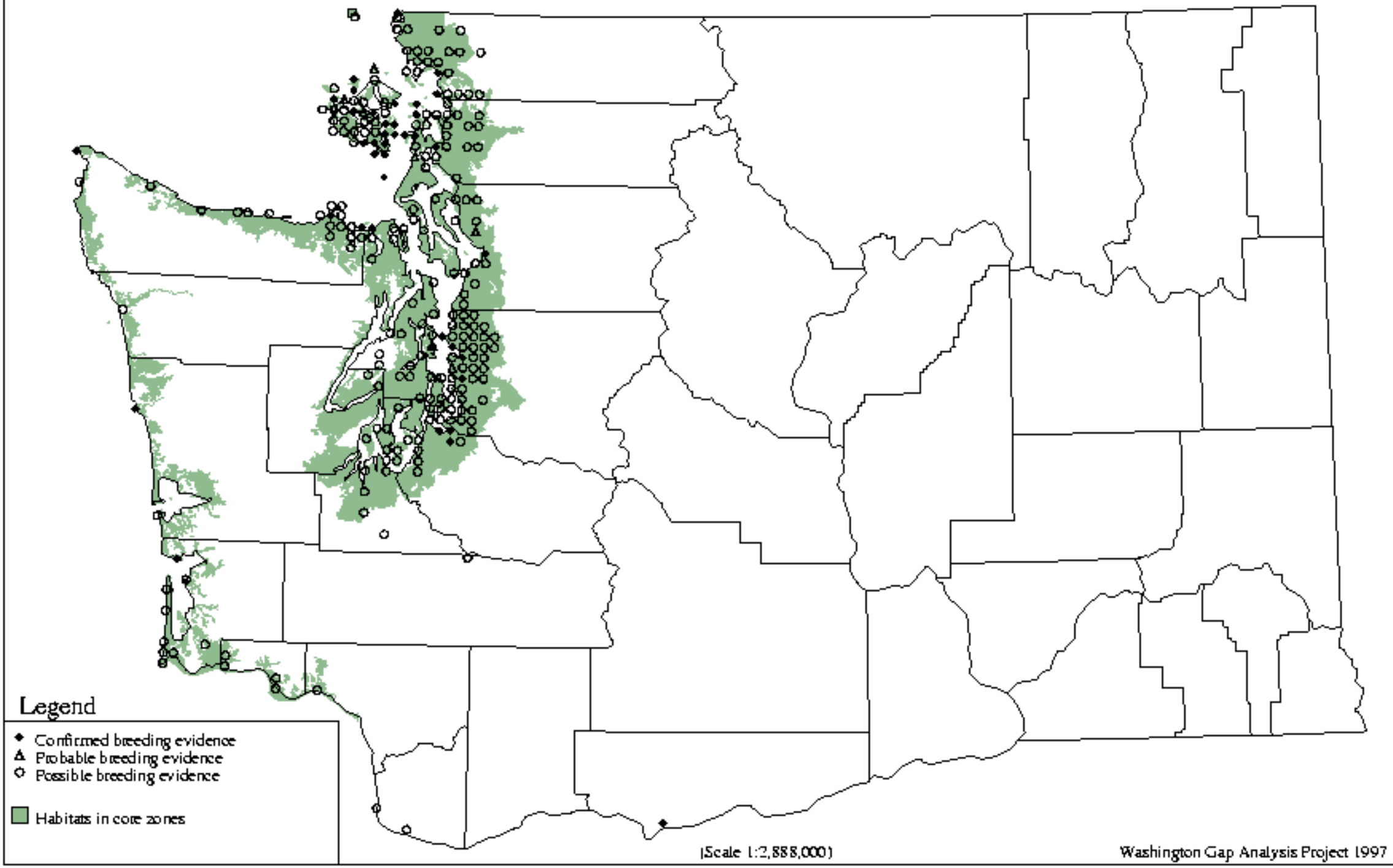
California Gull - *Larus californicus*



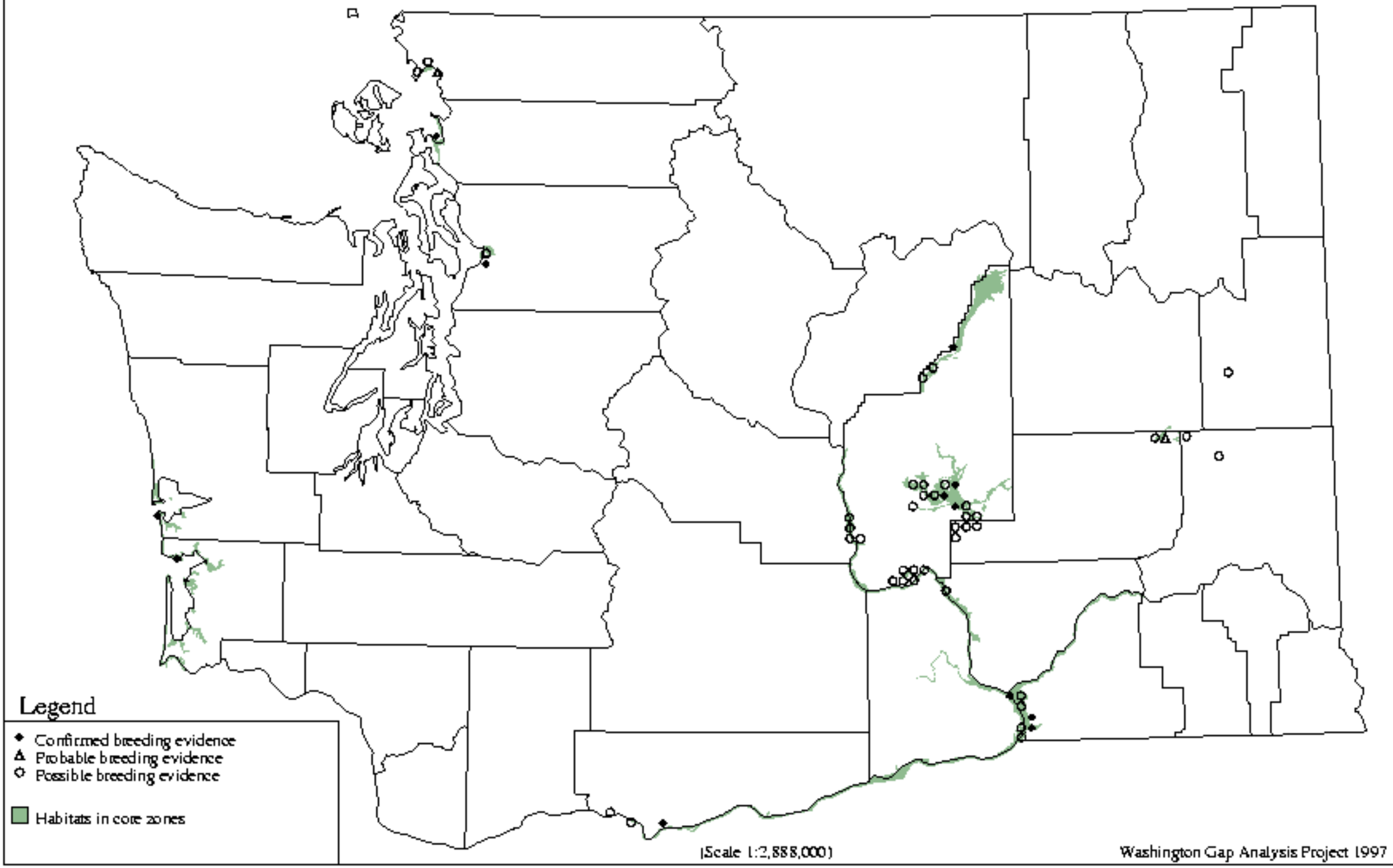
Western Gull - *Larus occidentalis*



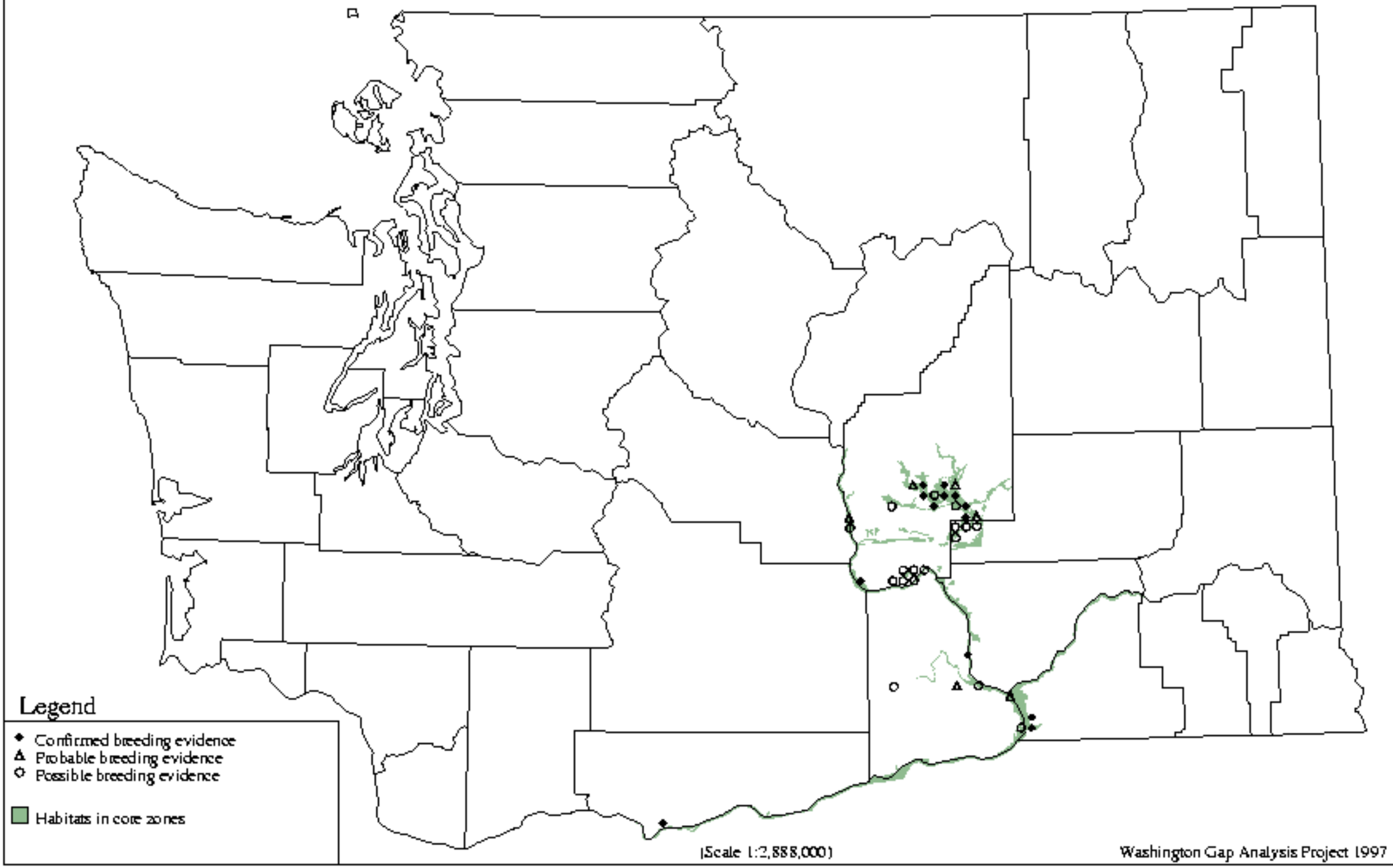
Glaucous-winged Gull - *Larus glaucescens*



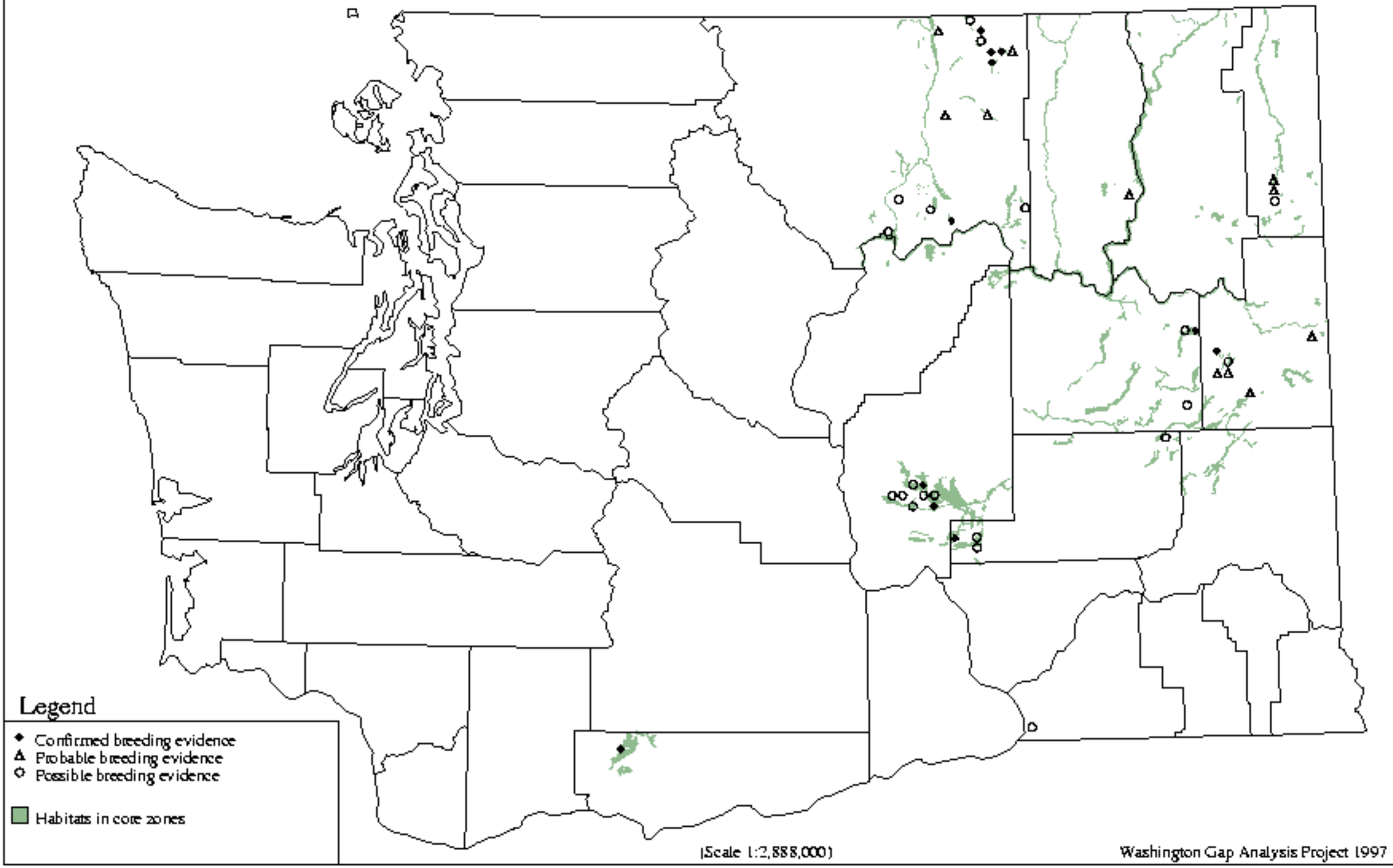
Caspian Tern - *Sterna caspia*



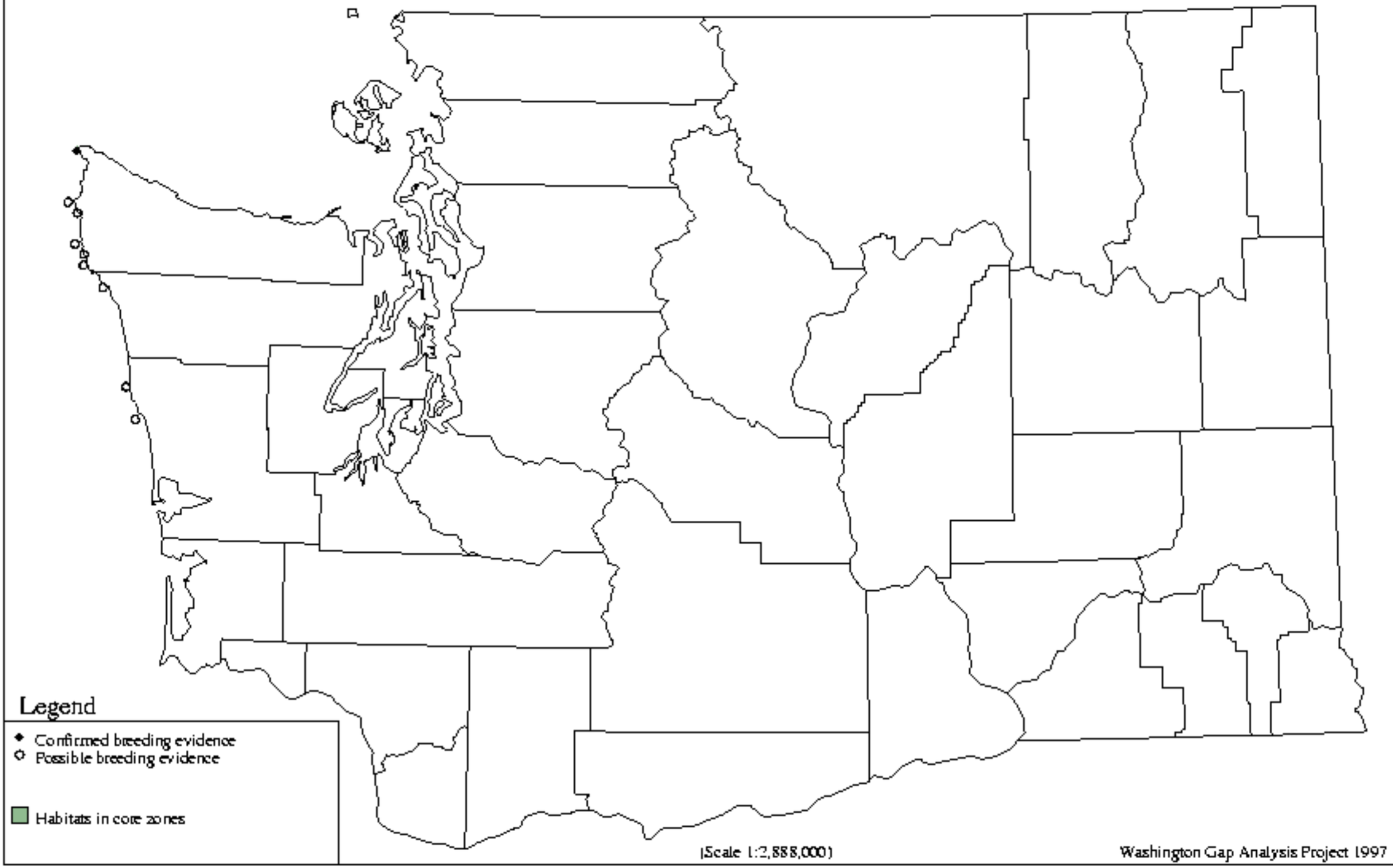
Forster`s Tern - *Sterna forsteri*



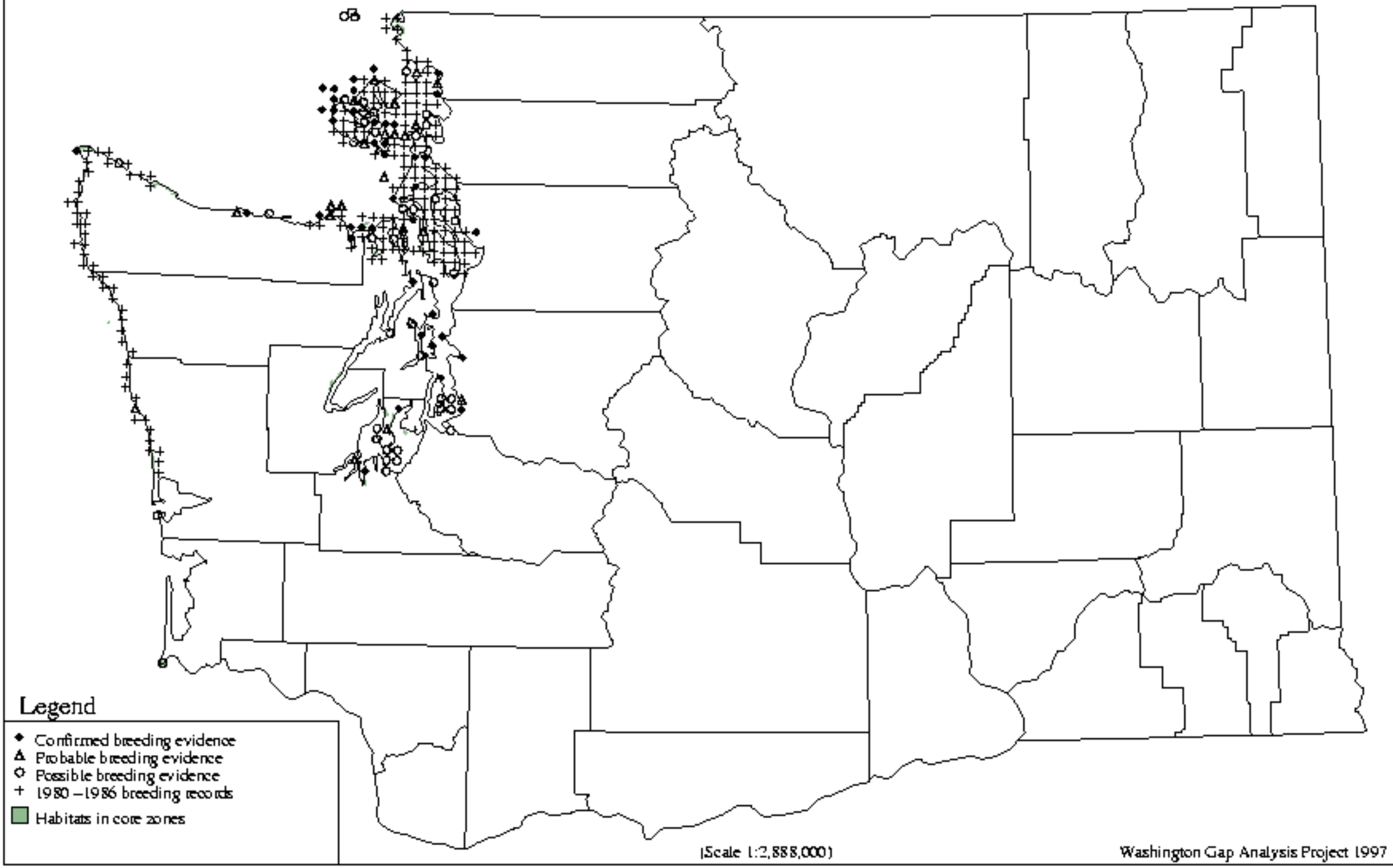
Black Tern - *Chlidonias niger*



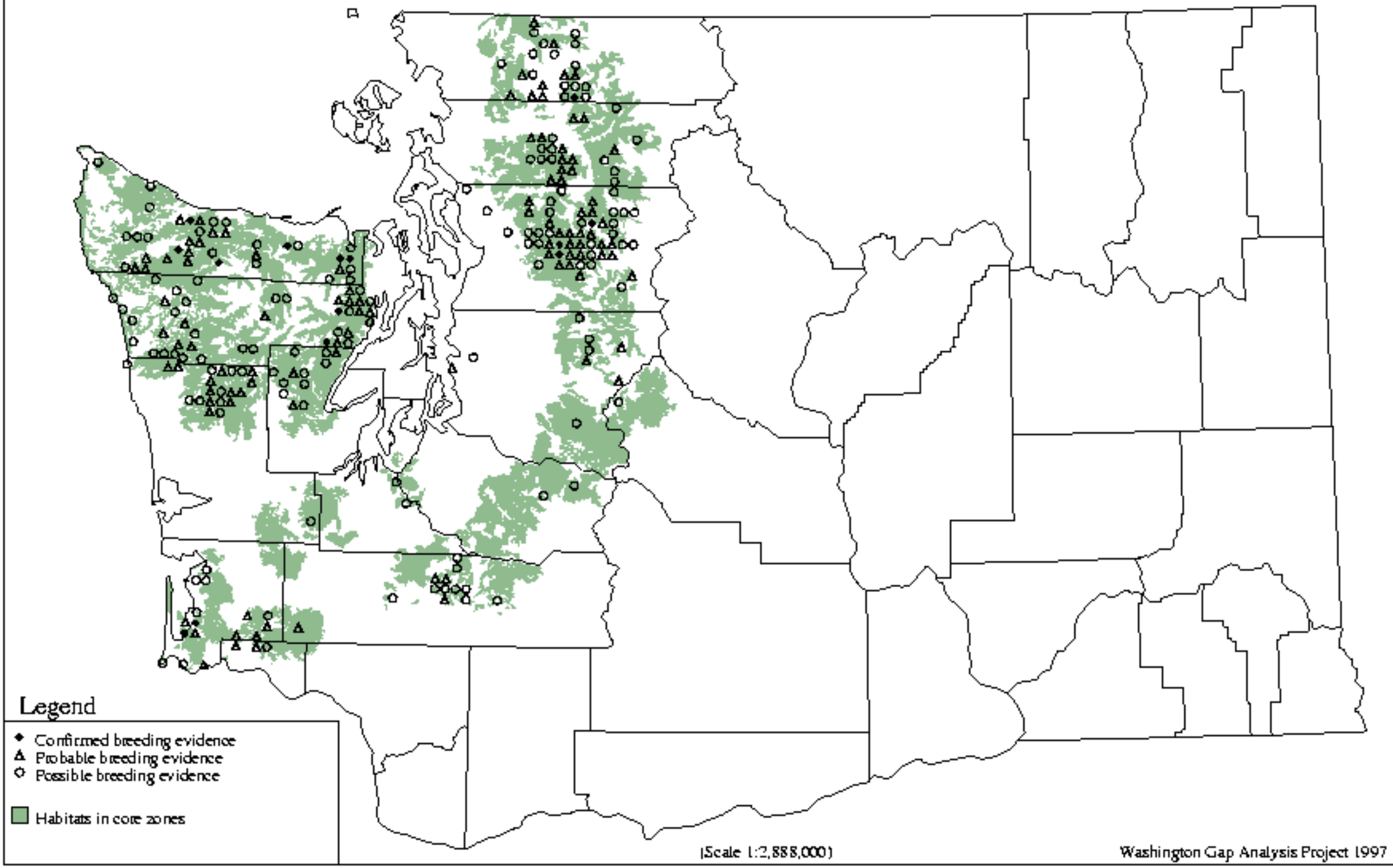
Common Murre - *Uria aalge*



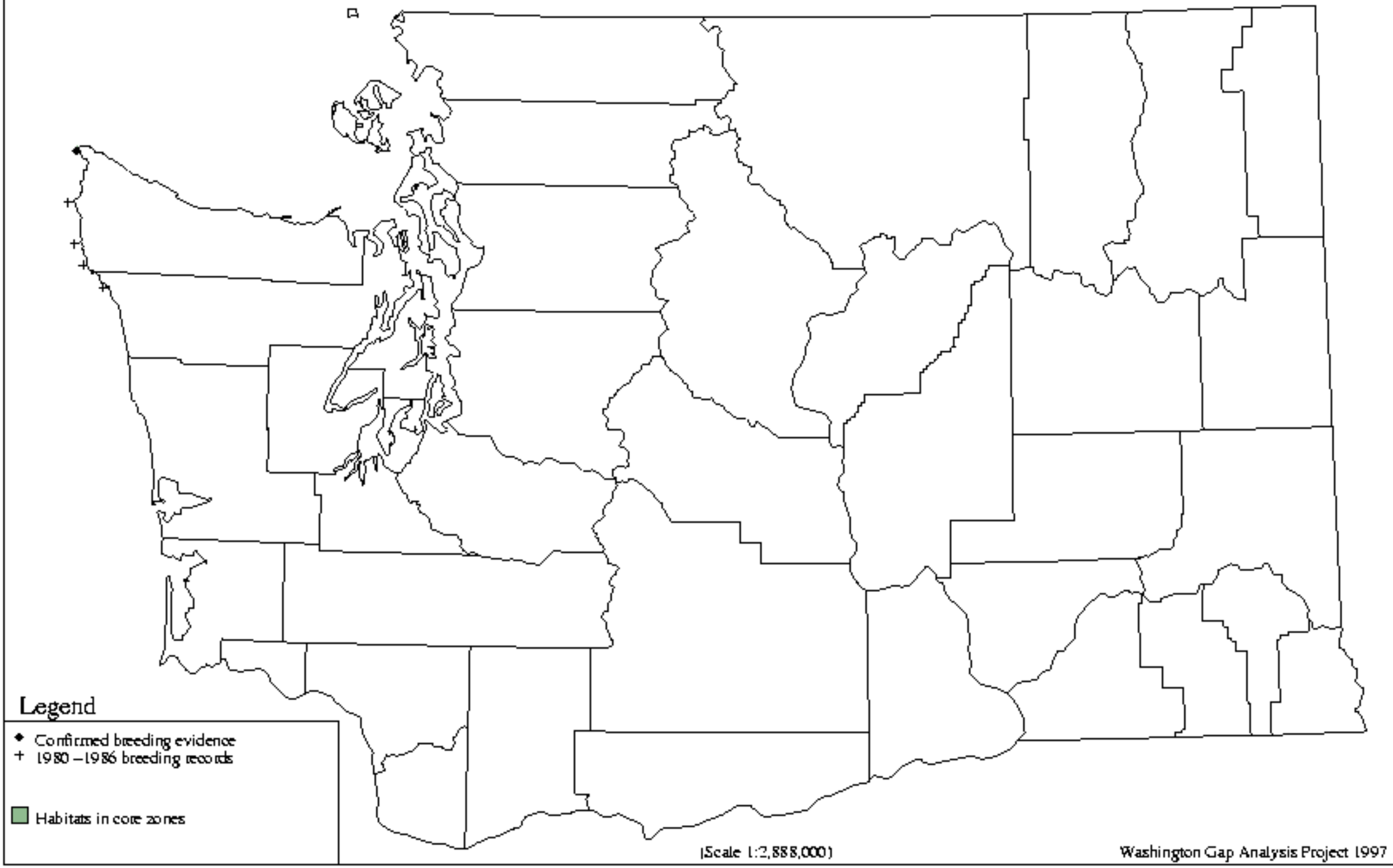
Pigeon Guillemot - *Cepphus columba*



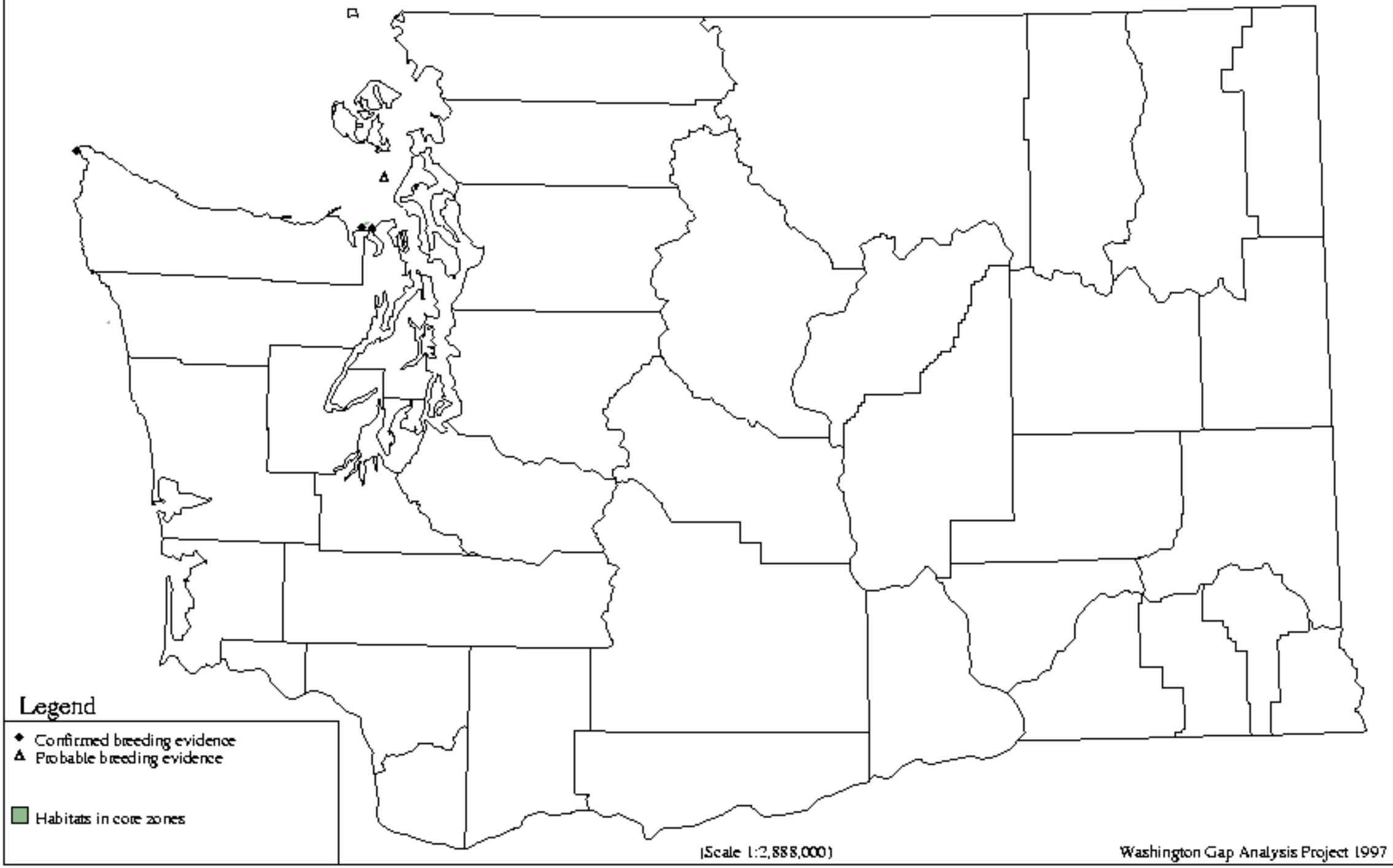
Marbled Murrelet - *Brachyramphus marmoratus*



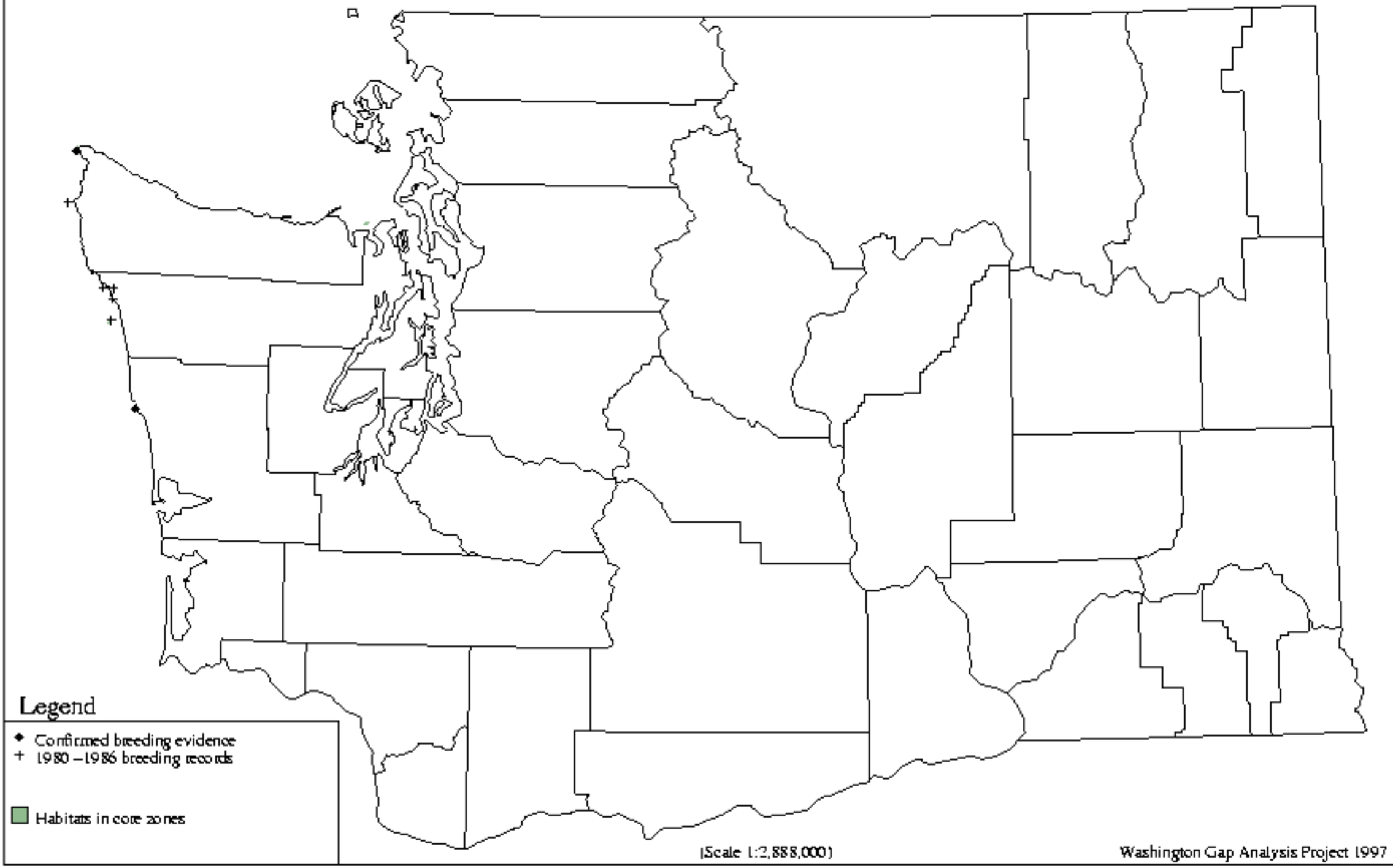
Cassin`s Auklet - *Ptychoramphus aleuticus*



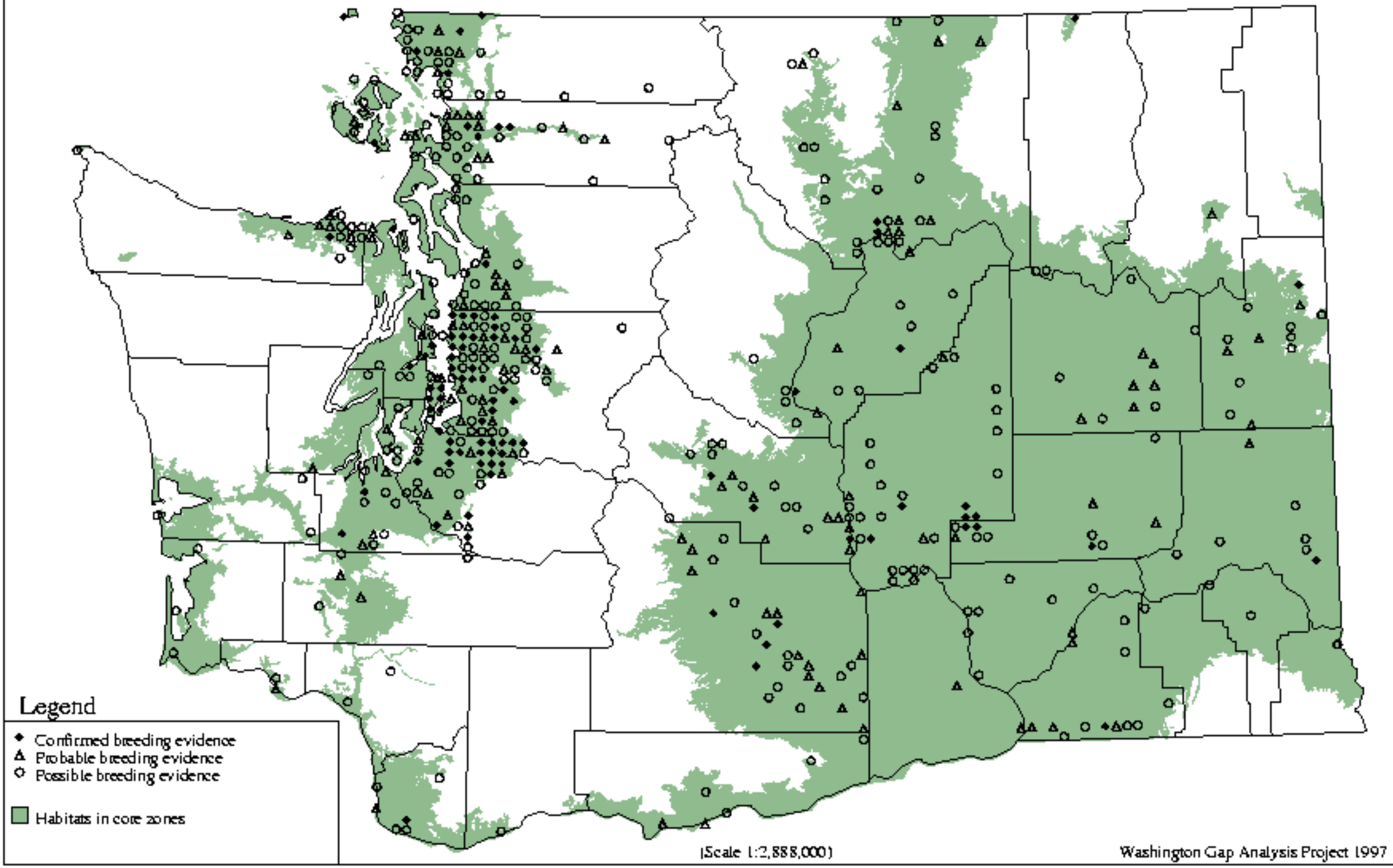
Rhinoceros Auklet - *Cerorhinca monocerata*



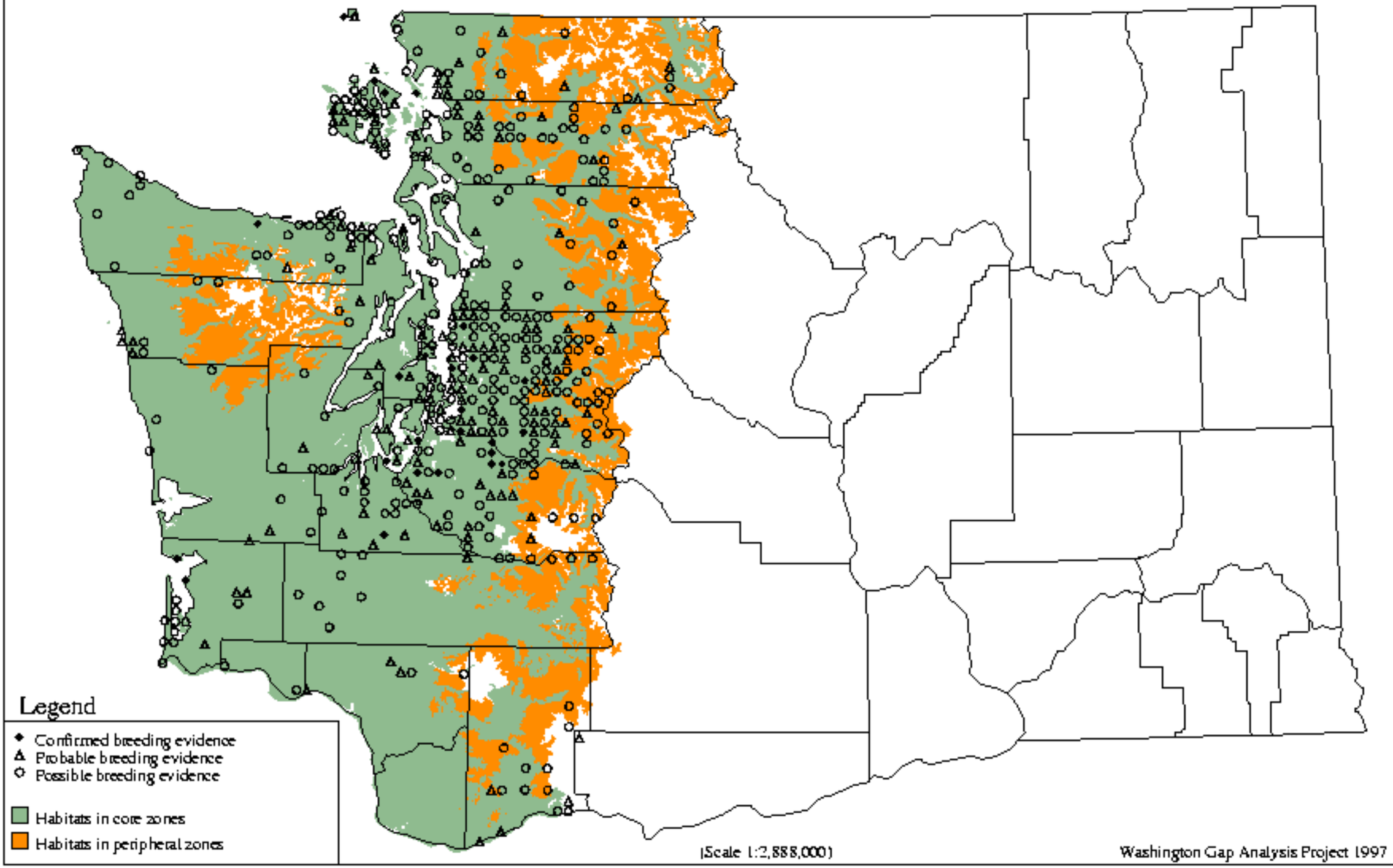
Tufted Puffin - *Fratercula cirrhata*



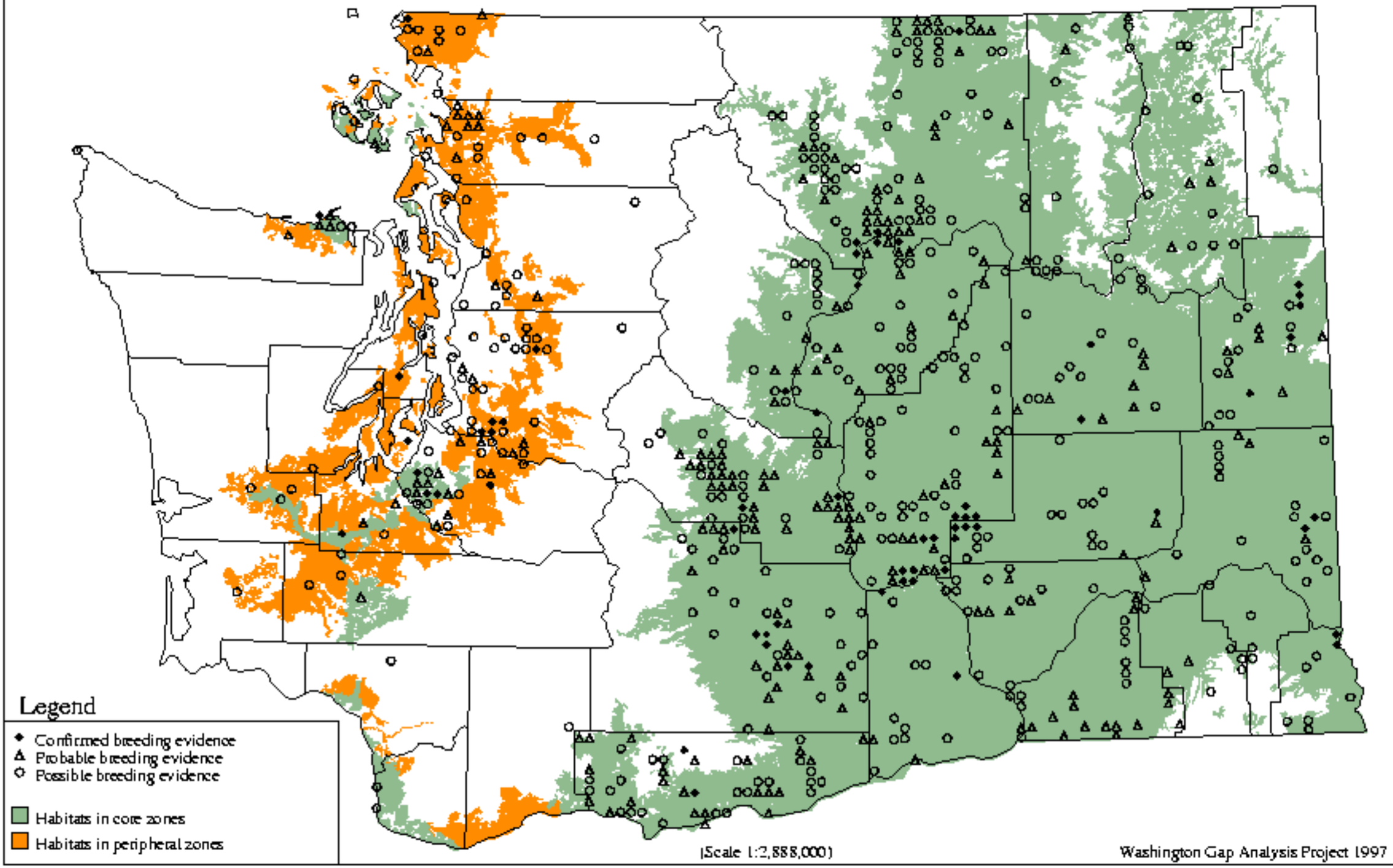
Rock Dove - *Columba livia*



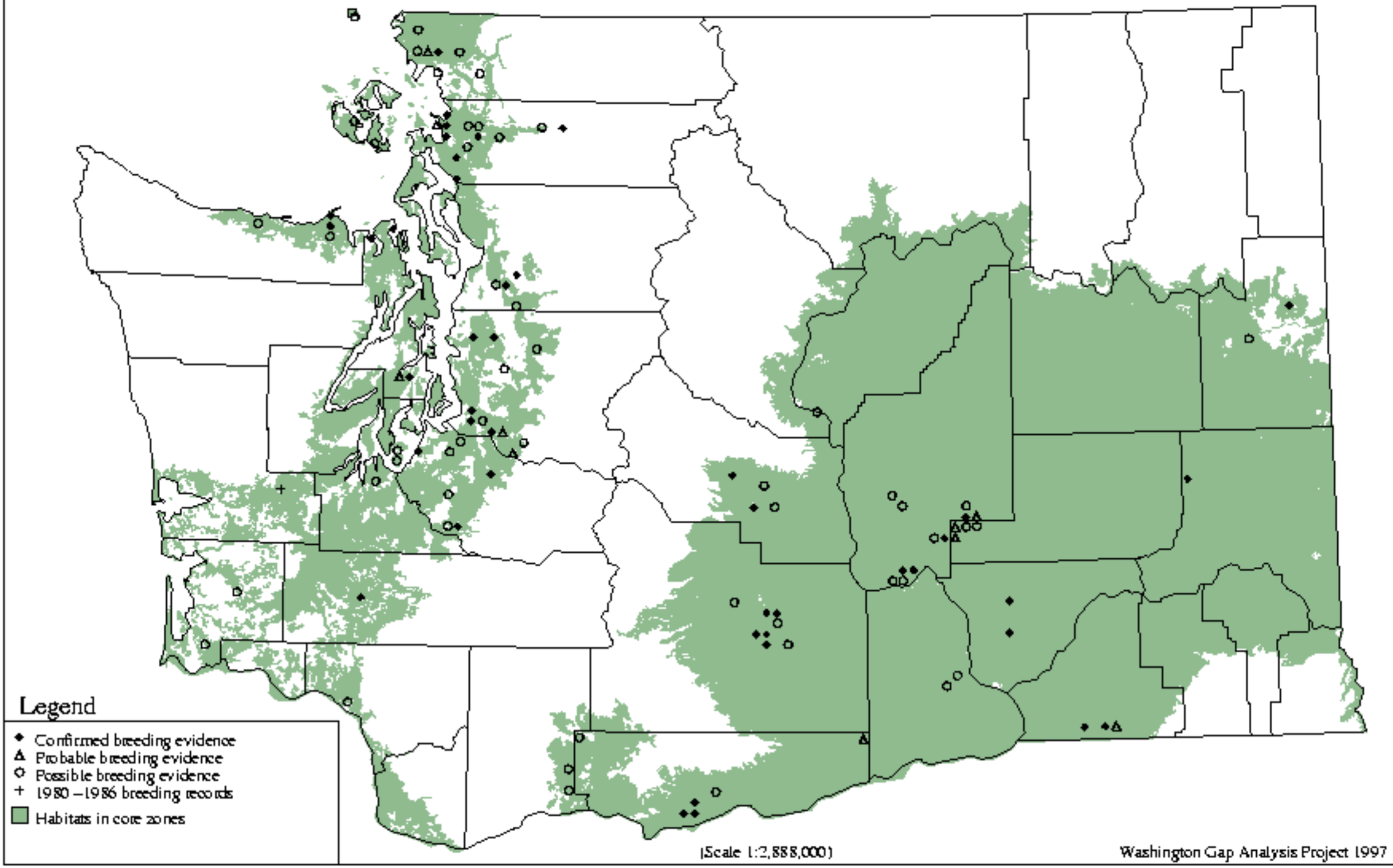
Band-tailed Pigeon - *Columba fasciata*



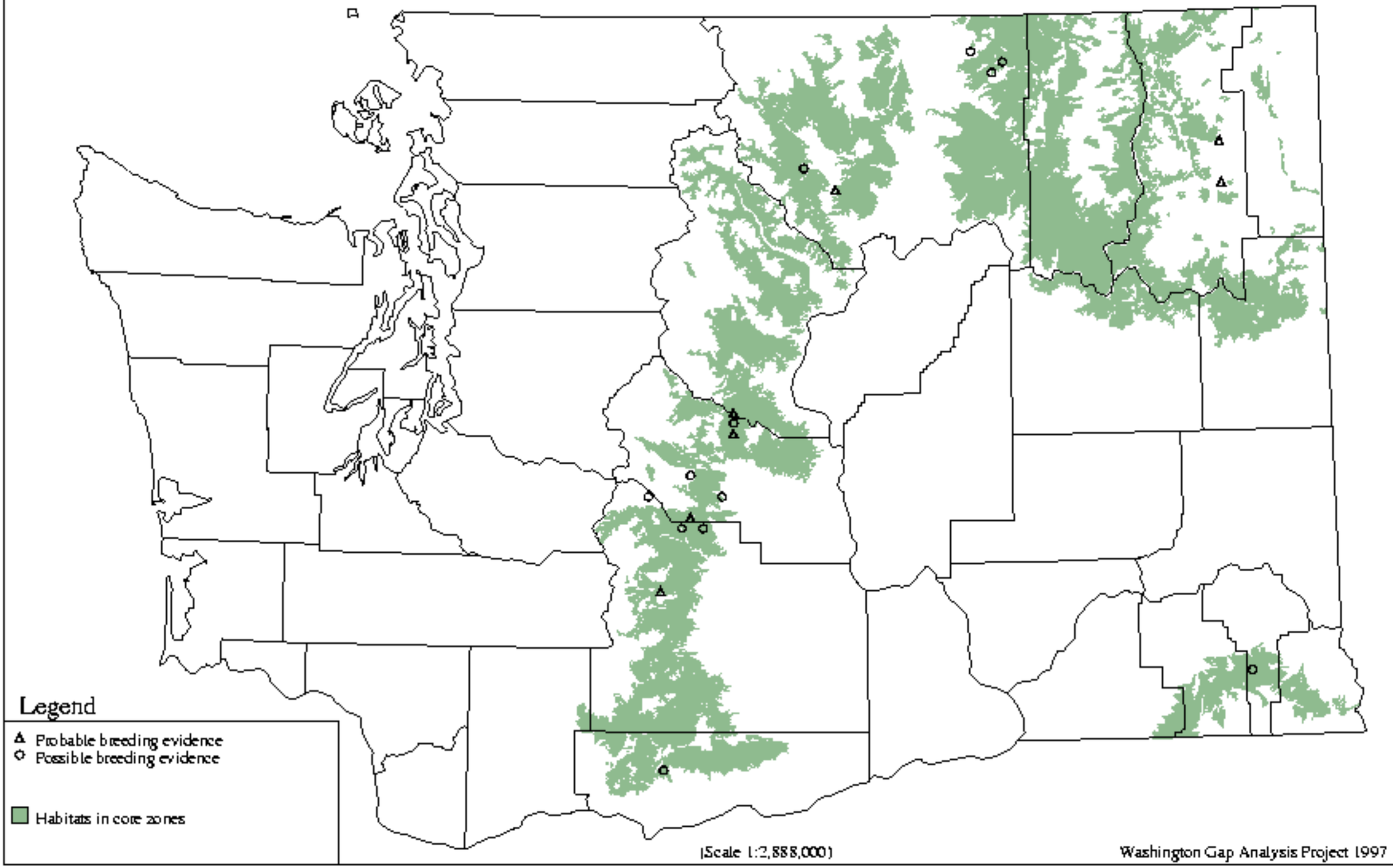
Mourning Dove - *Zenaida macroura*



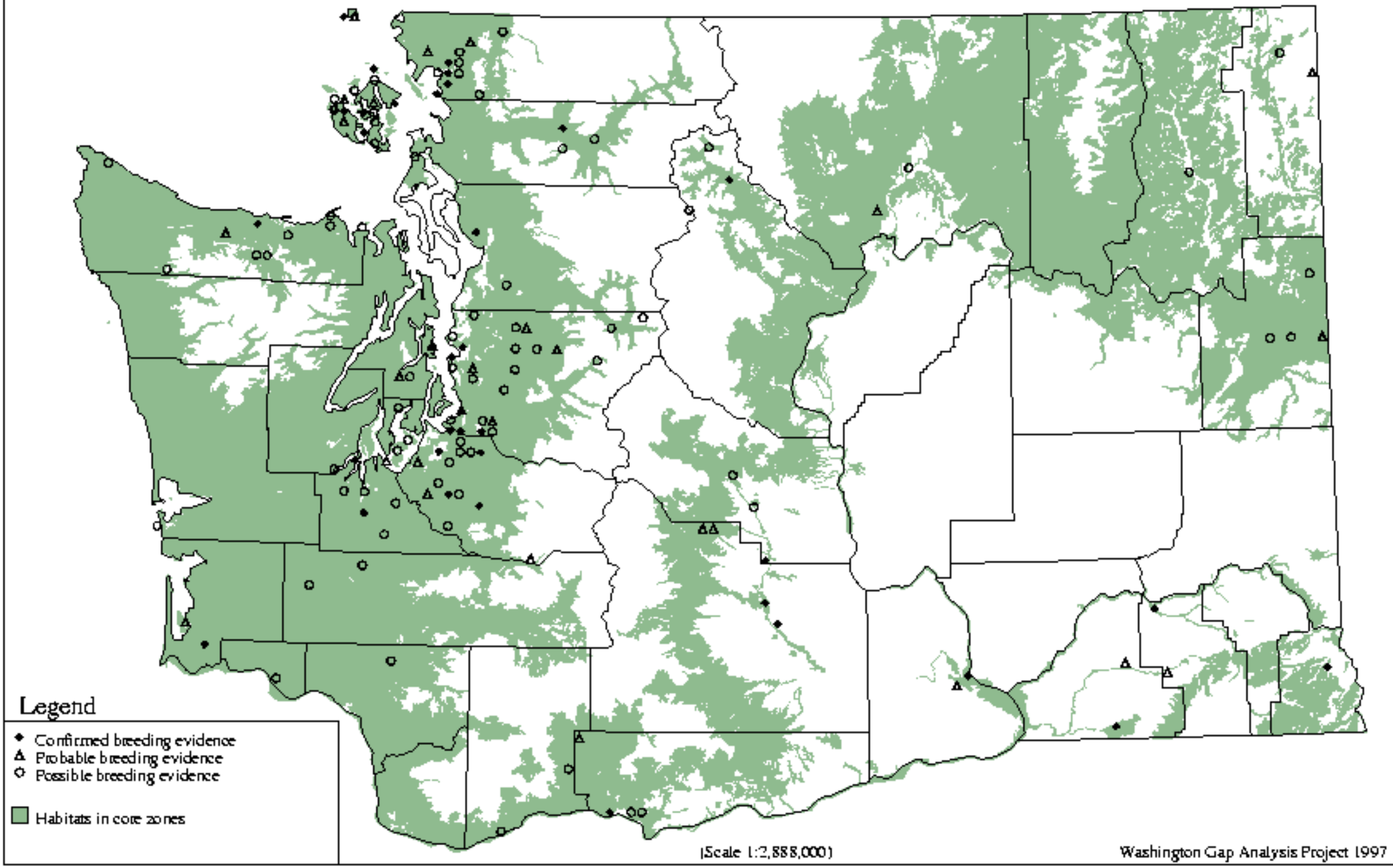
Barn Owl - *Tyto alba*



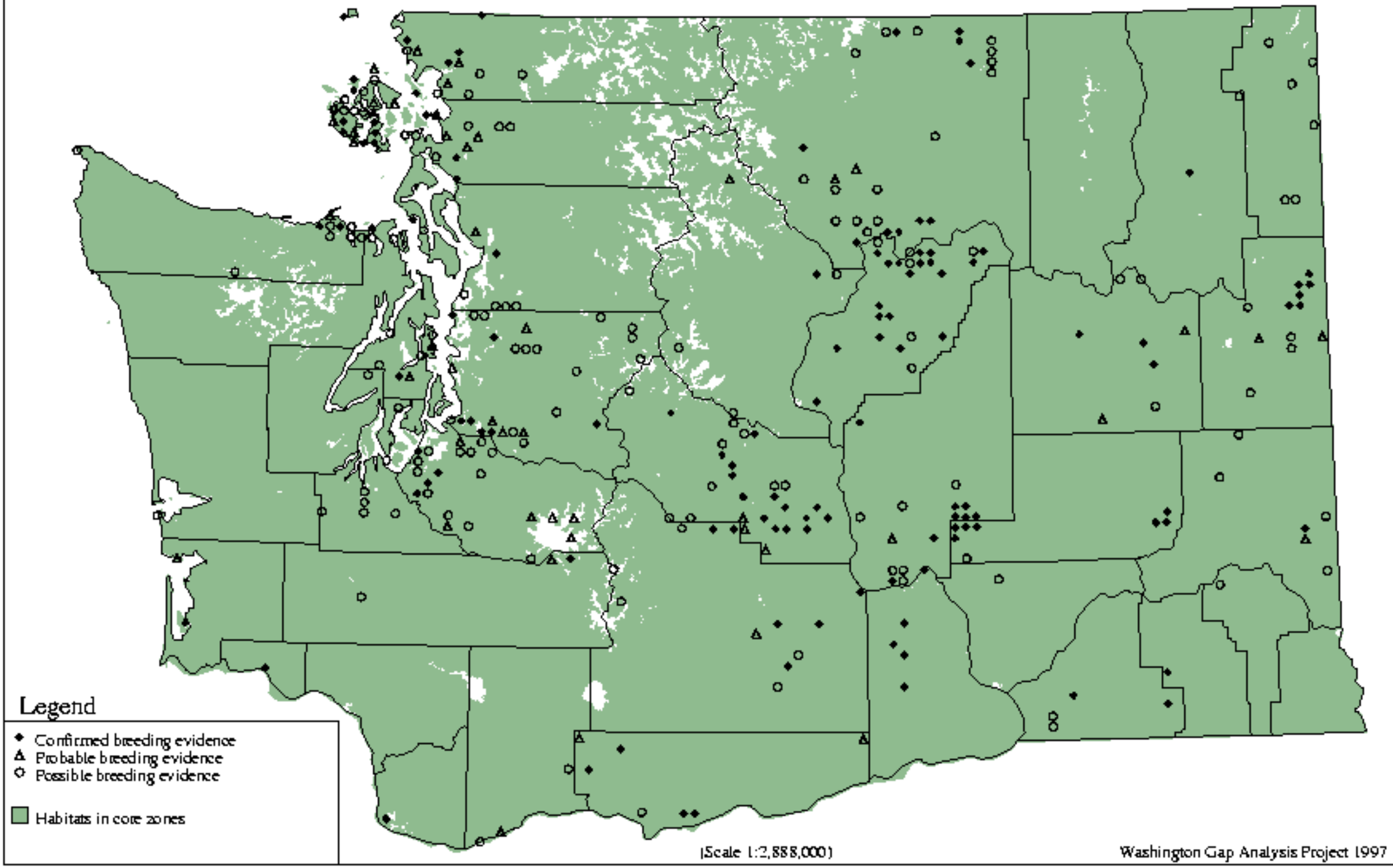
Flammulated Owl - *Otus flammeolus*



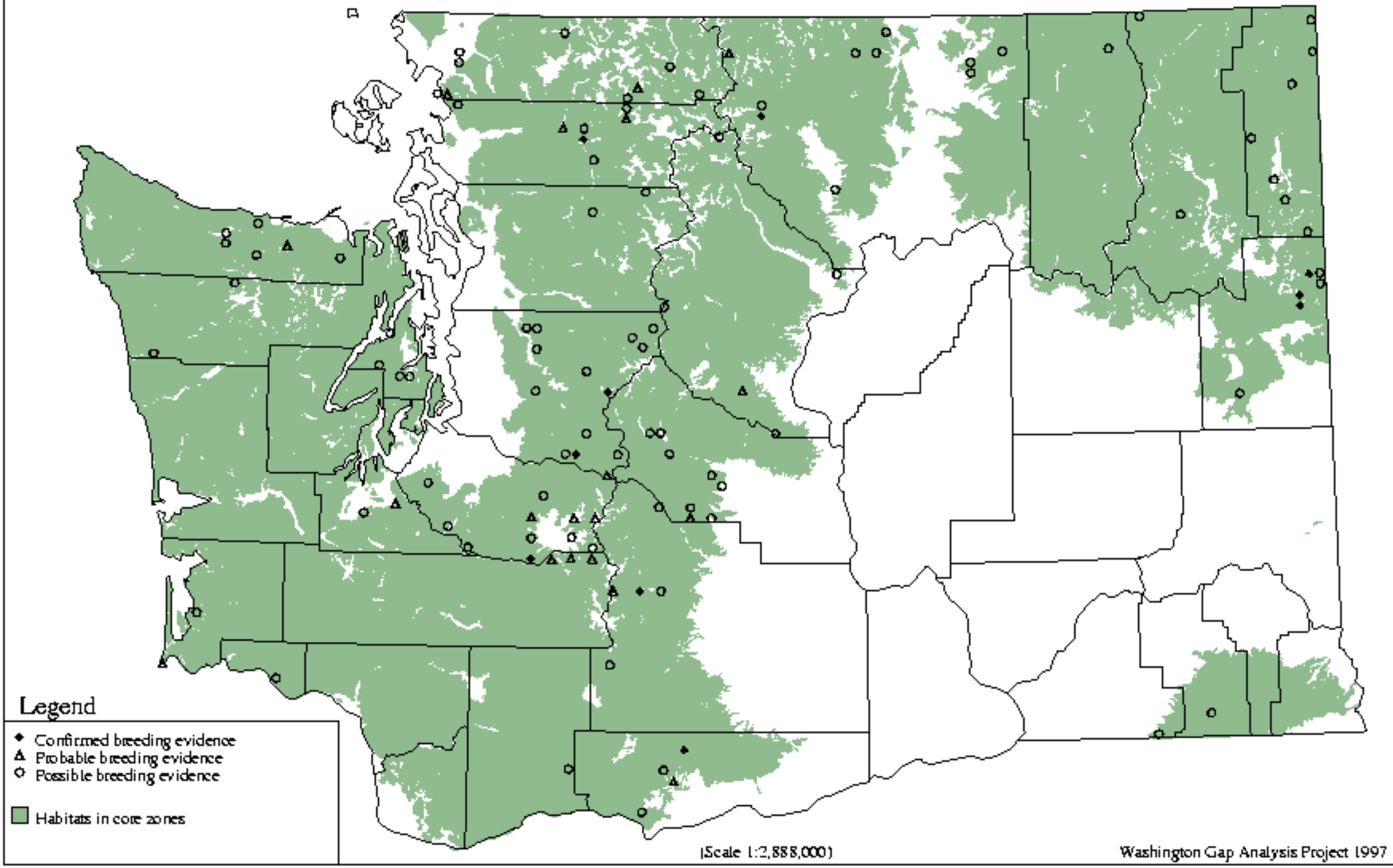
Western Screech-Owl - *Otus kennicotti*



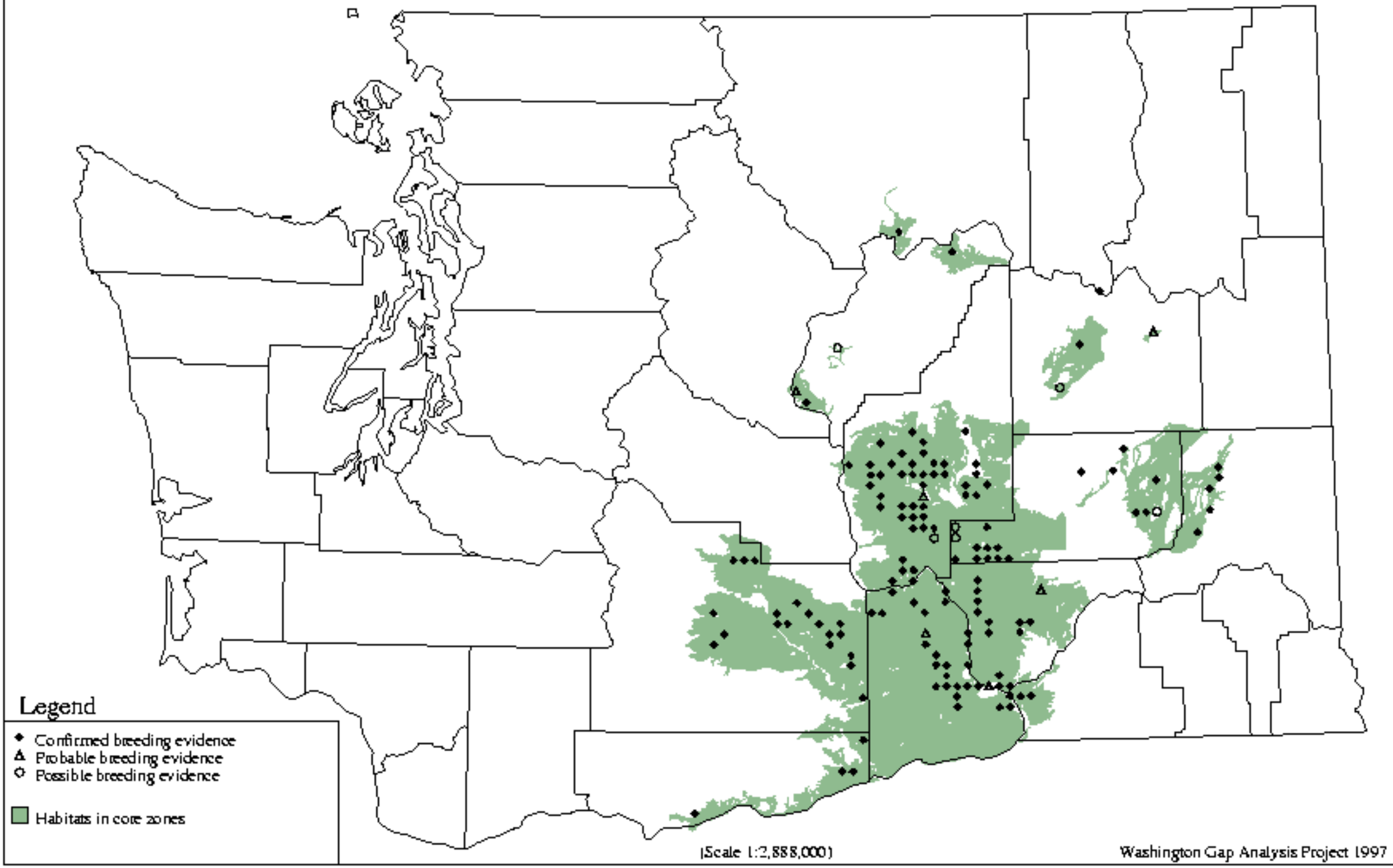
Great Horned Owl - *Bubo virginianus*



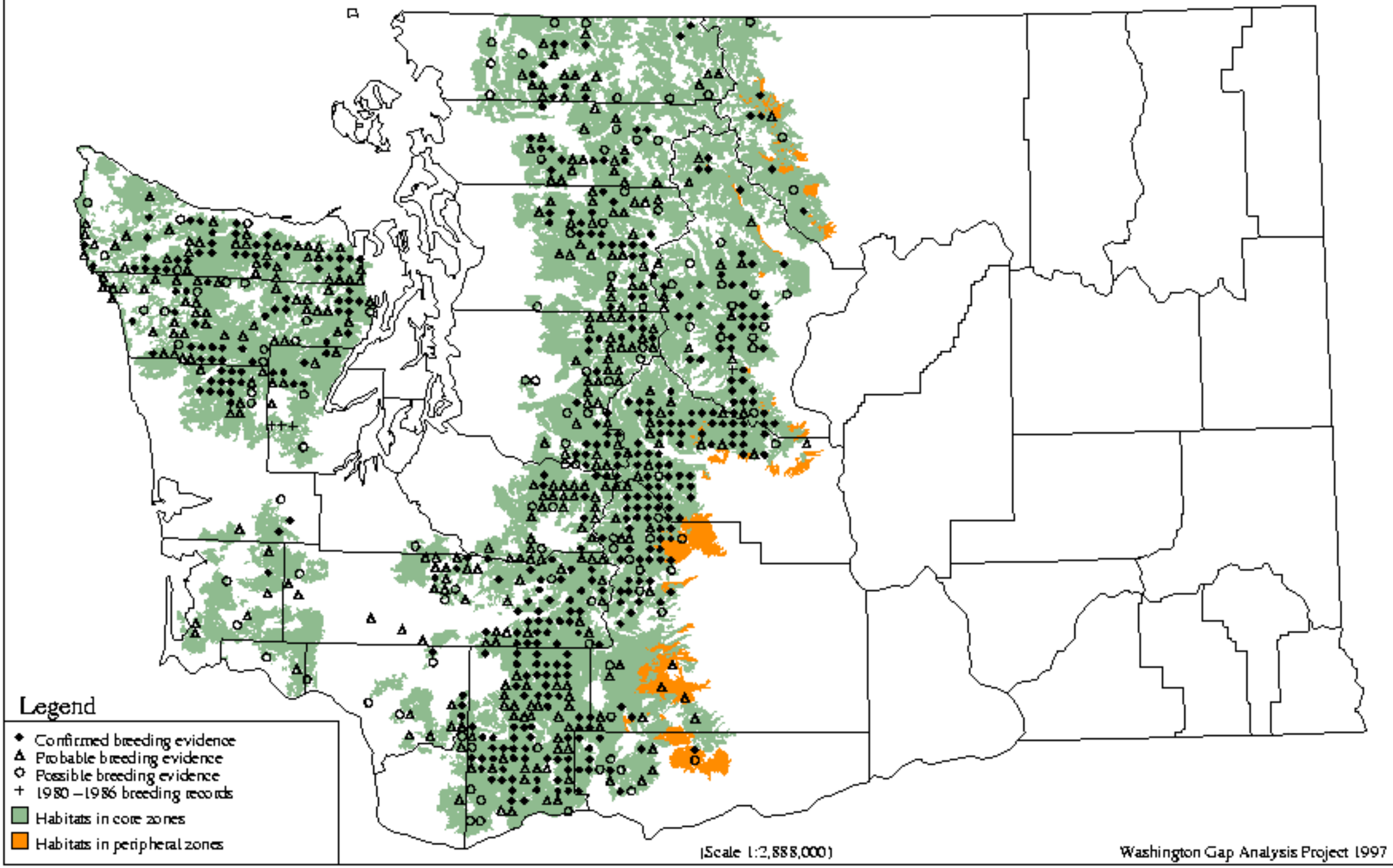
Northern Pygmy-Owl - *Glaucidium gnoma*



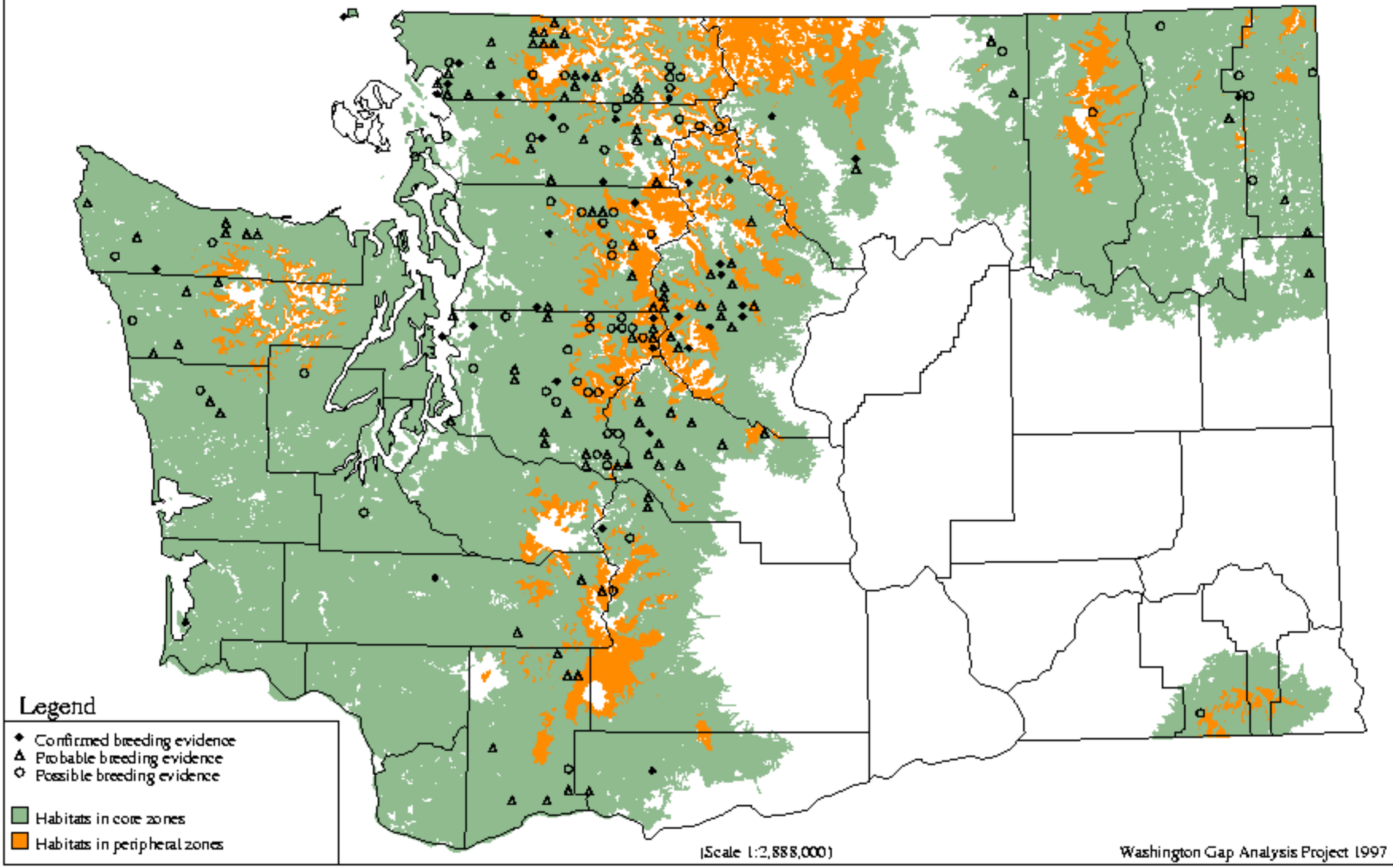
Burrowing Owl - *Speotyto cunicularia*



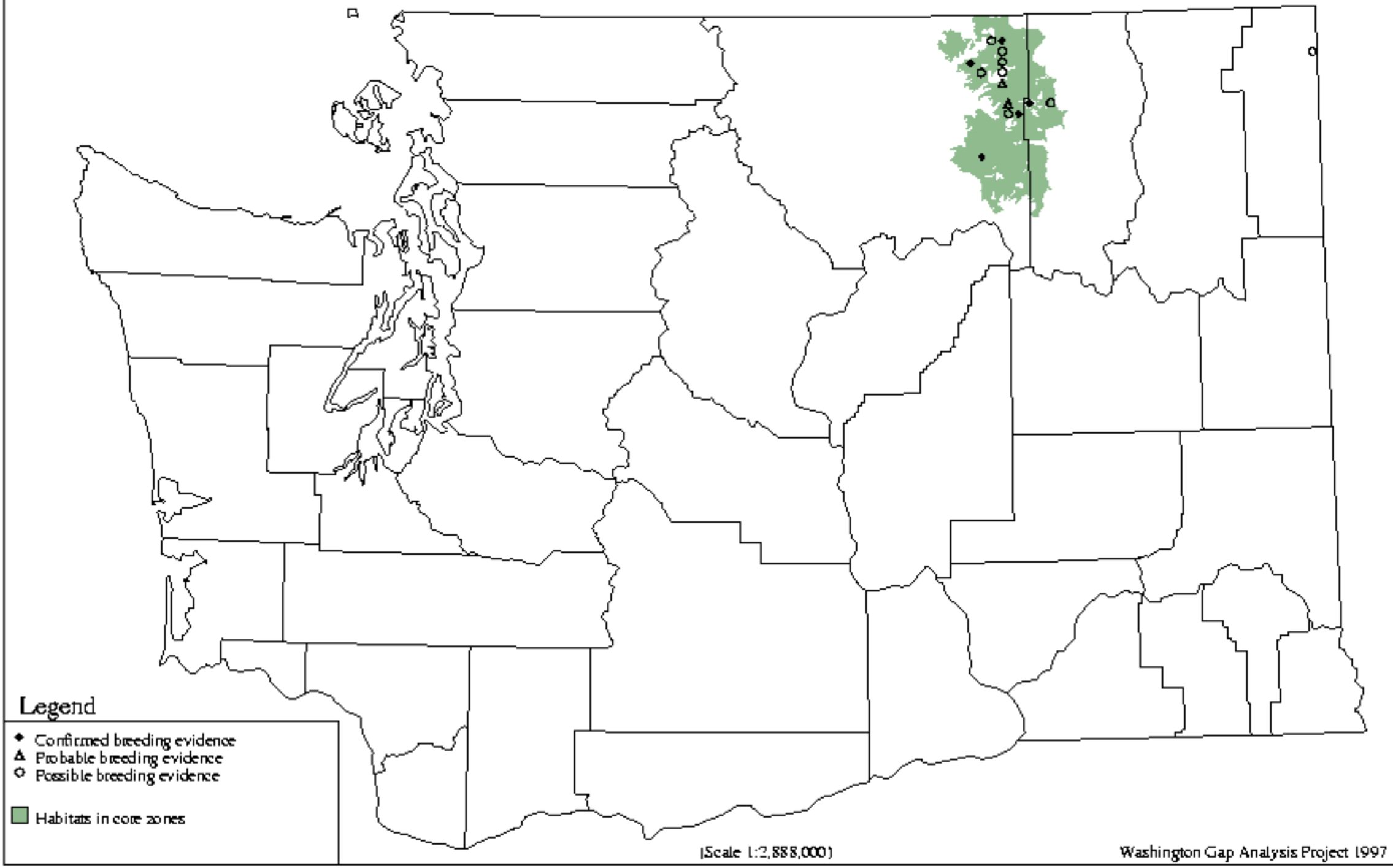
Spotted Owl - *Strix occidentalis*



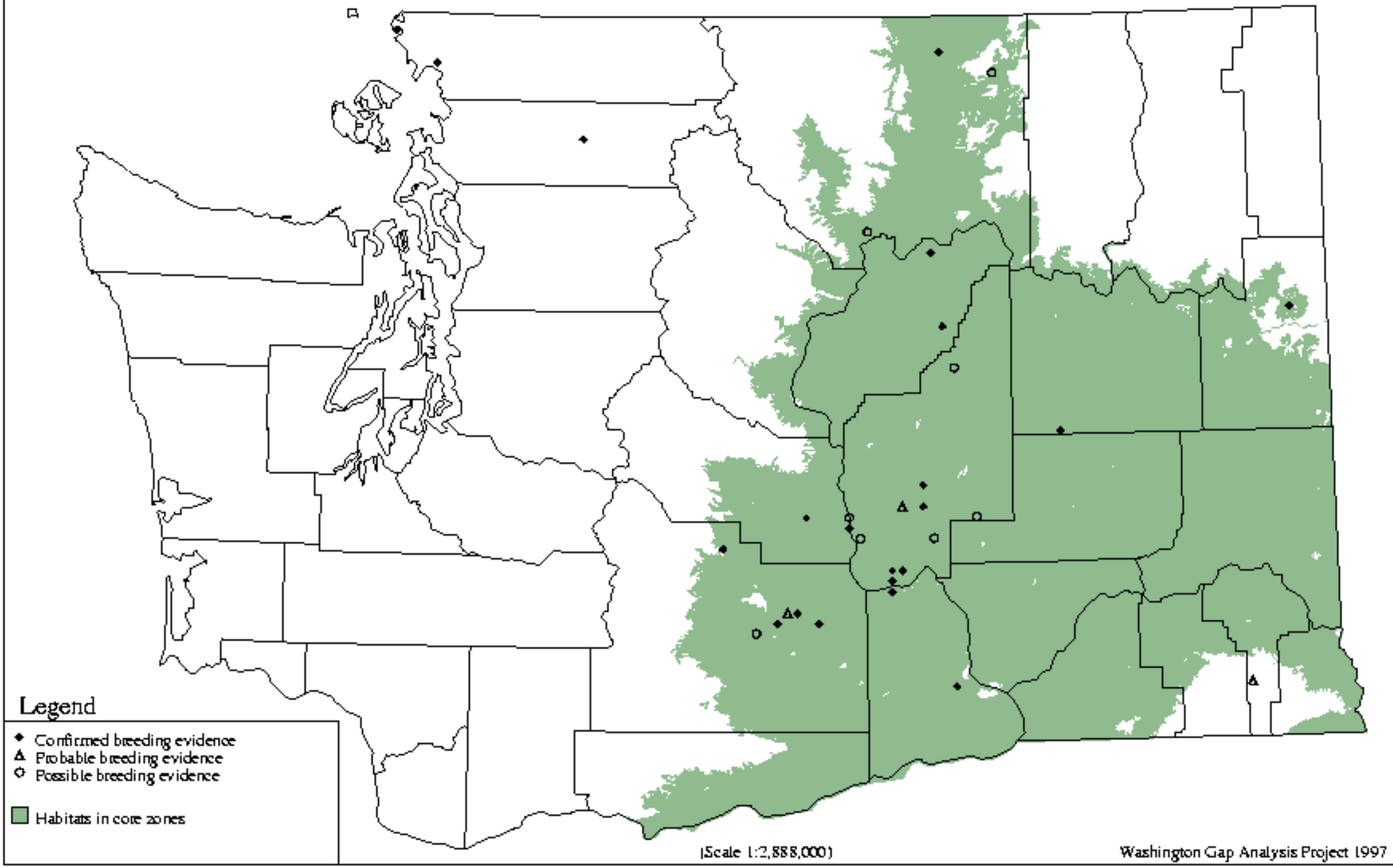
Barred Owl - *Strix varia*



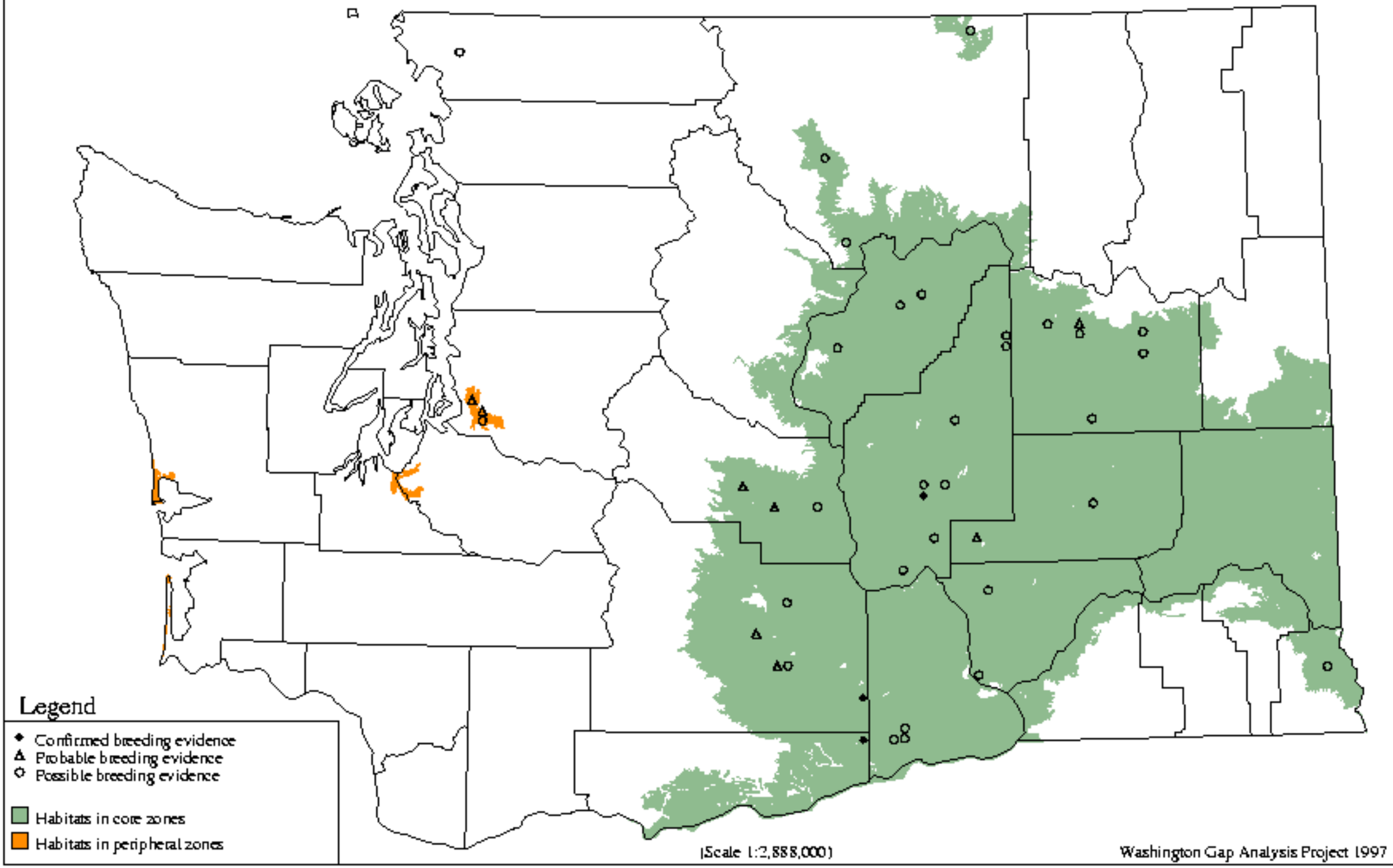
Great Gray Owl - *Strix nebulosa*



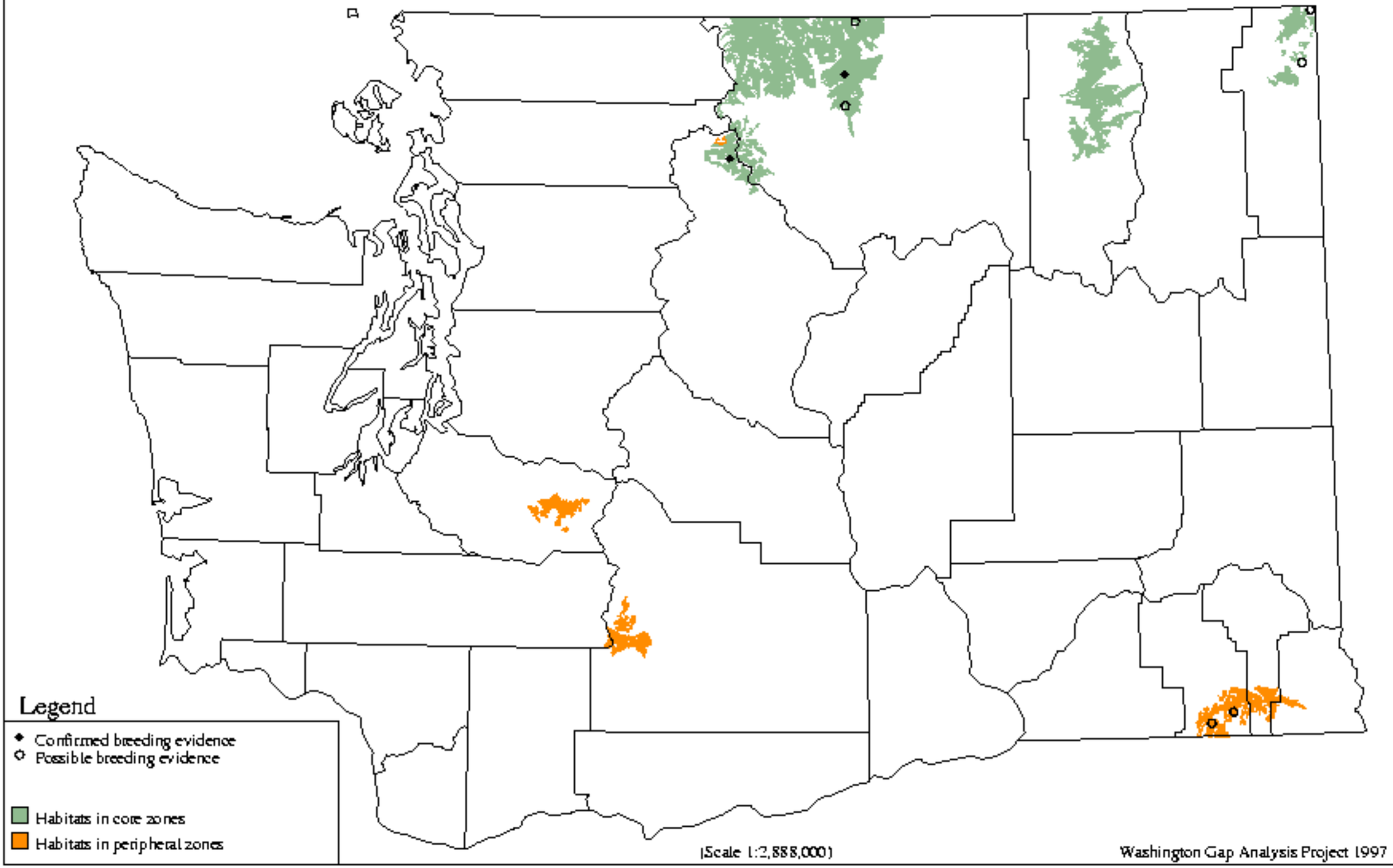
Long-eared Owl - *Asio otus*



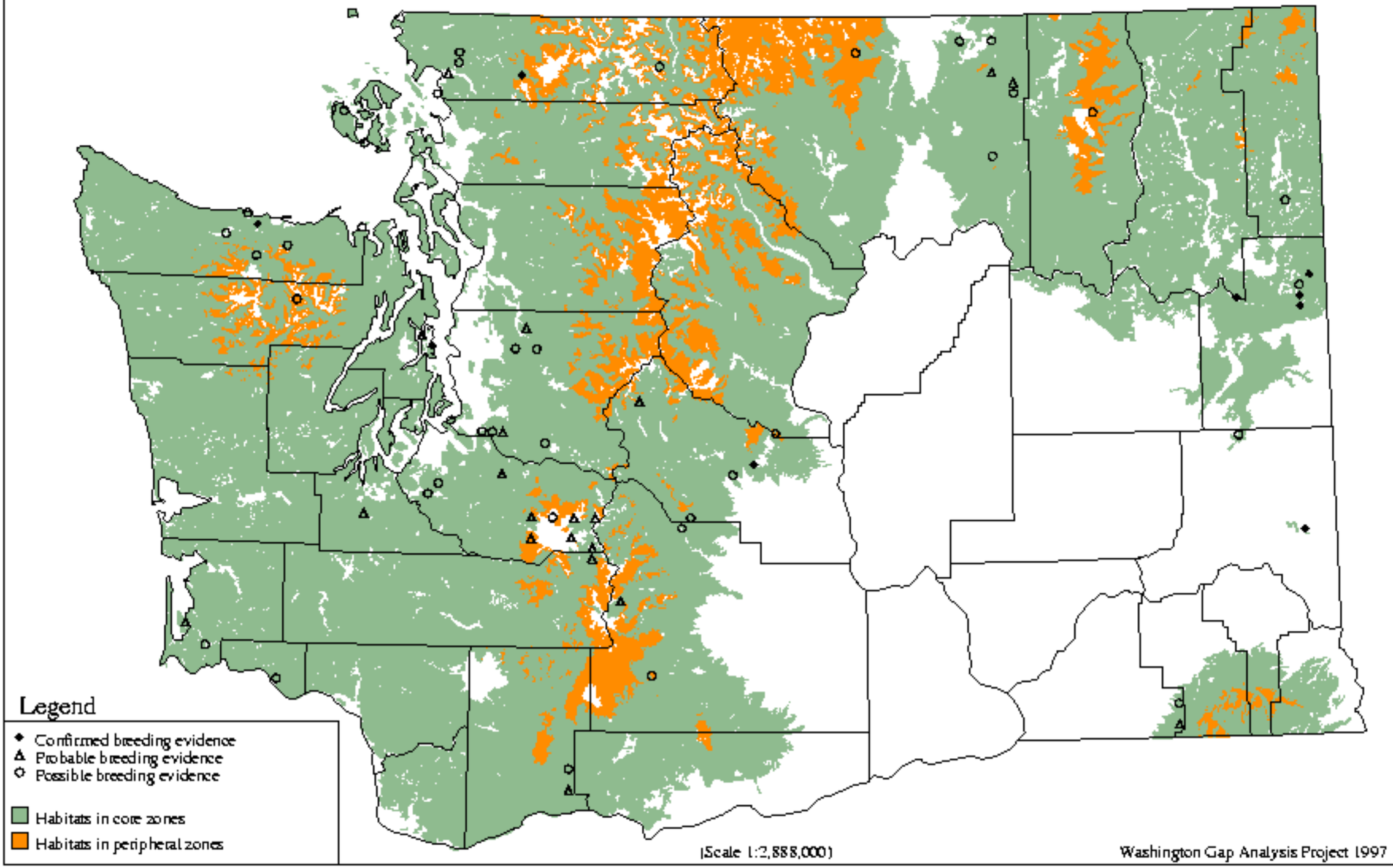
Short-eared Owl - *Asio flammeus*



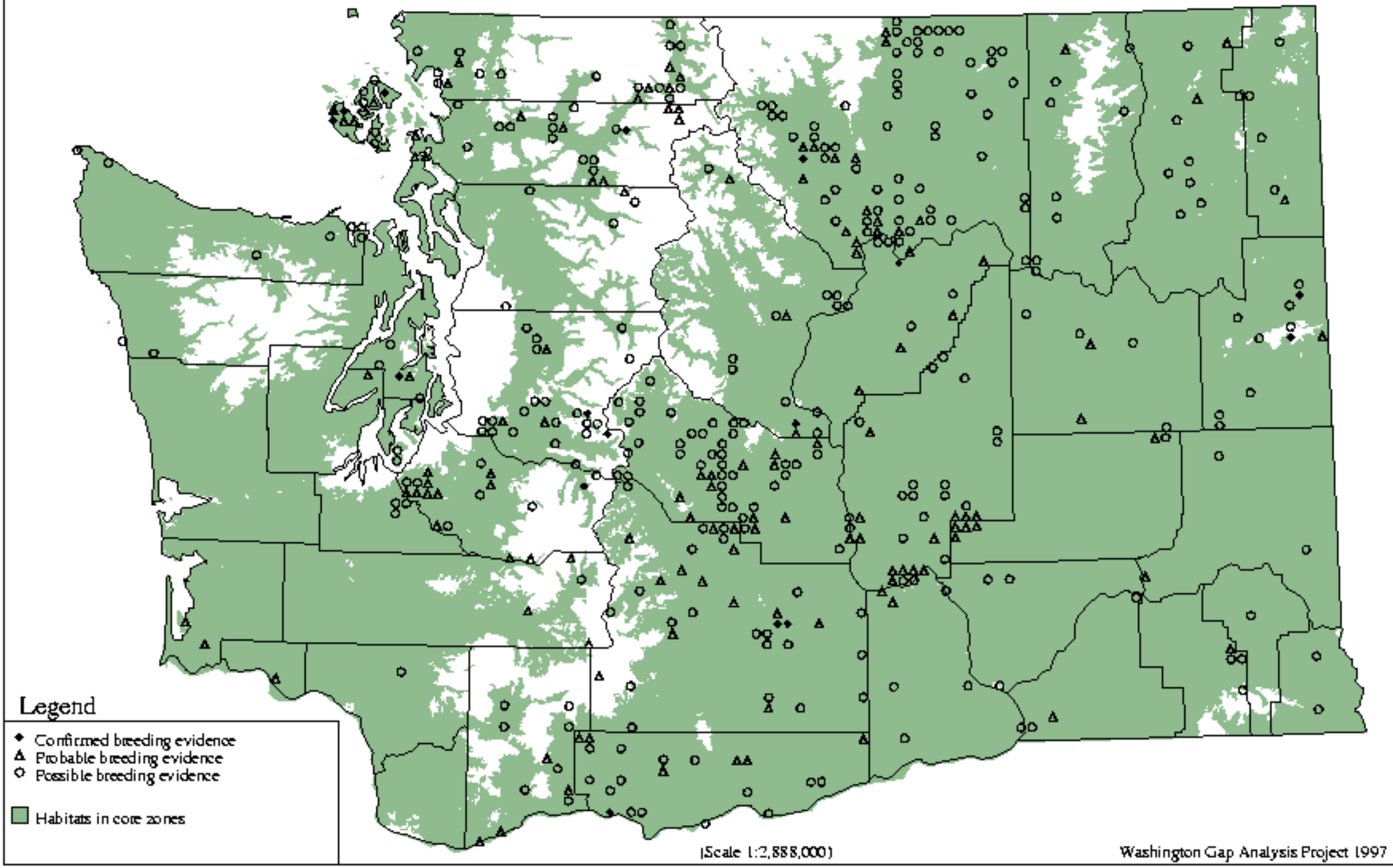
Boreal Owl - *Aegolius funereus*



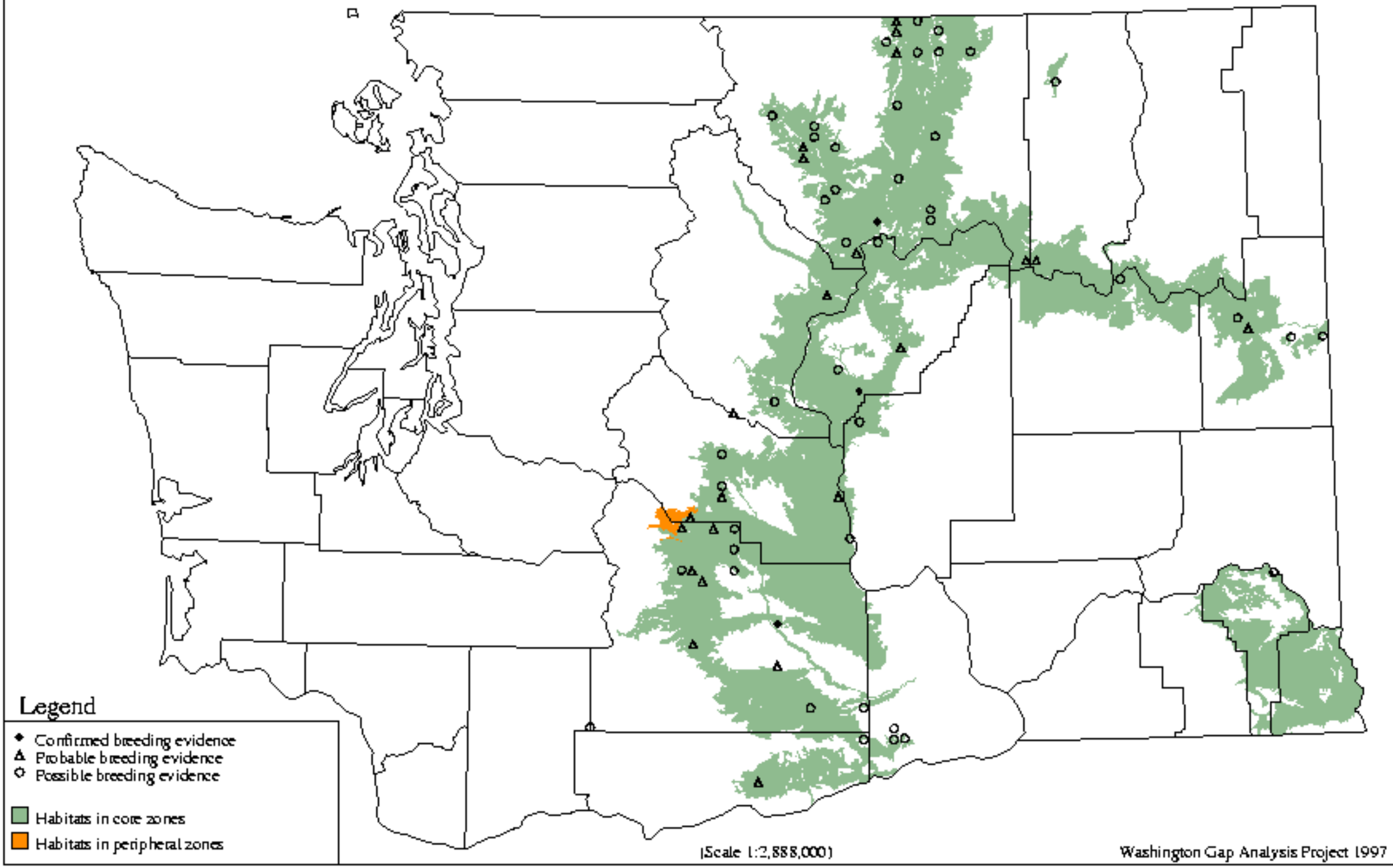
Northern Saw-whet Owl - *Aegolius acadicus*



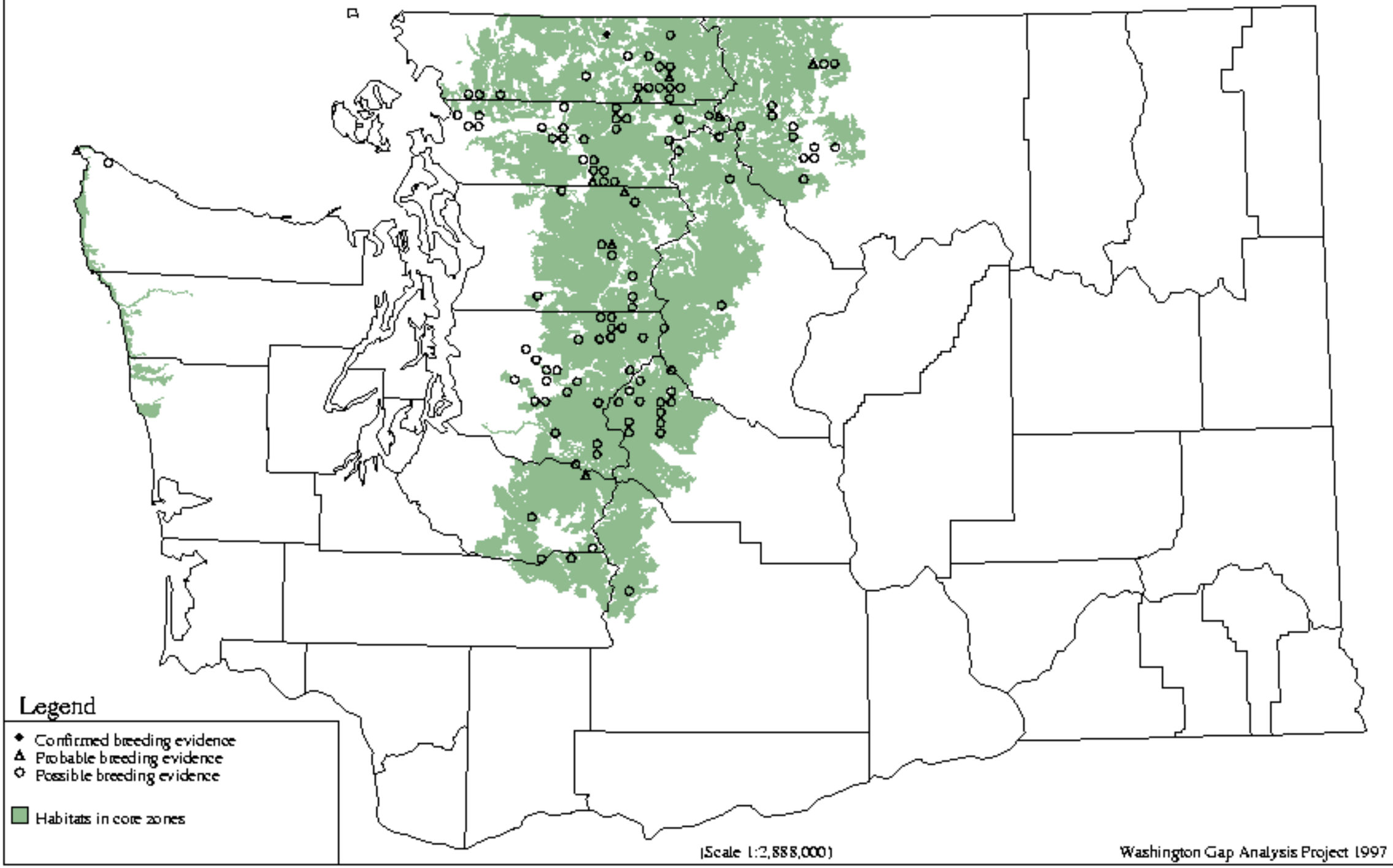
Common Nighthawk - *Chordeiles minor*



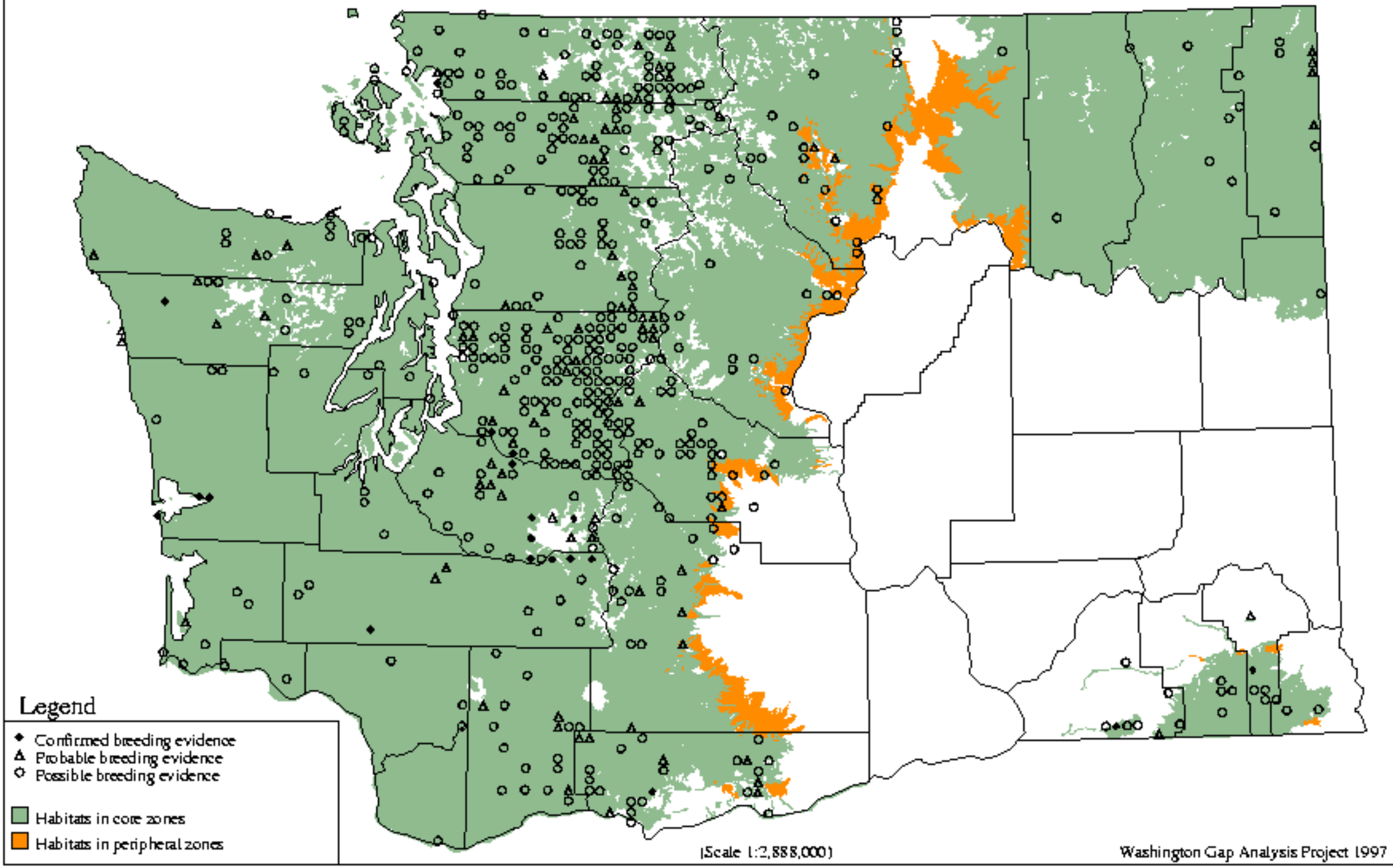
Common Poorwill - *Phalaenoptilus nuttalli*



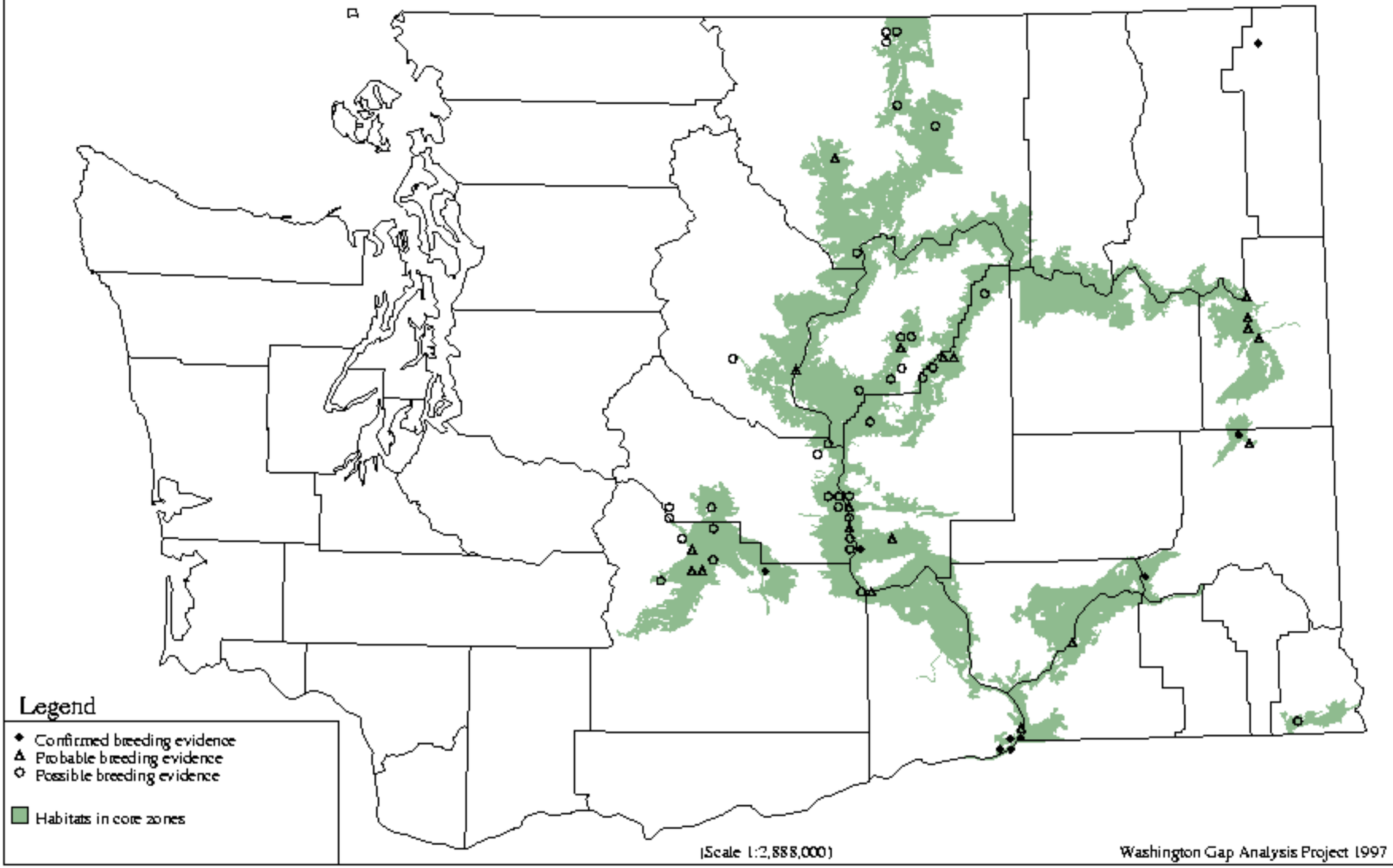
Black Swift - *Cypseloides niger*



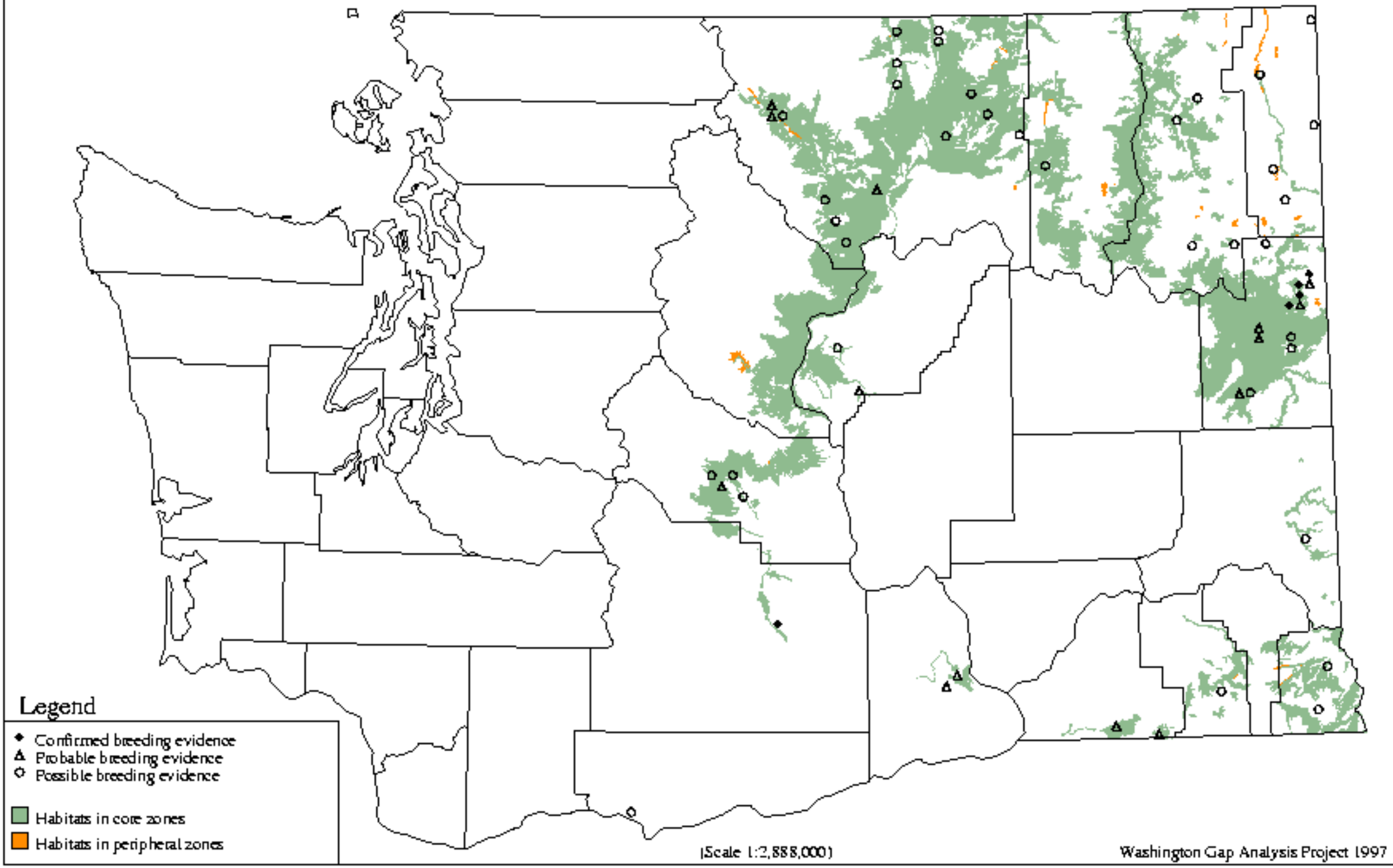
Vaux`s Swift - *Chaetura vauxi*



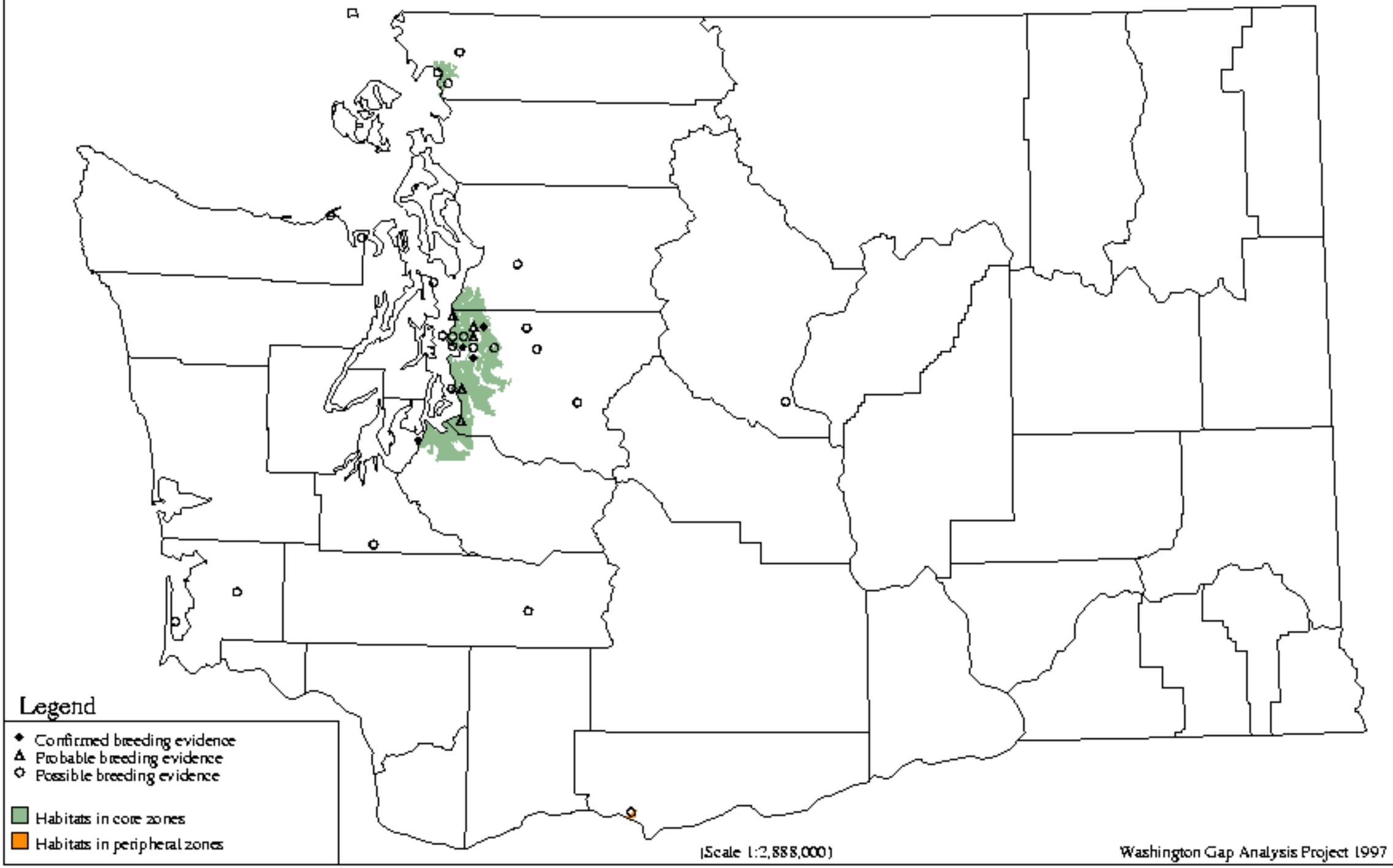
White-throated Swift - *Aeronautes saxatalis*



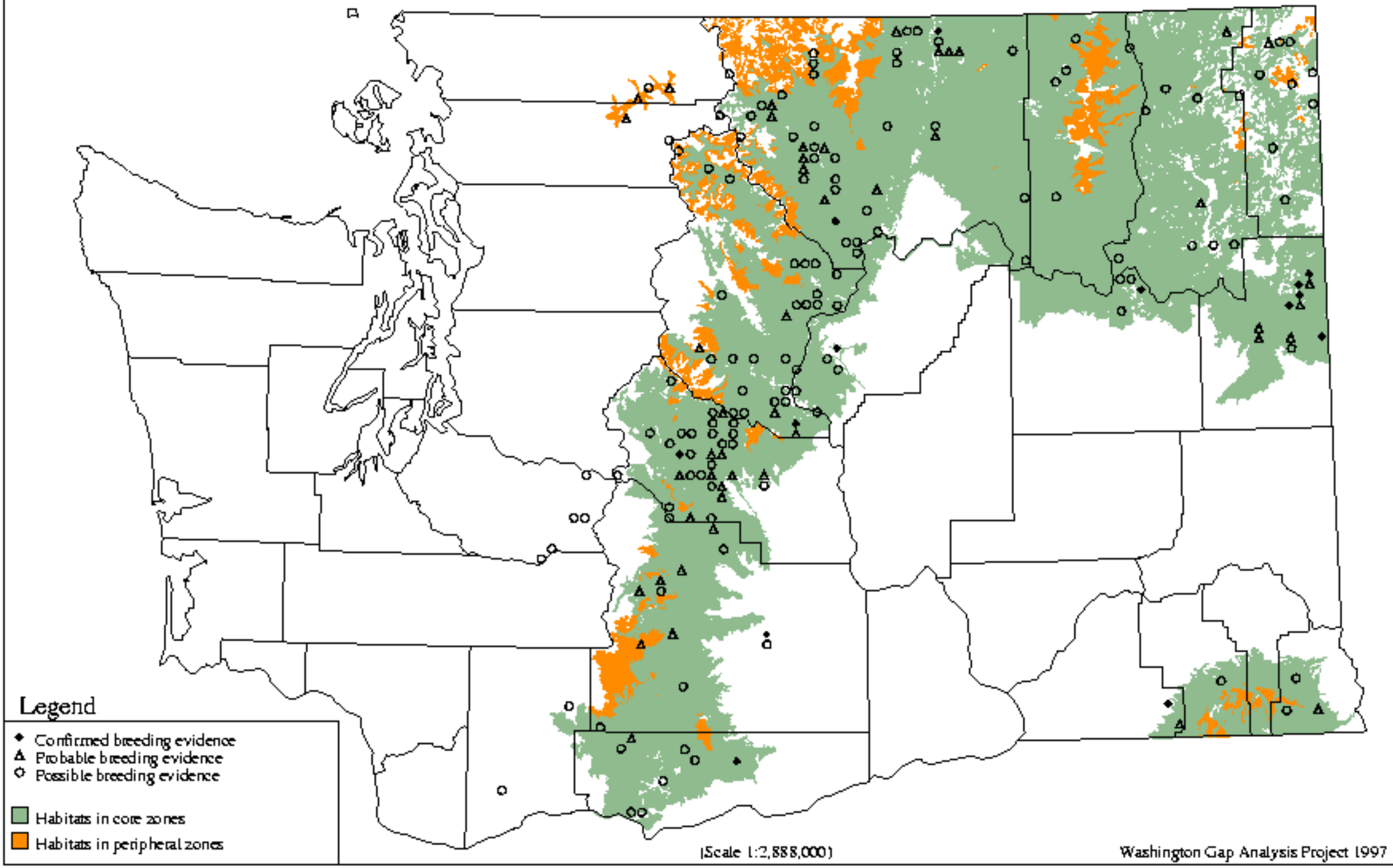
Black-chinned Hummingbird - *Archilochus alexandri*



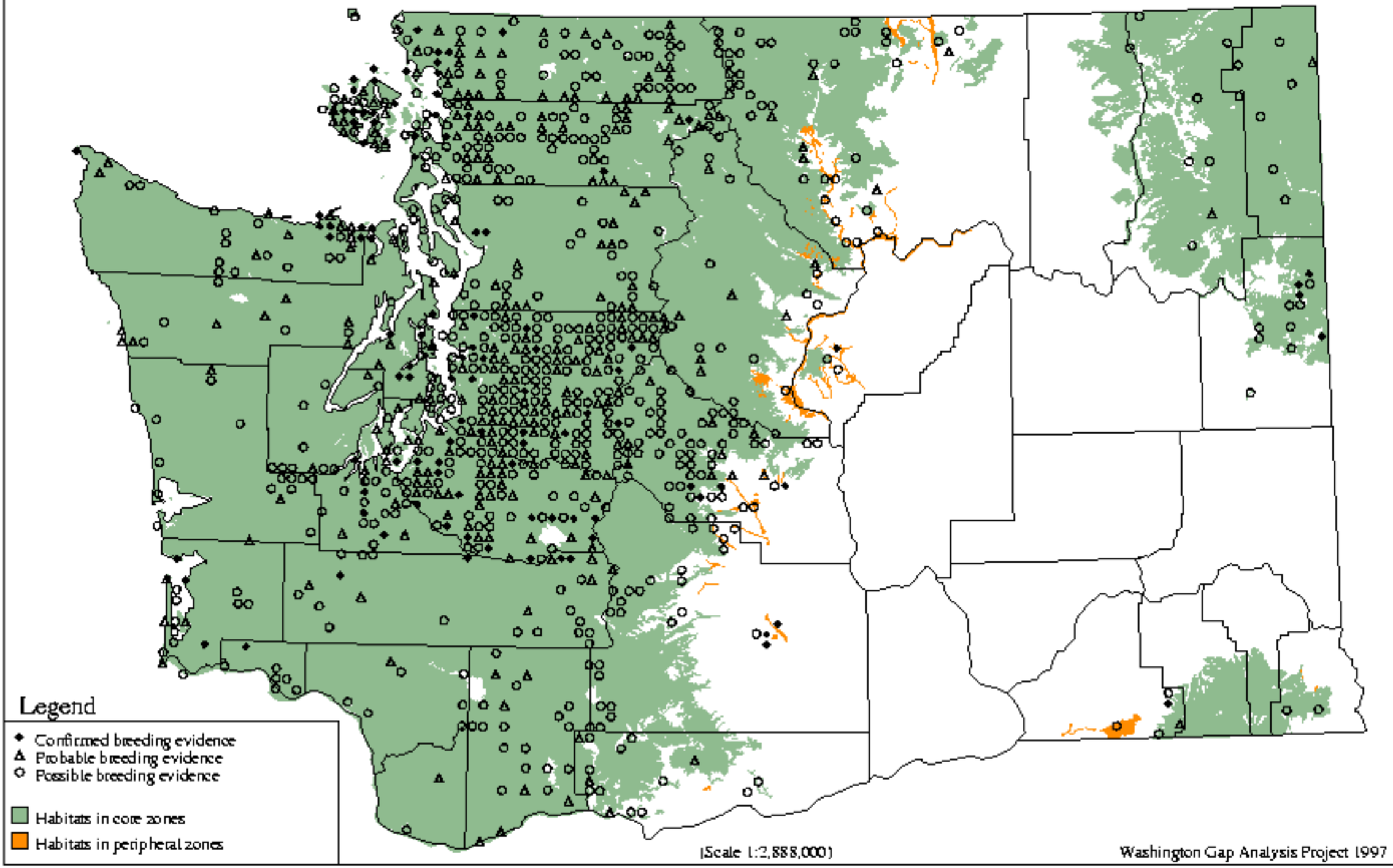
Anna`s Hummingbird - *Calypte anna*



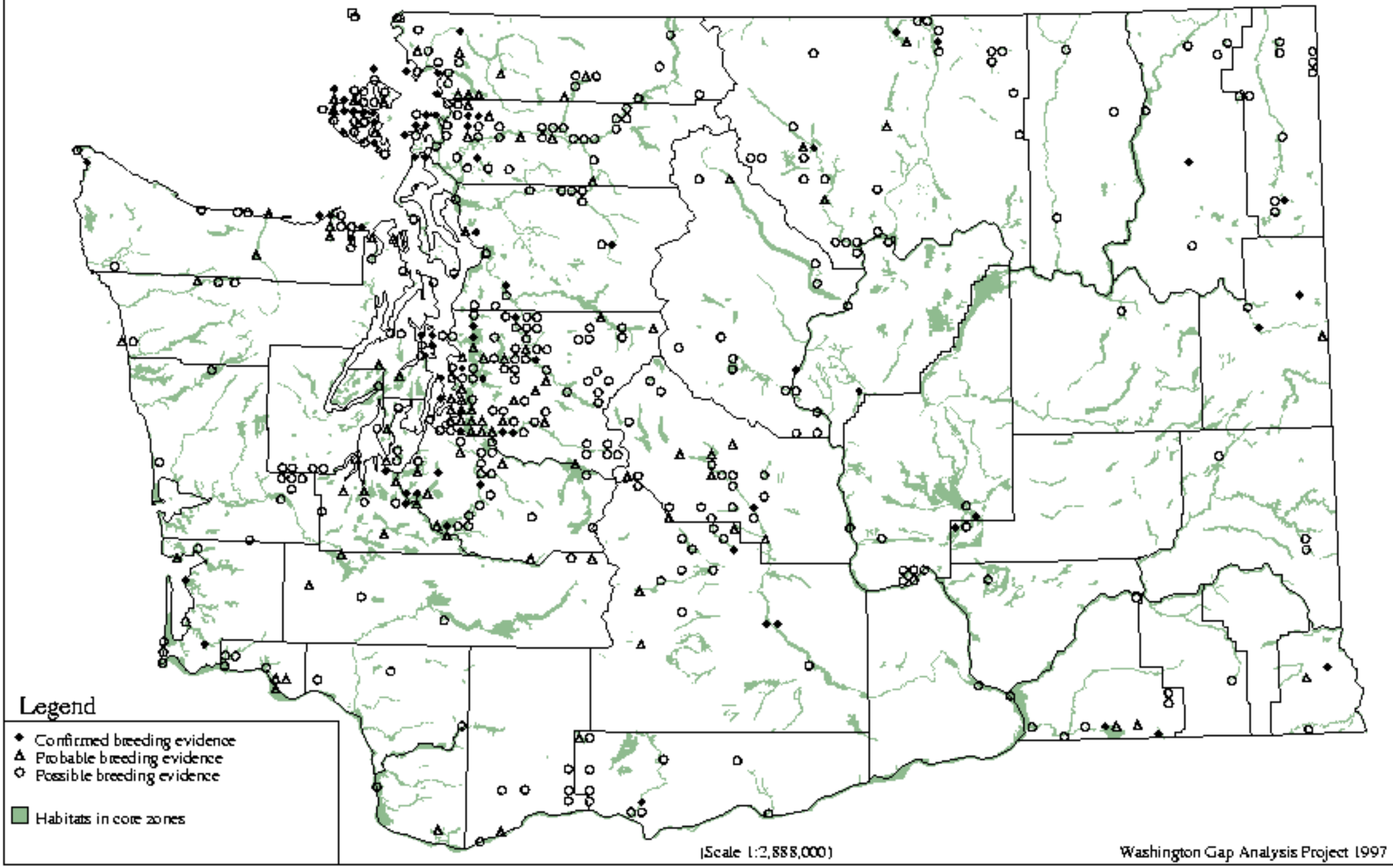
Calliope Hummingbird - *Stellula calliope*



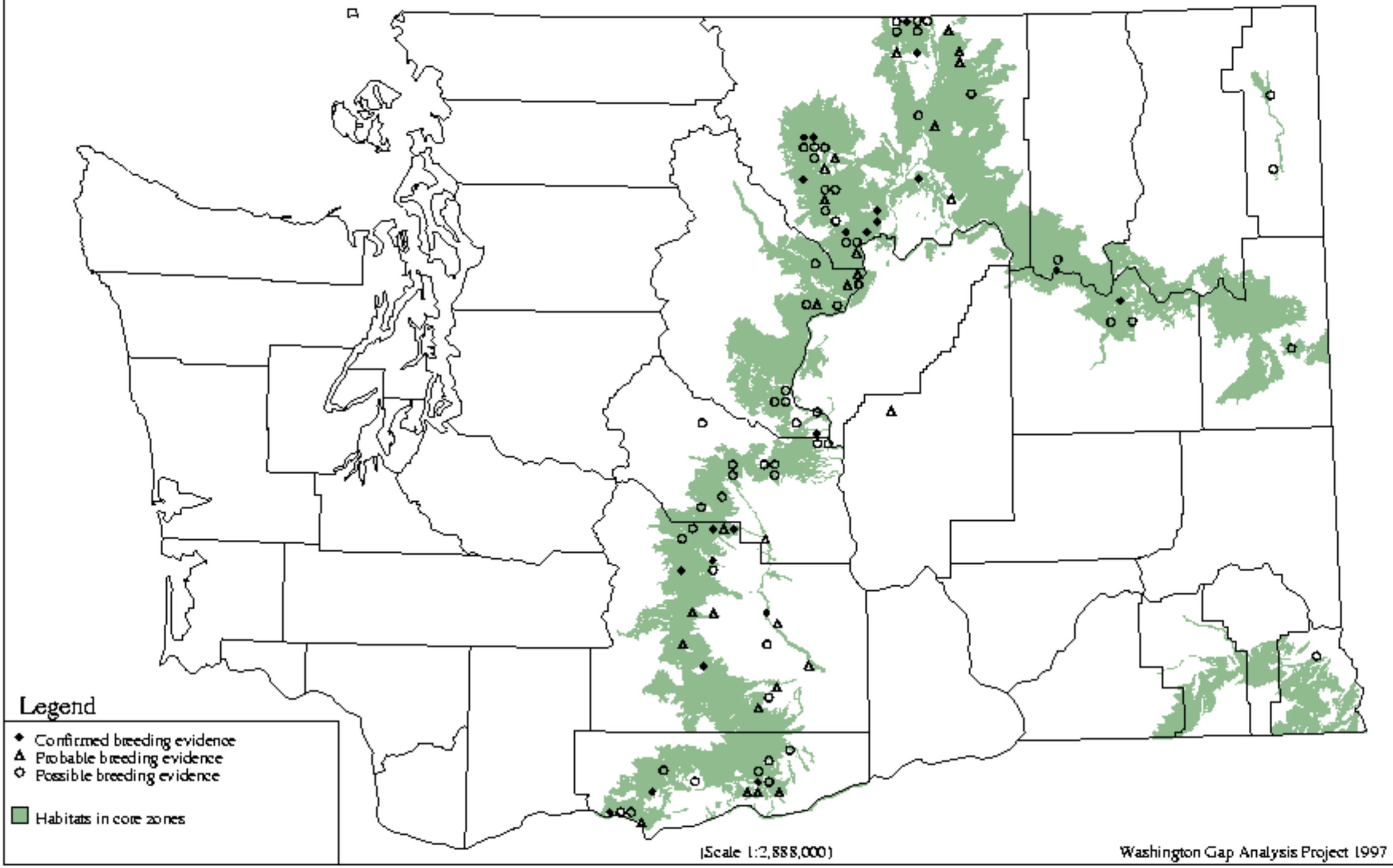
Rufous Hummingbird - *Selasphorus rufus*



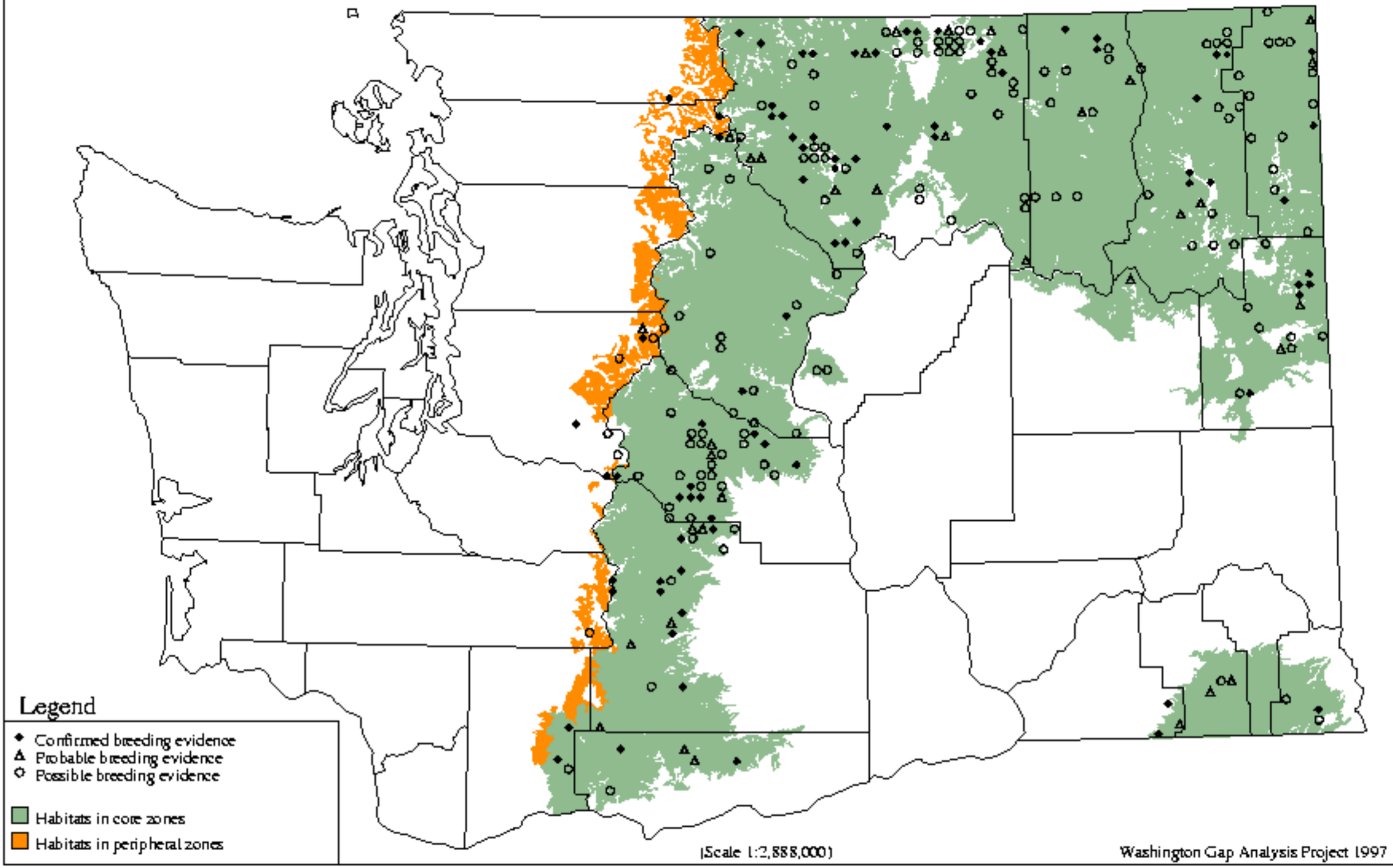
Belted Kingfisher - *Ceryle alcyon*



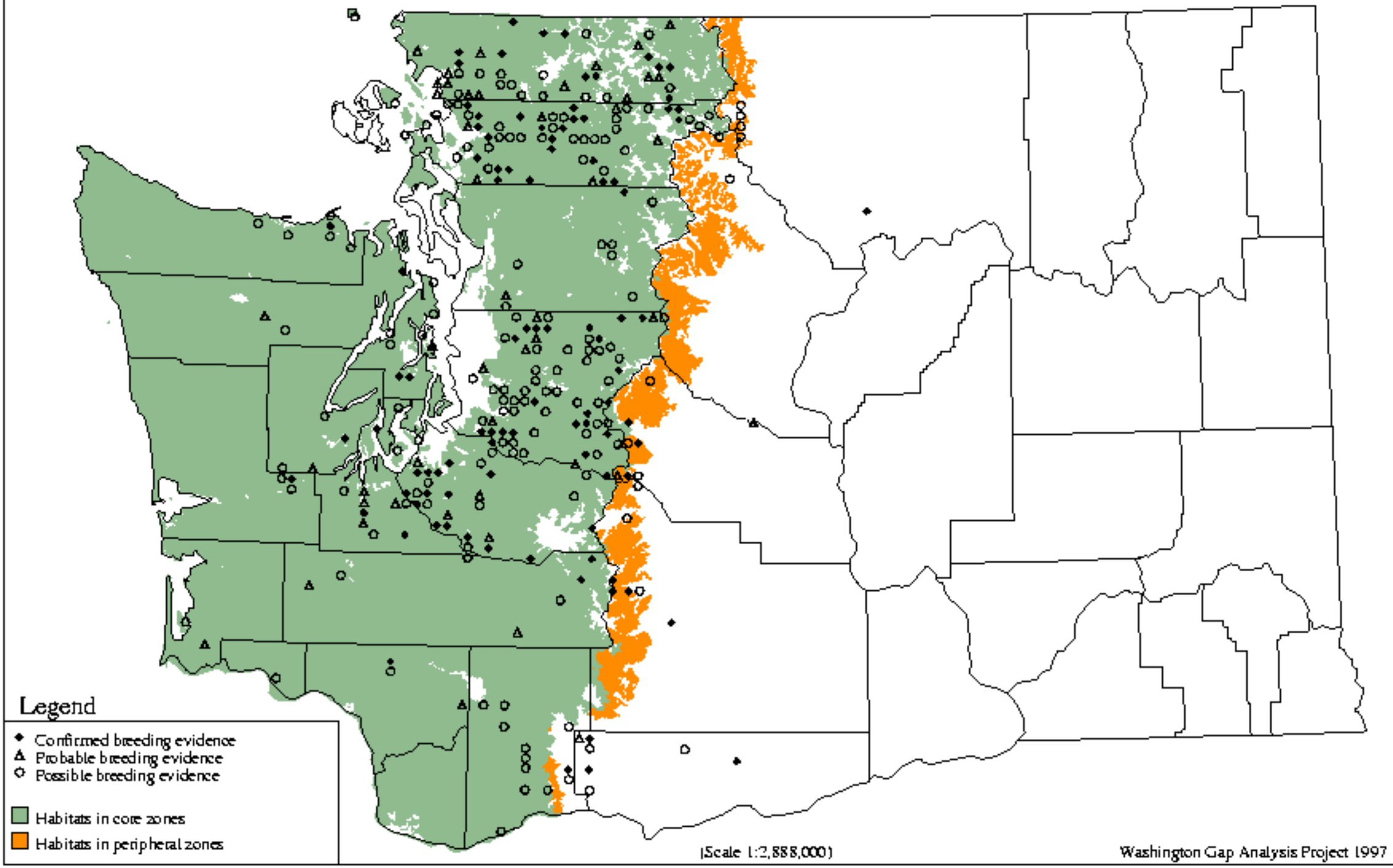
Lewis` Woodpecker - *Melanerpes lewis*



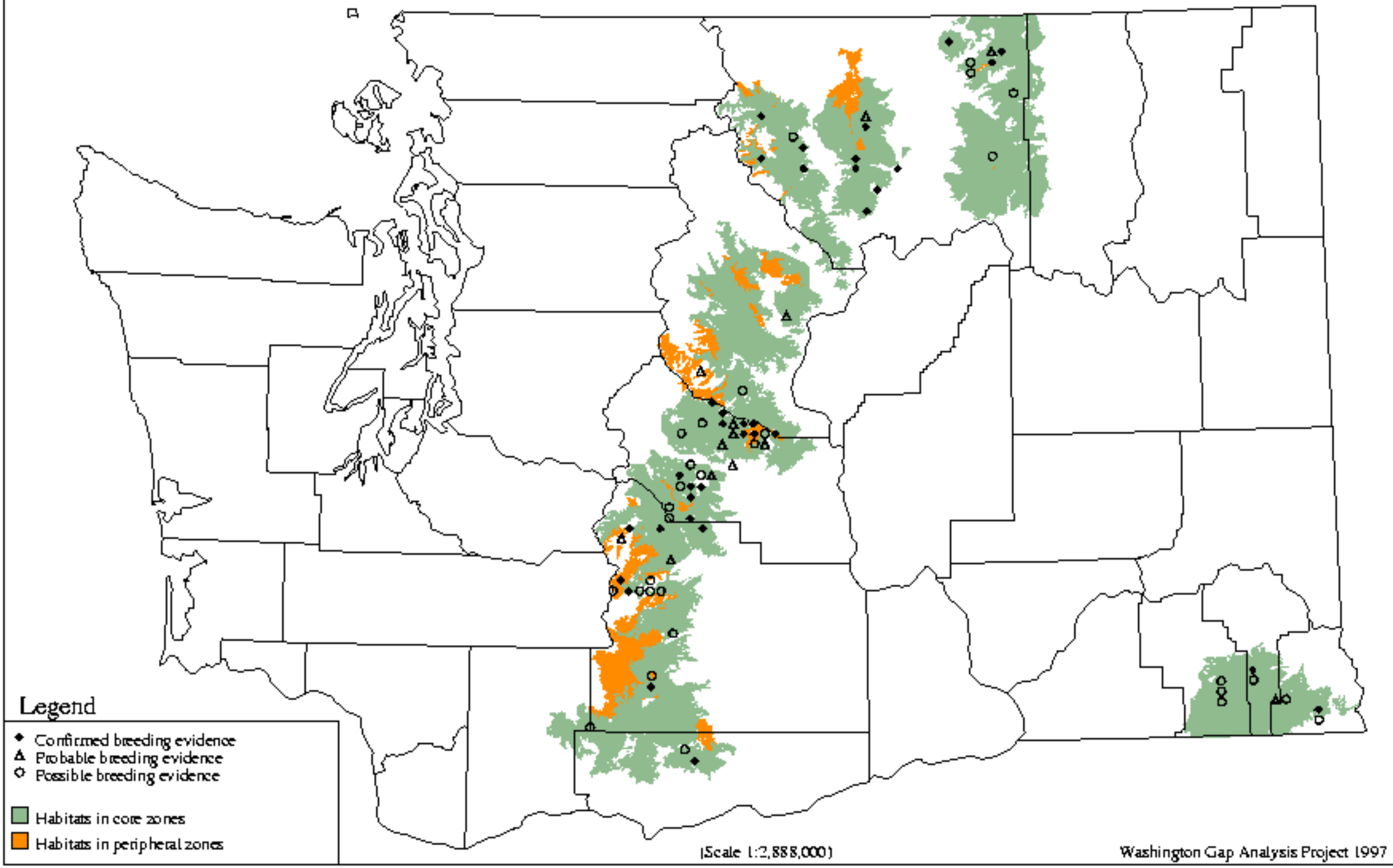
Red-naped Sapsucker - *Sphyrapicus nuchalis*



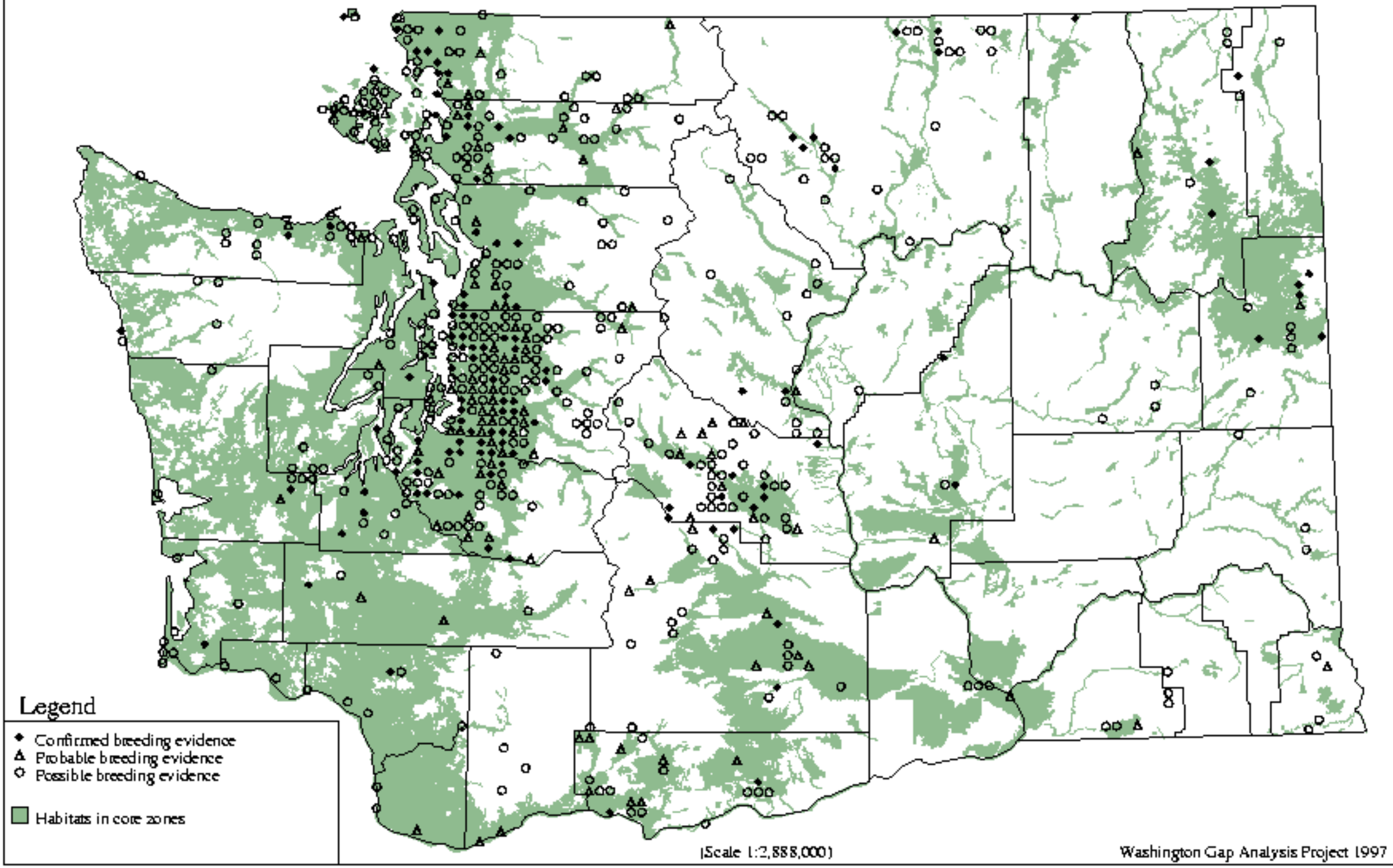
Red-breasted Sapsucker - *Sphyrapicus ruber*



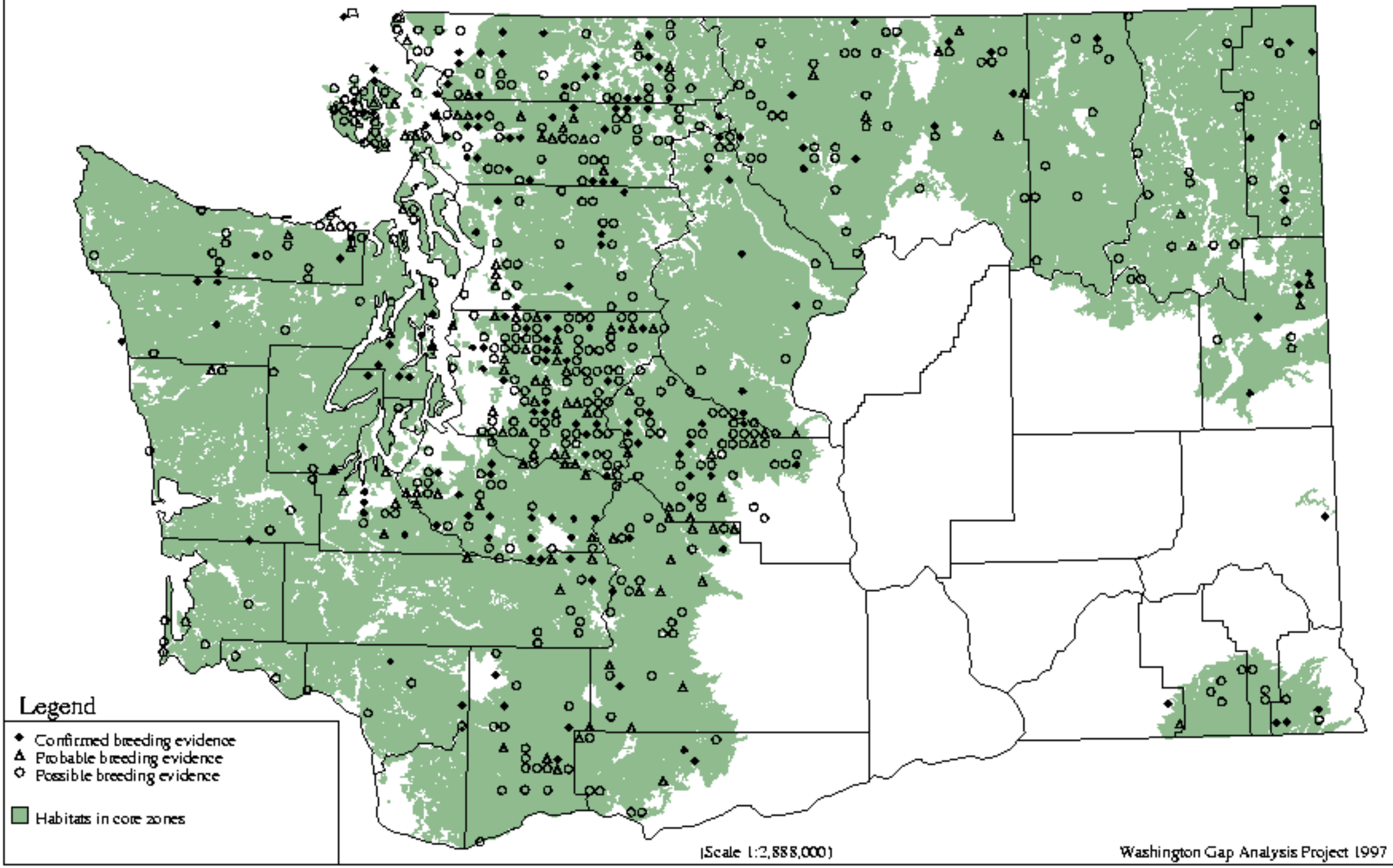
Williamson`s Sapsucker - *Sphyrapicus thyroideus*



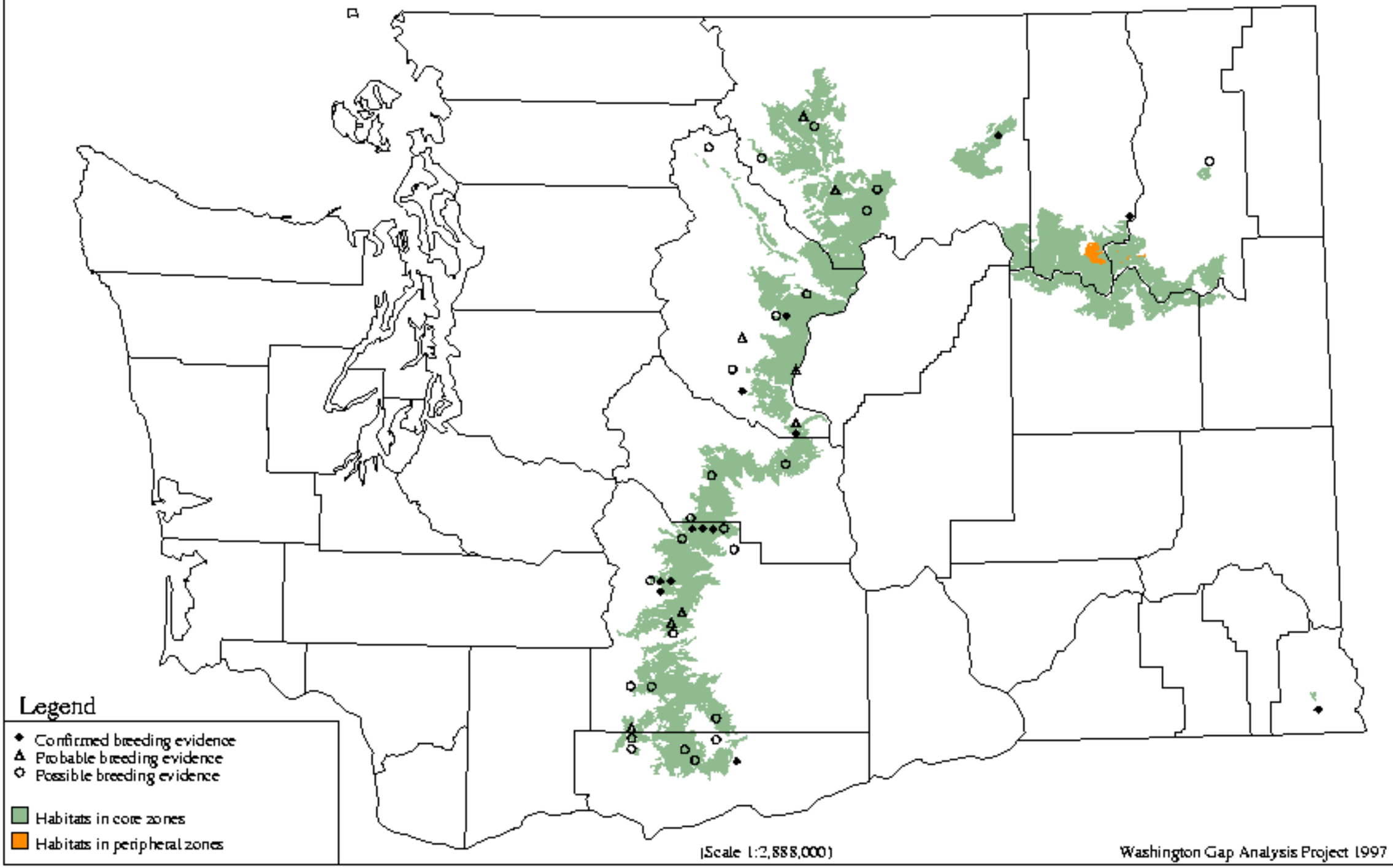
Downy Woodpecker - *Picoides pubescens*



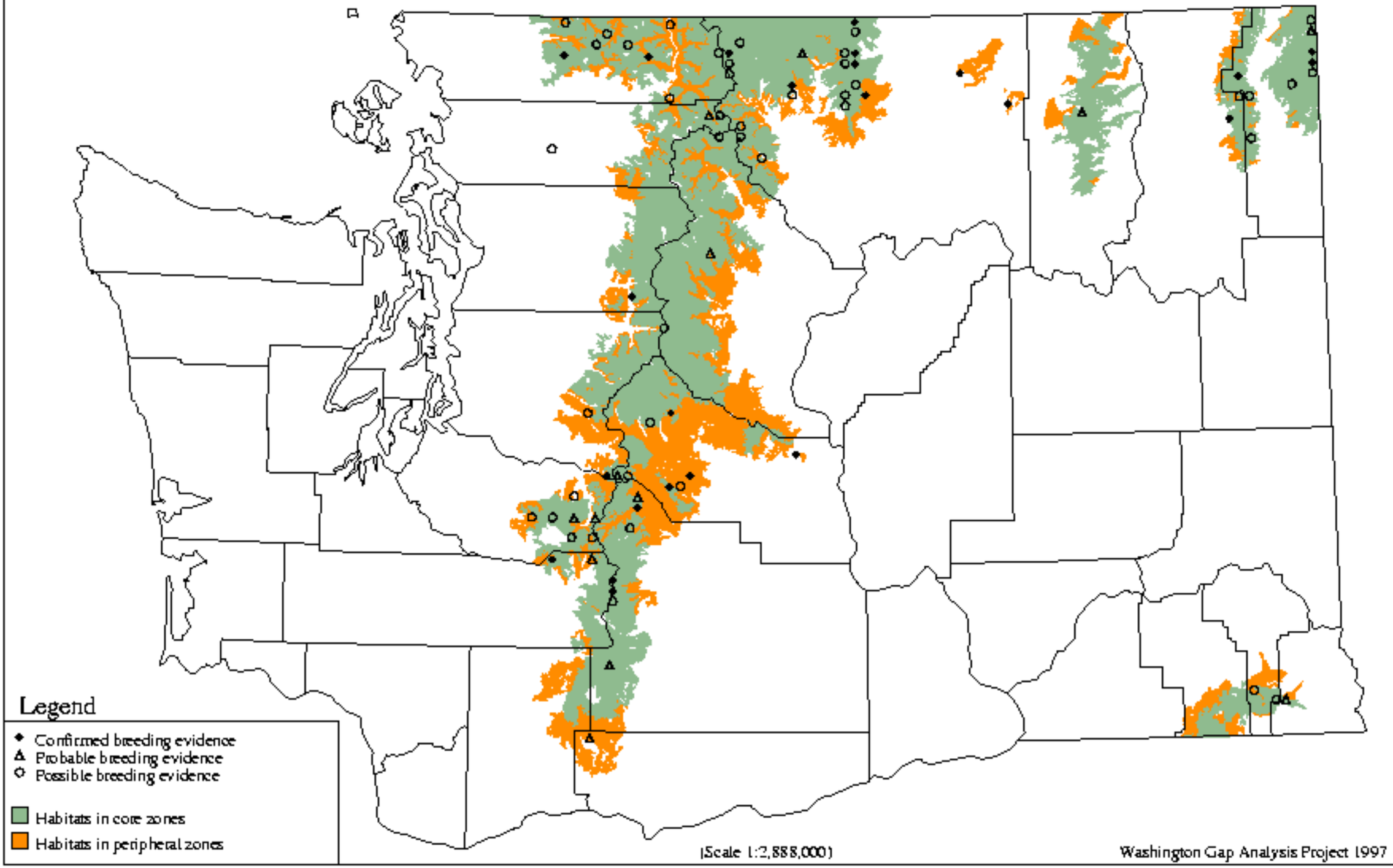
Hairy Woodpecker - *Picoides villosus*



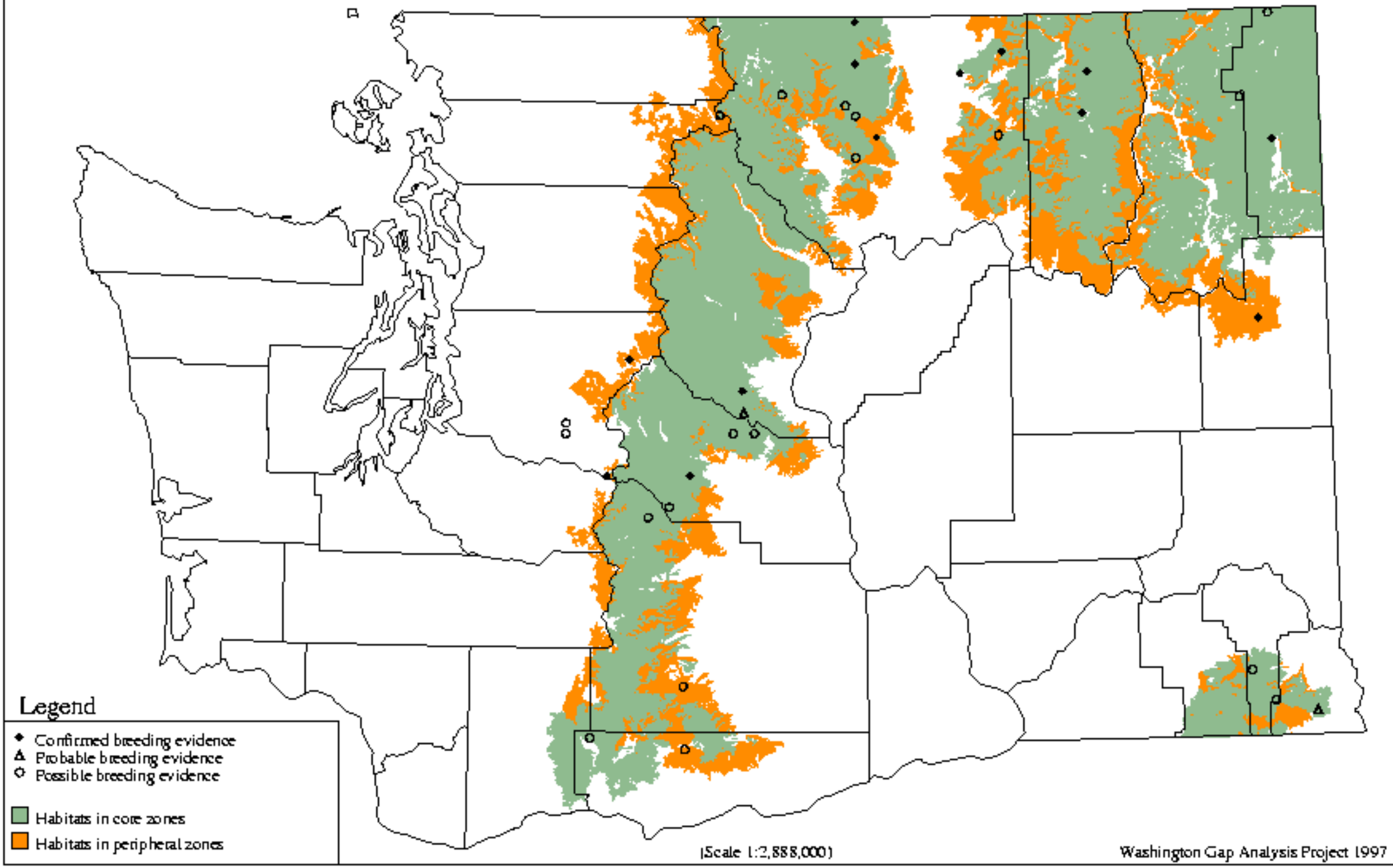
White-headed Woodpecker - *Picoides albolarvatus*



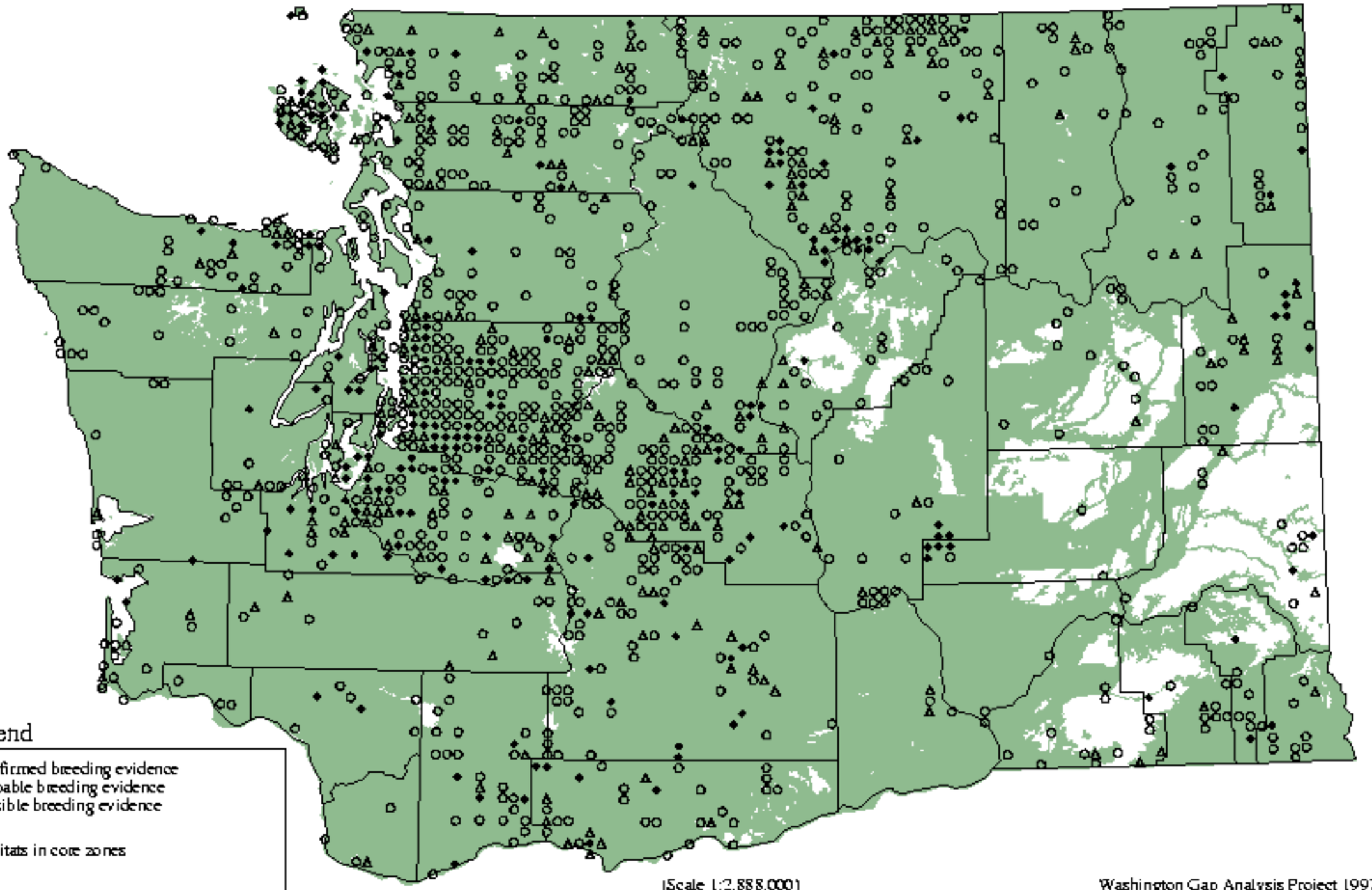
Three-toed Woodpecker - *Picoides tridactylus*



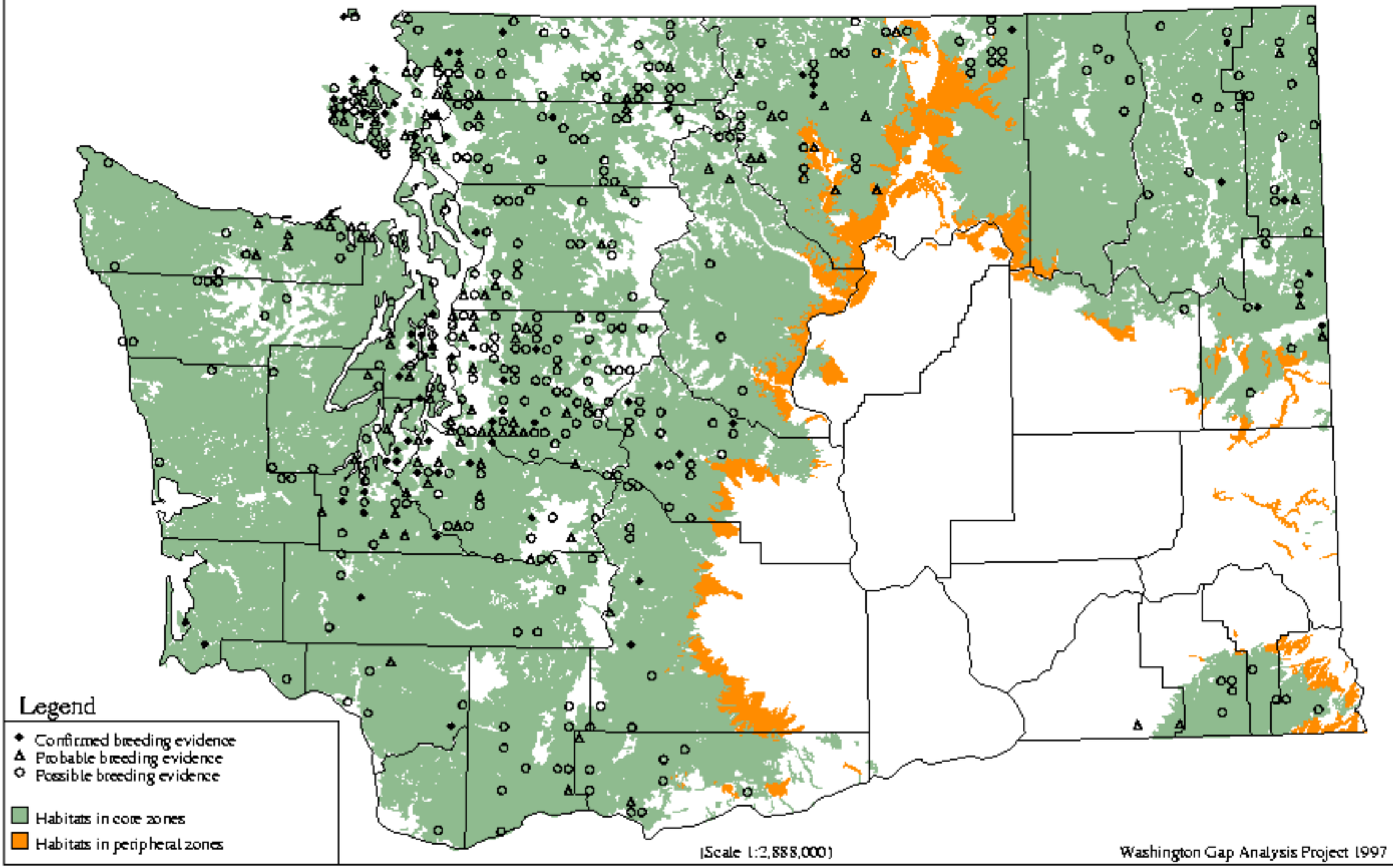
Black-backed Woodpecker - *Picoides arcticus*



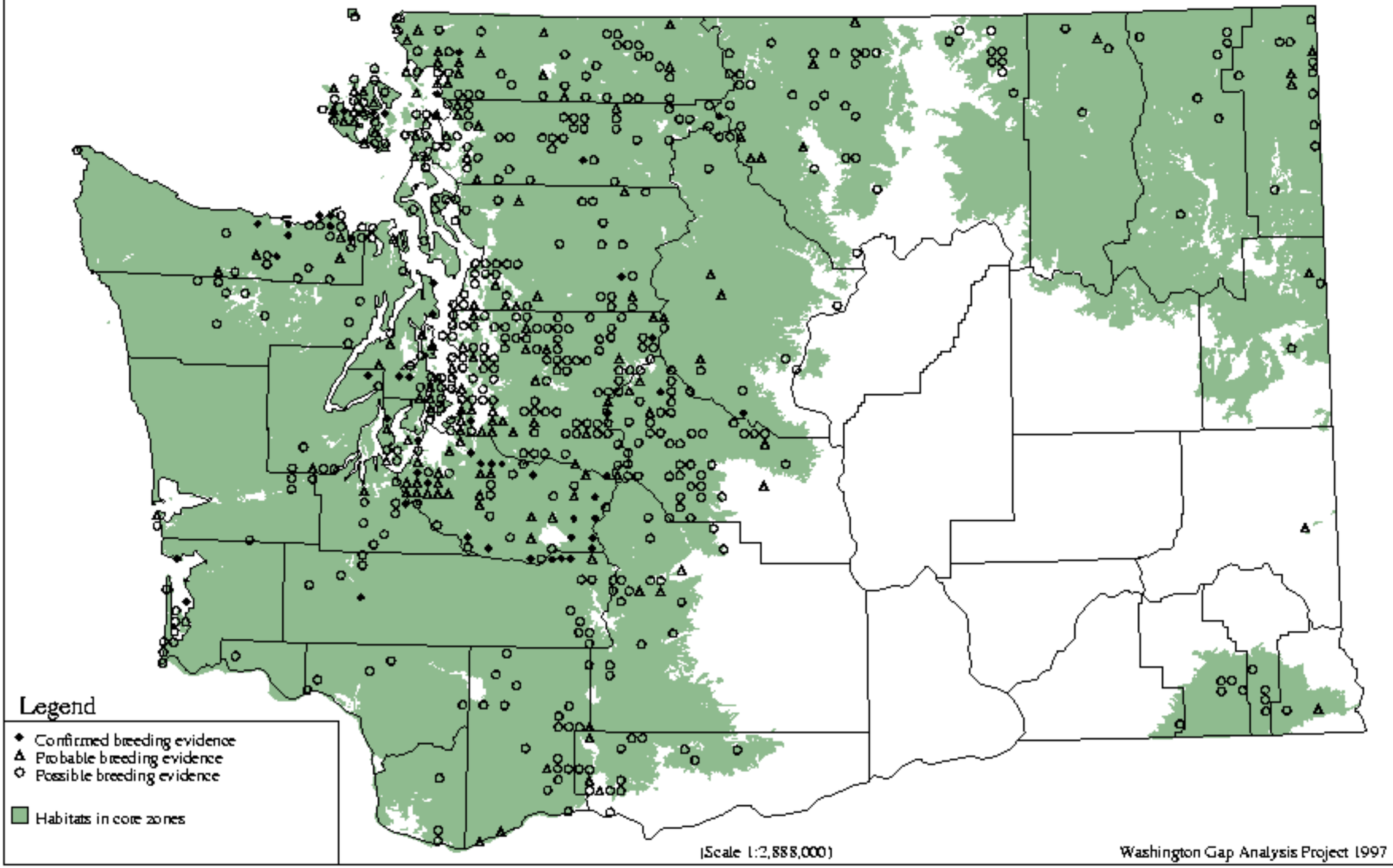
Northern Flicker - *Colaptes auratus*



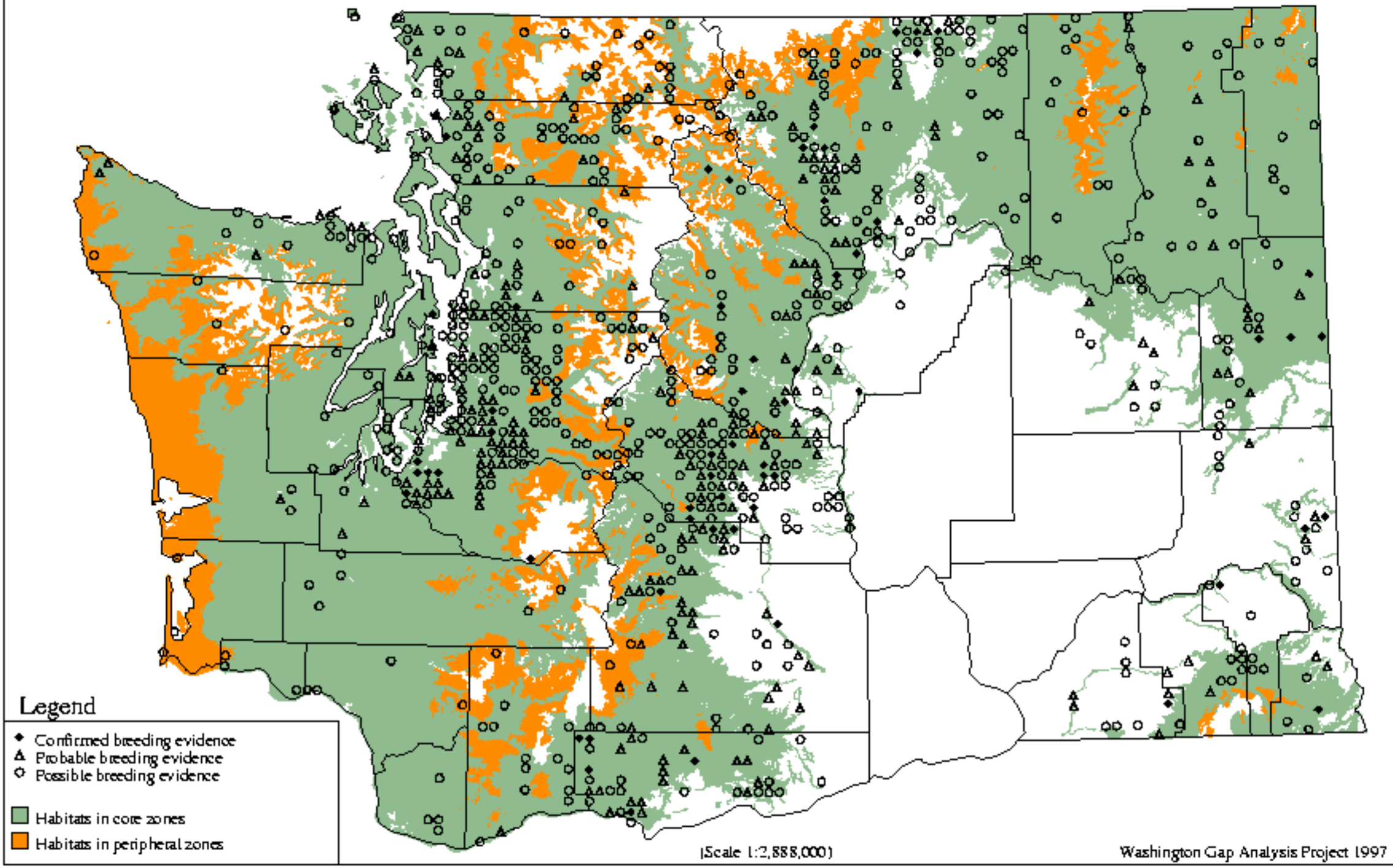
Pileated Woodpecker - *Dryocopus pileatus*



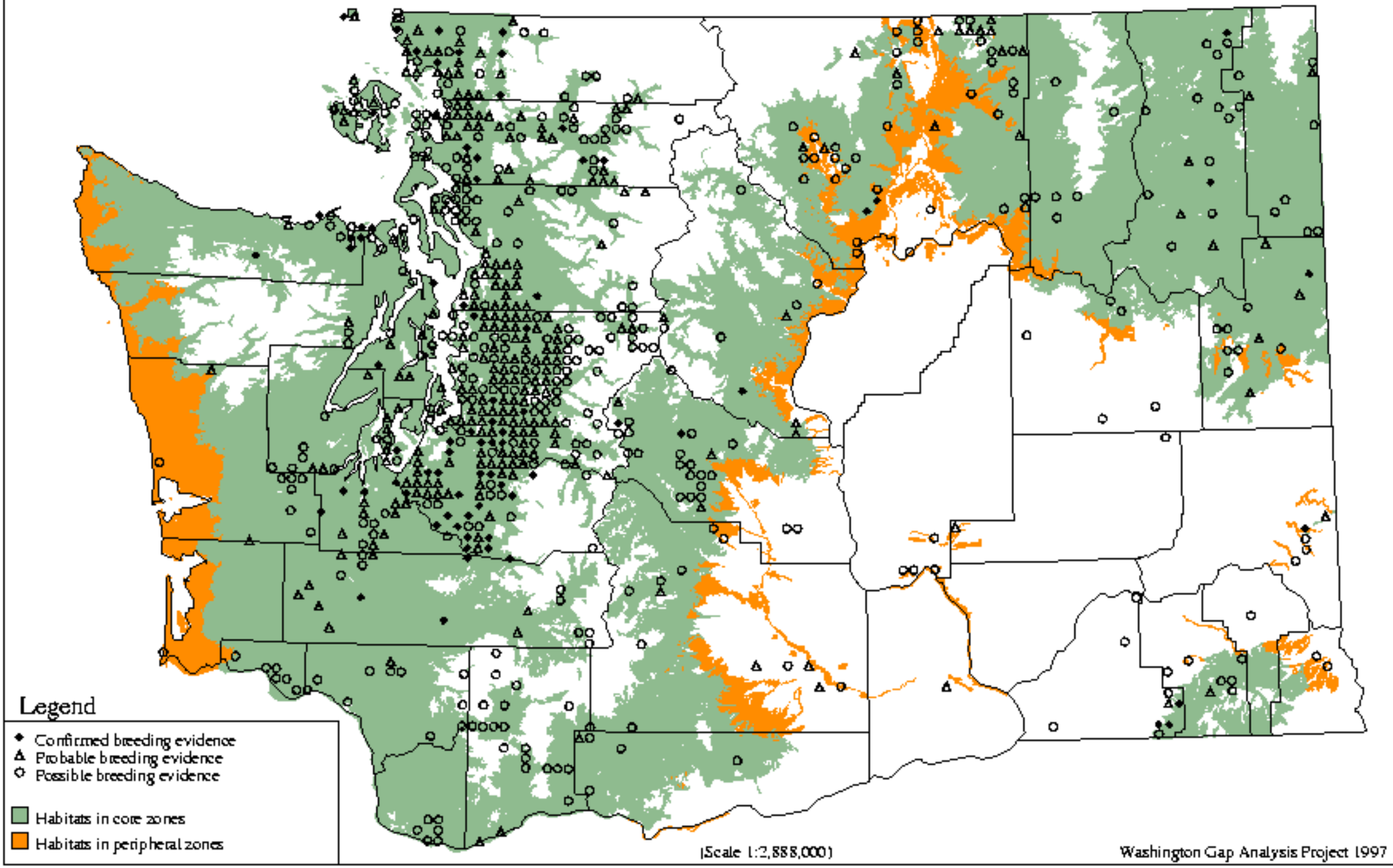
Olive-sided Flycatcher - *Contopus borealis*



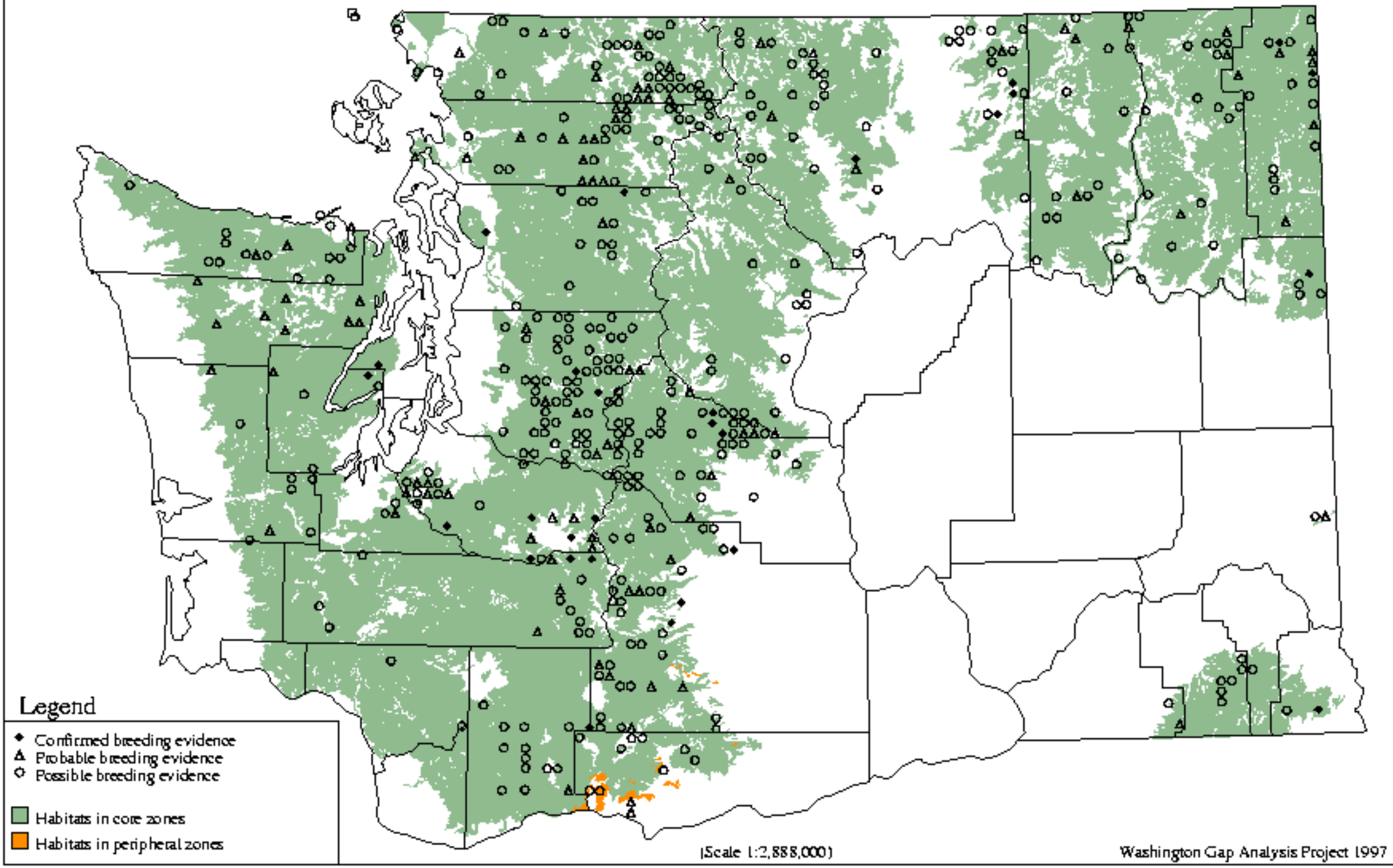
Western Wood-Pewee - *Contopus sordidulus*



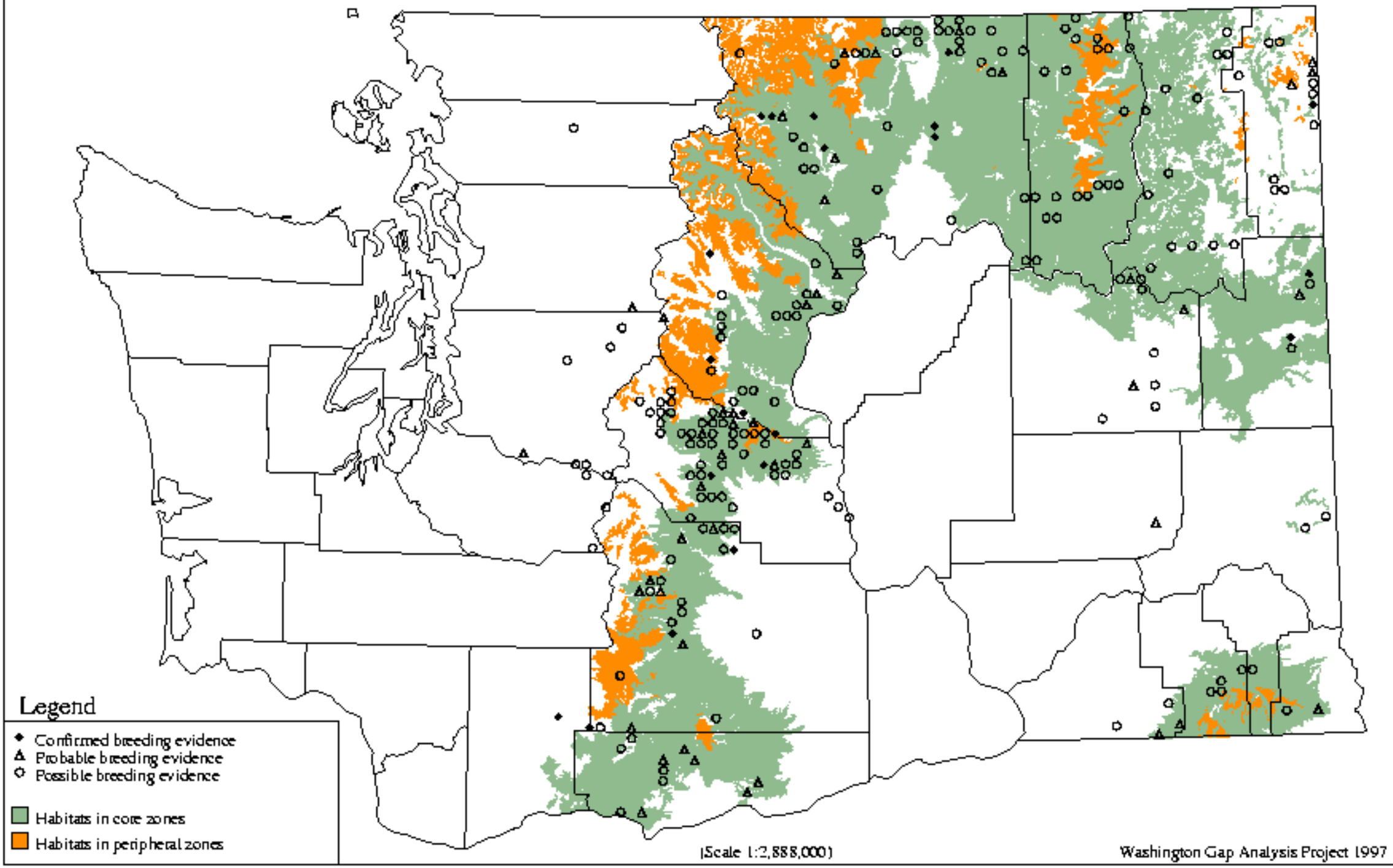
Willow Flycatcher - *Empidonax traillii*



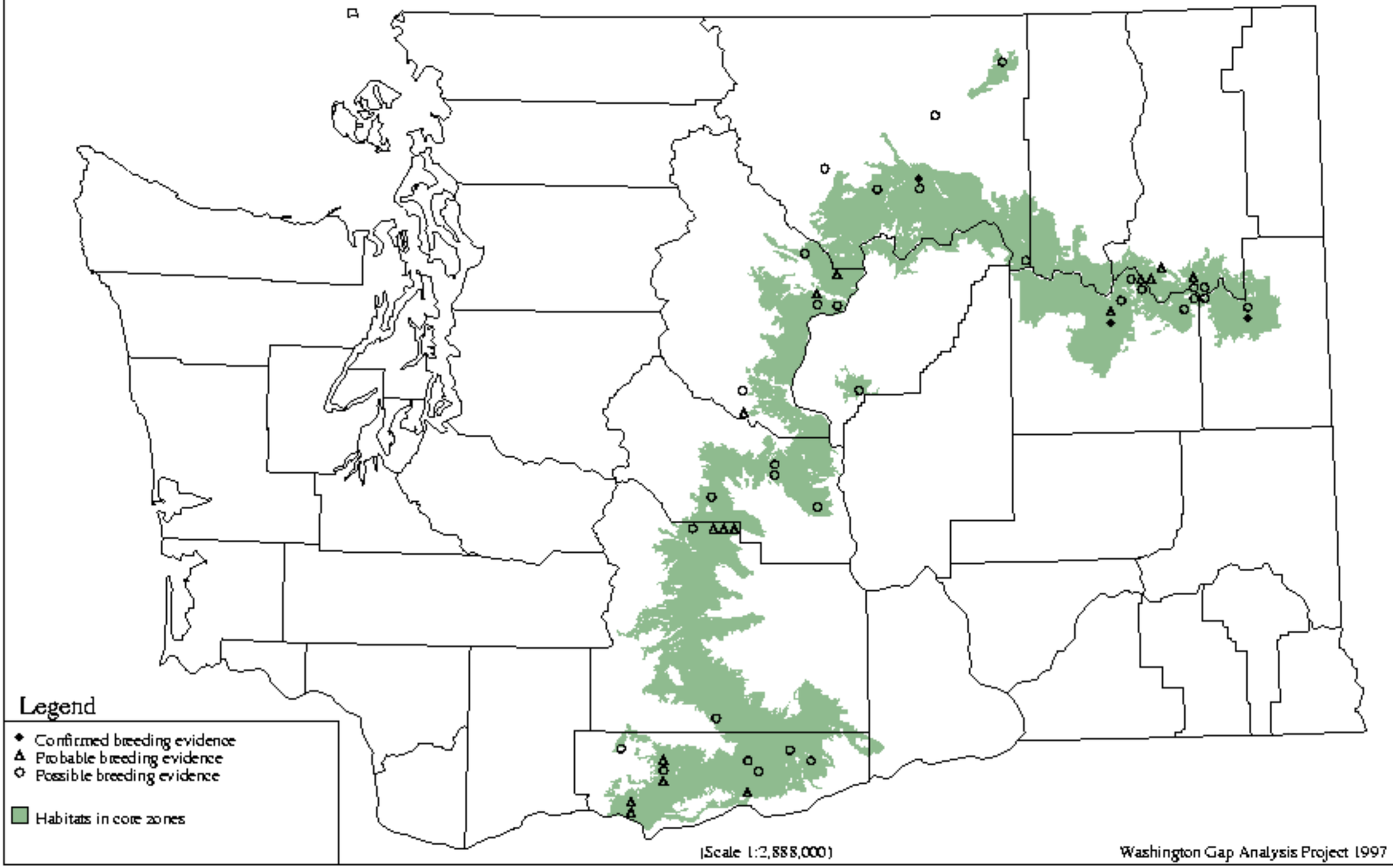
Hammond`s Flycatcher - *Empidonax hammondi*



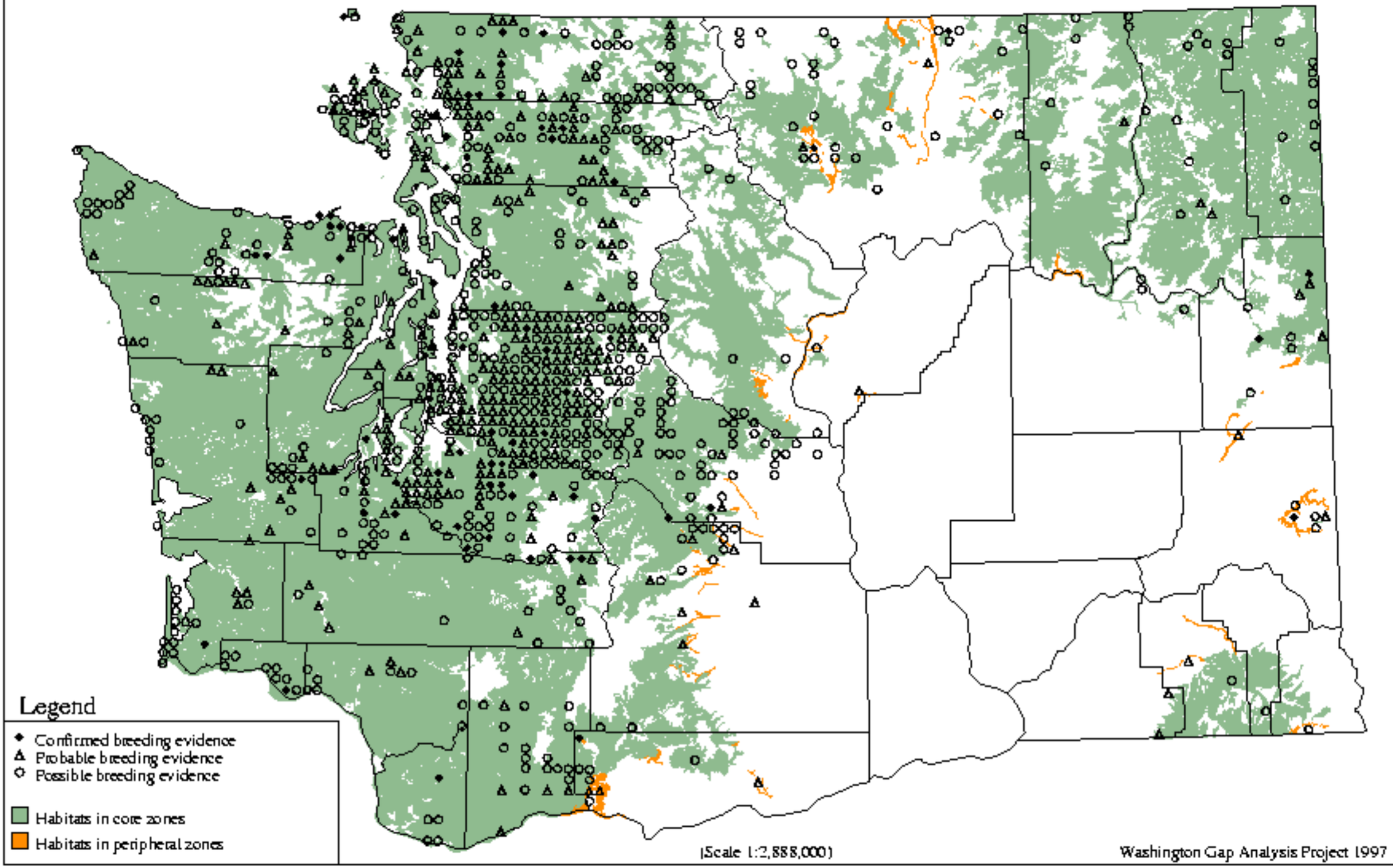
Dusky Flycatcher - *Empidonax oberholseri*



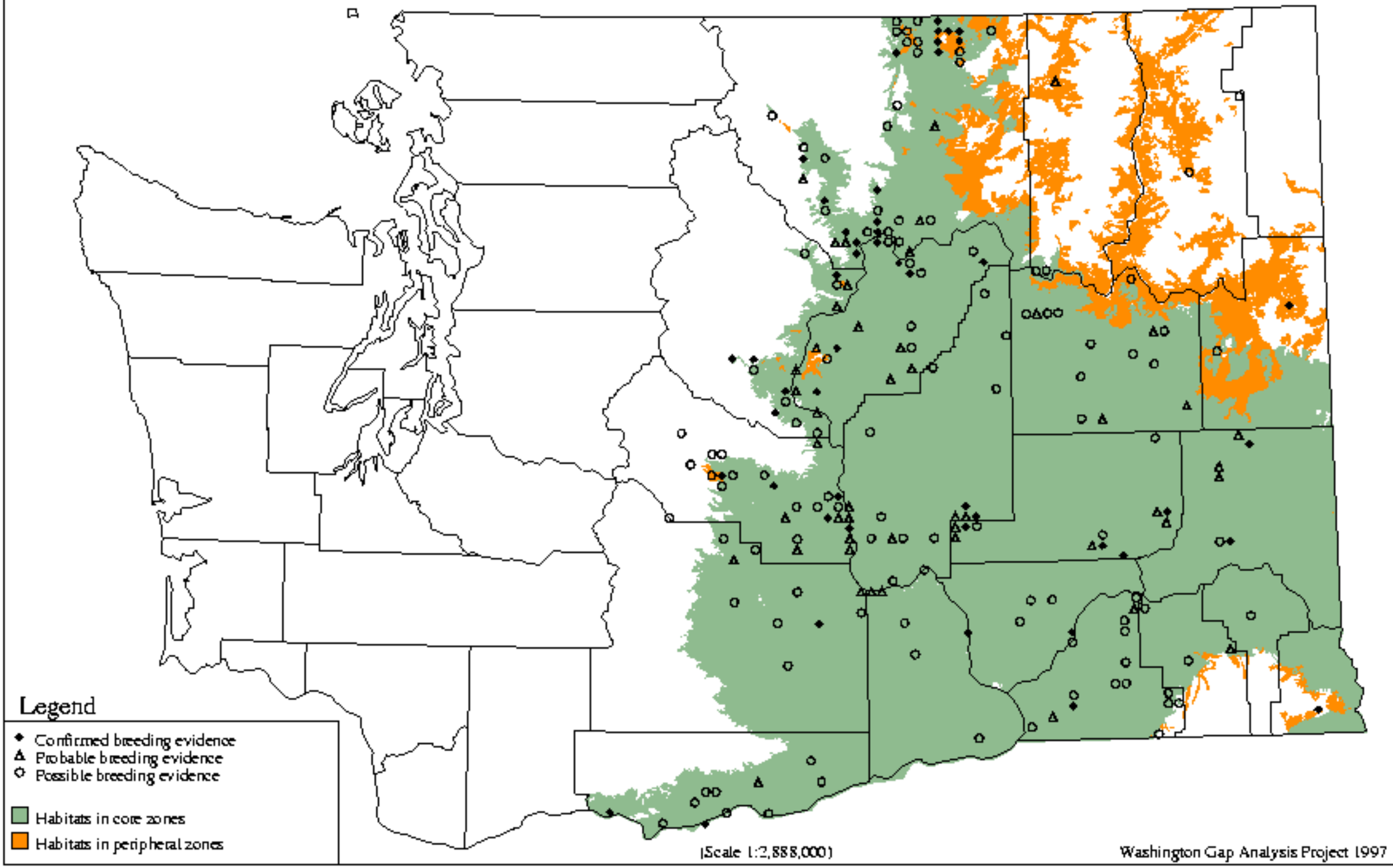
Gray Flycatcher - *Empidonax wrightii*



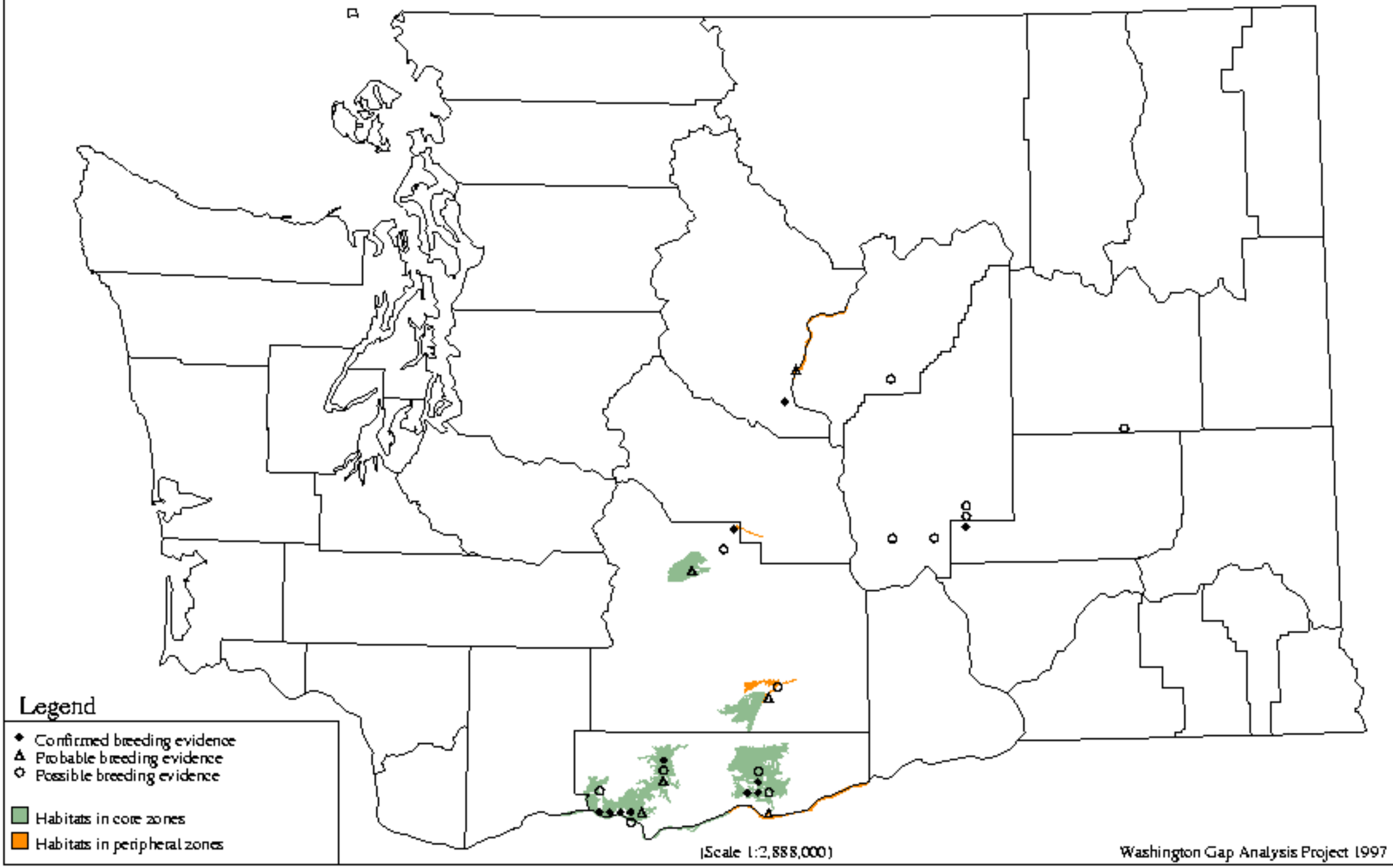
Pacific-slope/Cordilleran Flycatcher - *Empidonax difficilis/occidentalis*



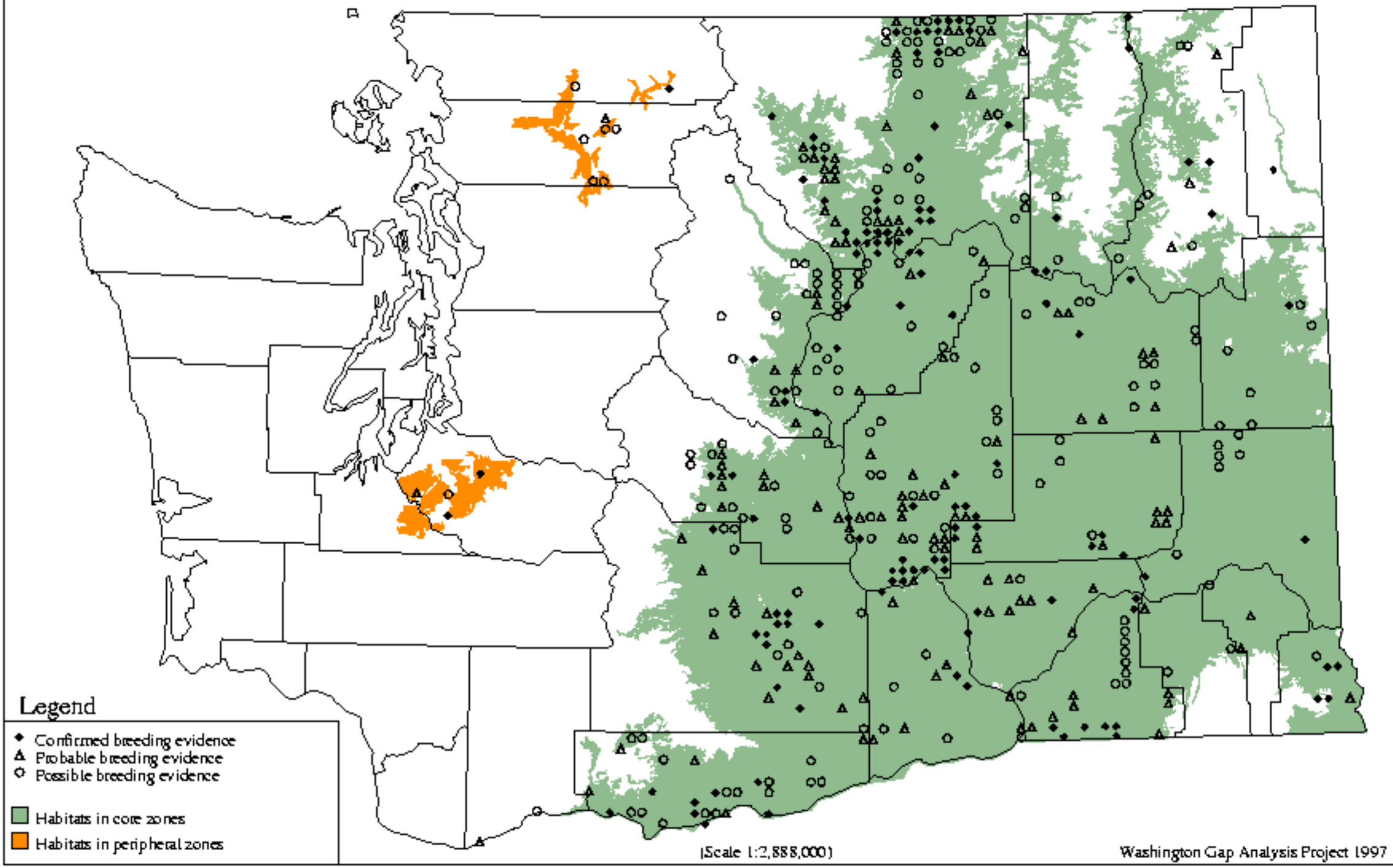
Say`s Phoebe - *Sayornis saya*



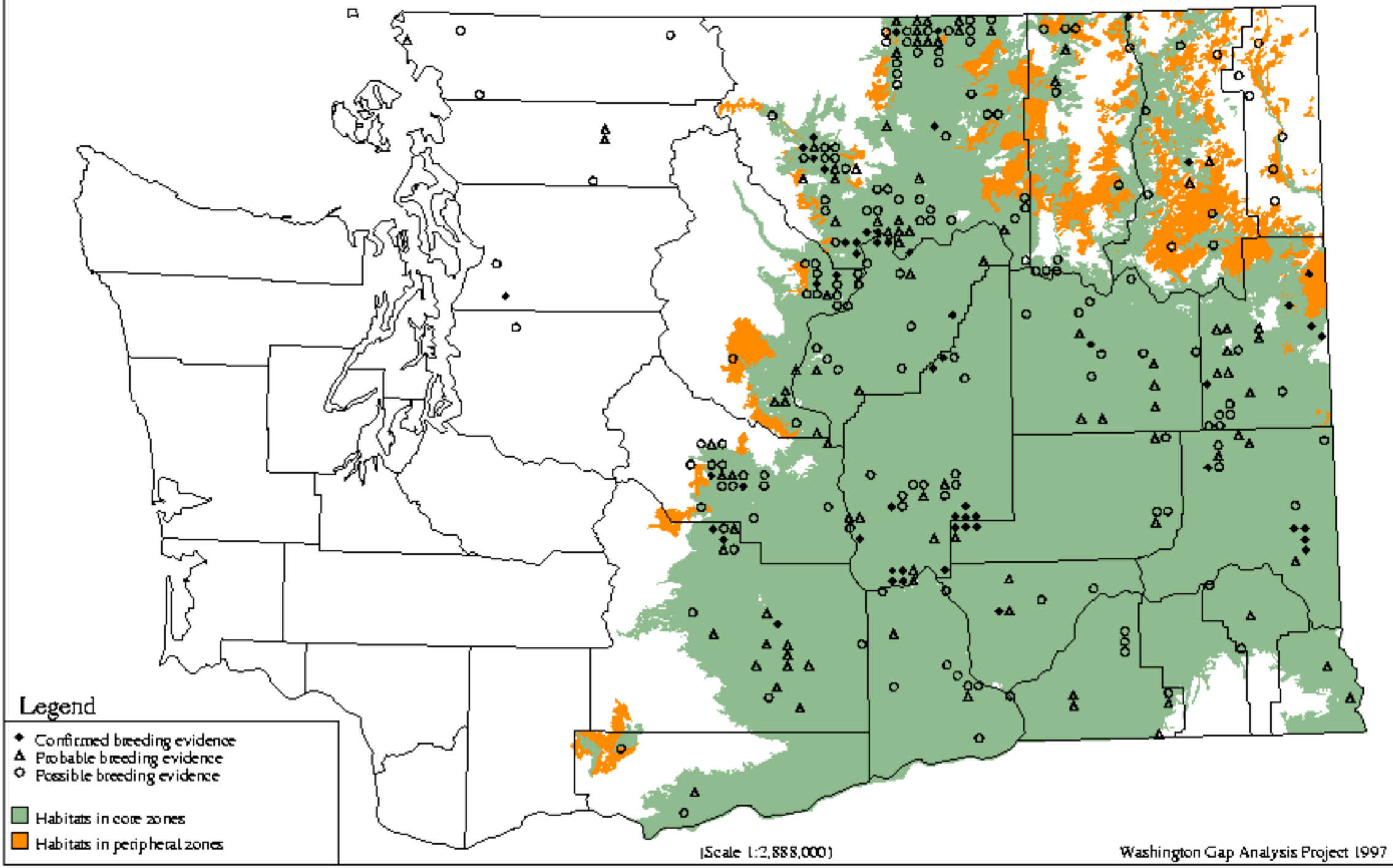
Ash-throated Flycatcher - *Myiarchus cinerascens*



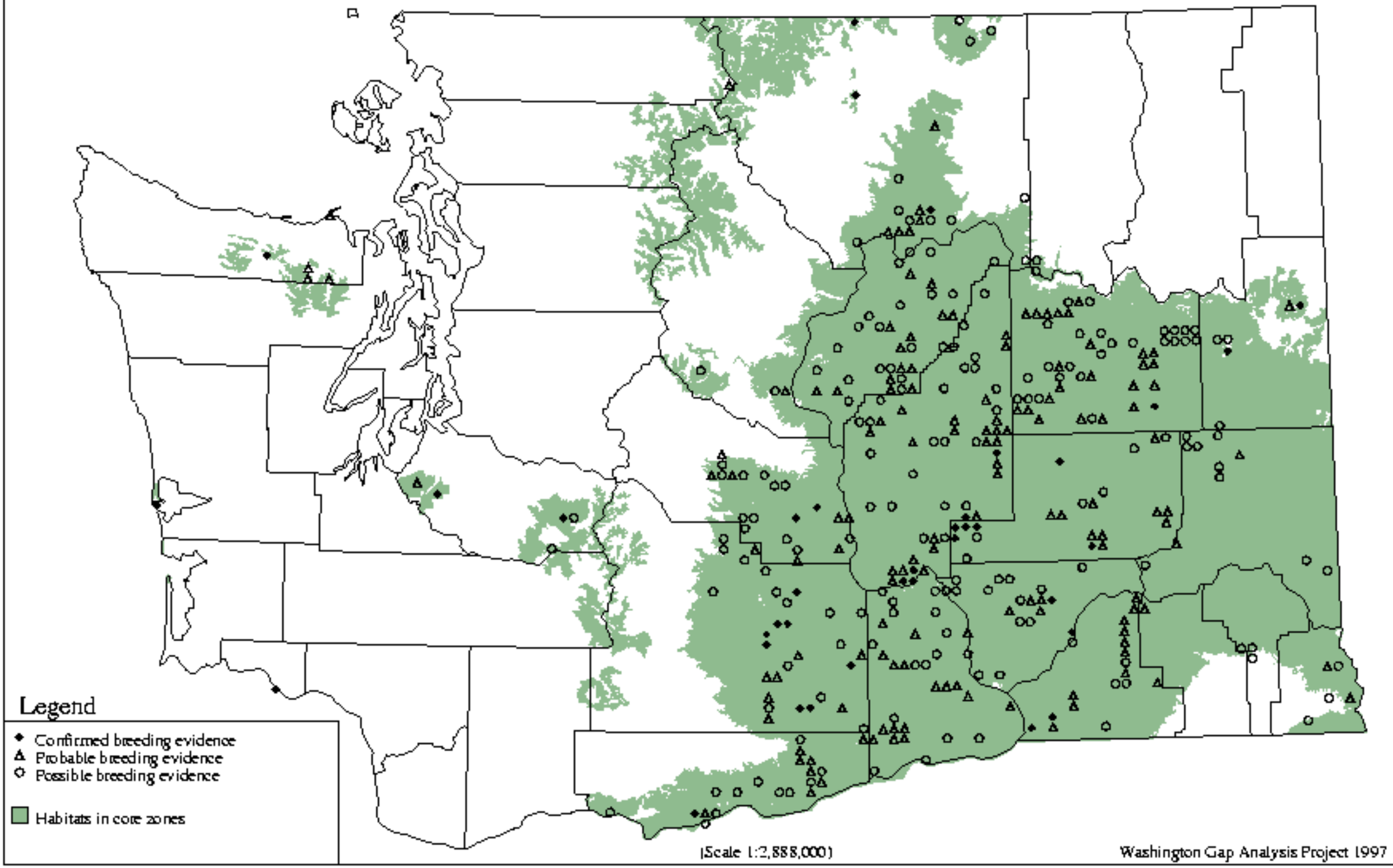
Western Kingbird - *Tyrannus verticalis*



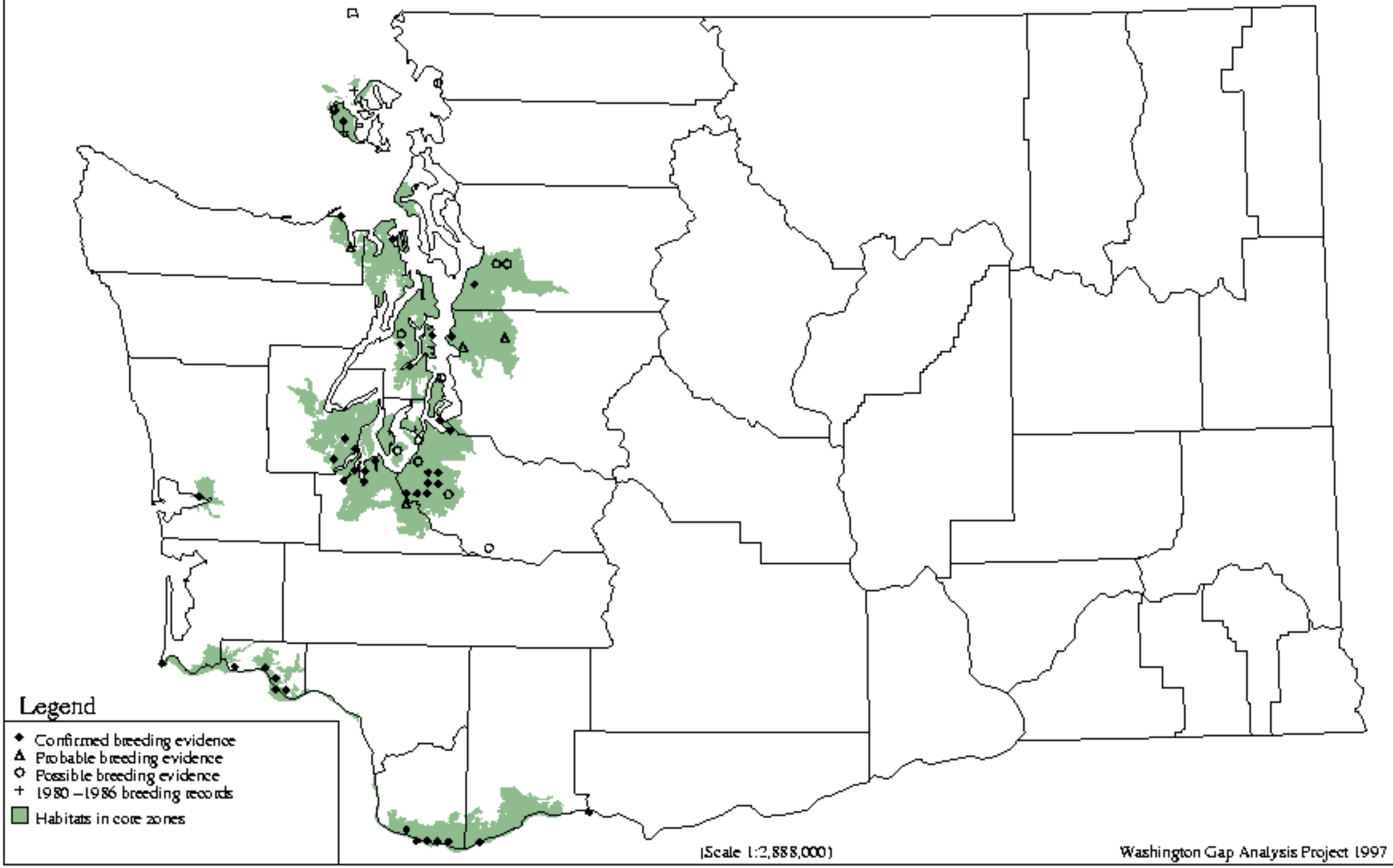
Eastern Kingbird - *Tyrannus tyrannus*



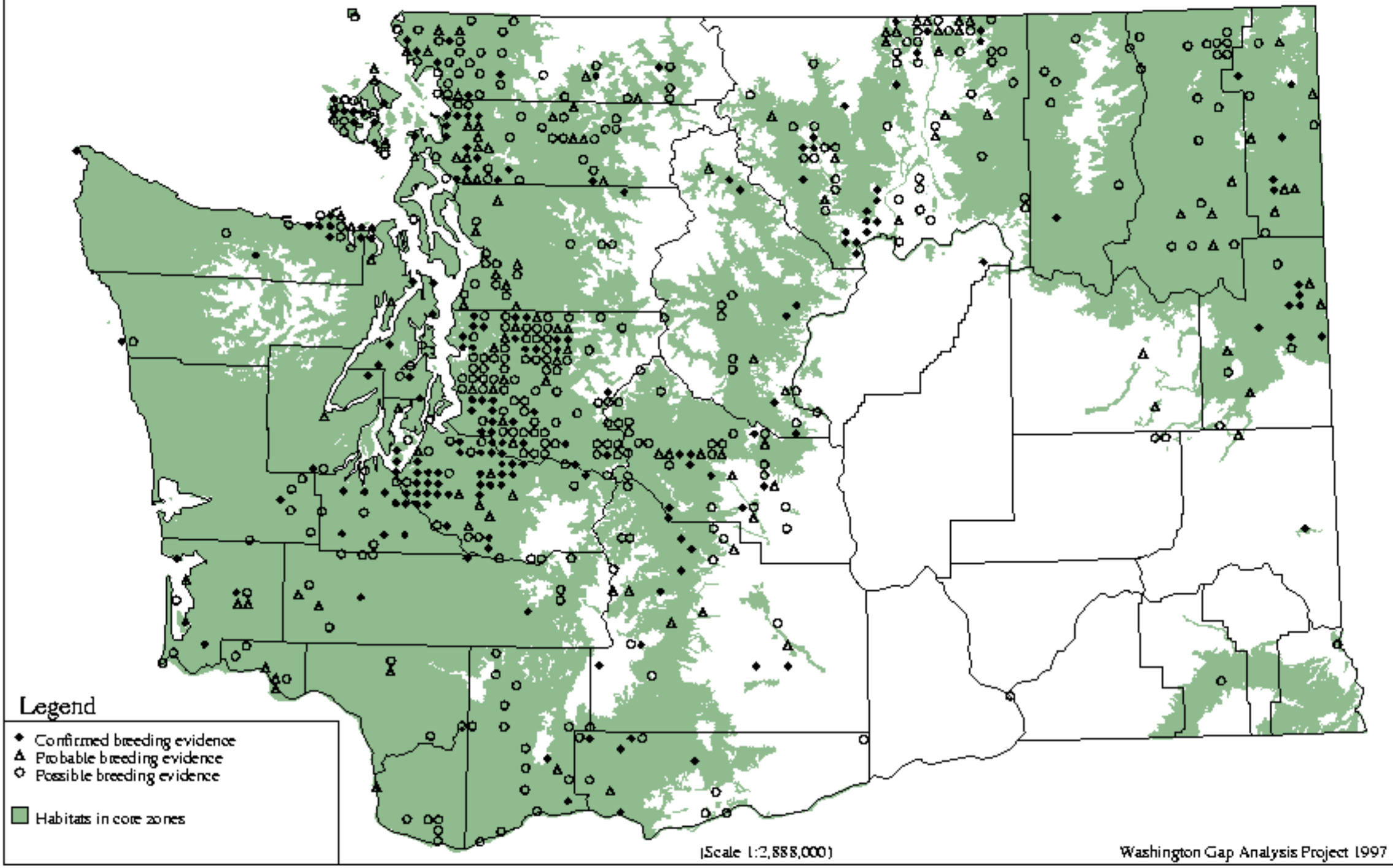
Horned Lark - *Eremophila alpestris*



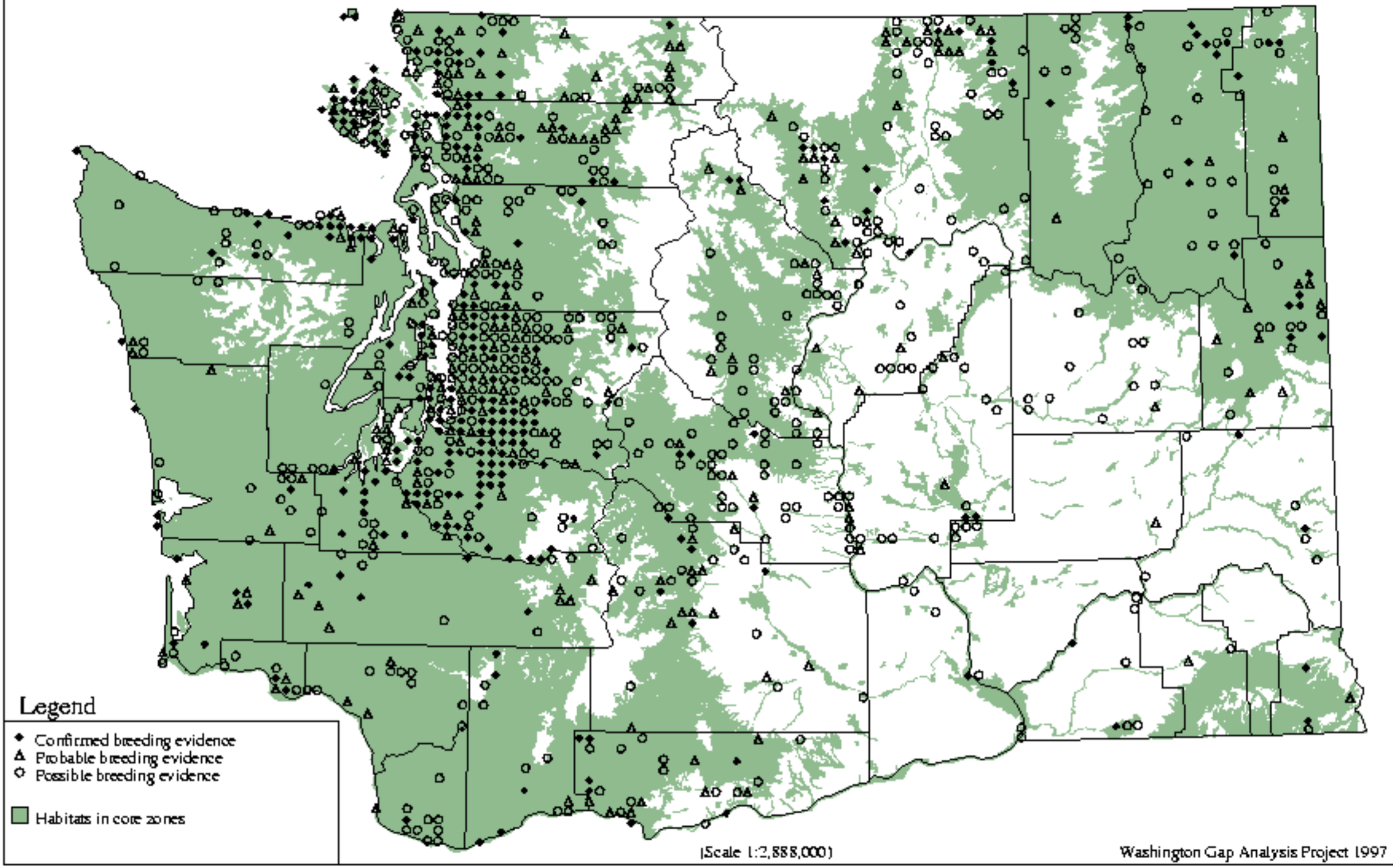
Purple Martin - *Progne subis*



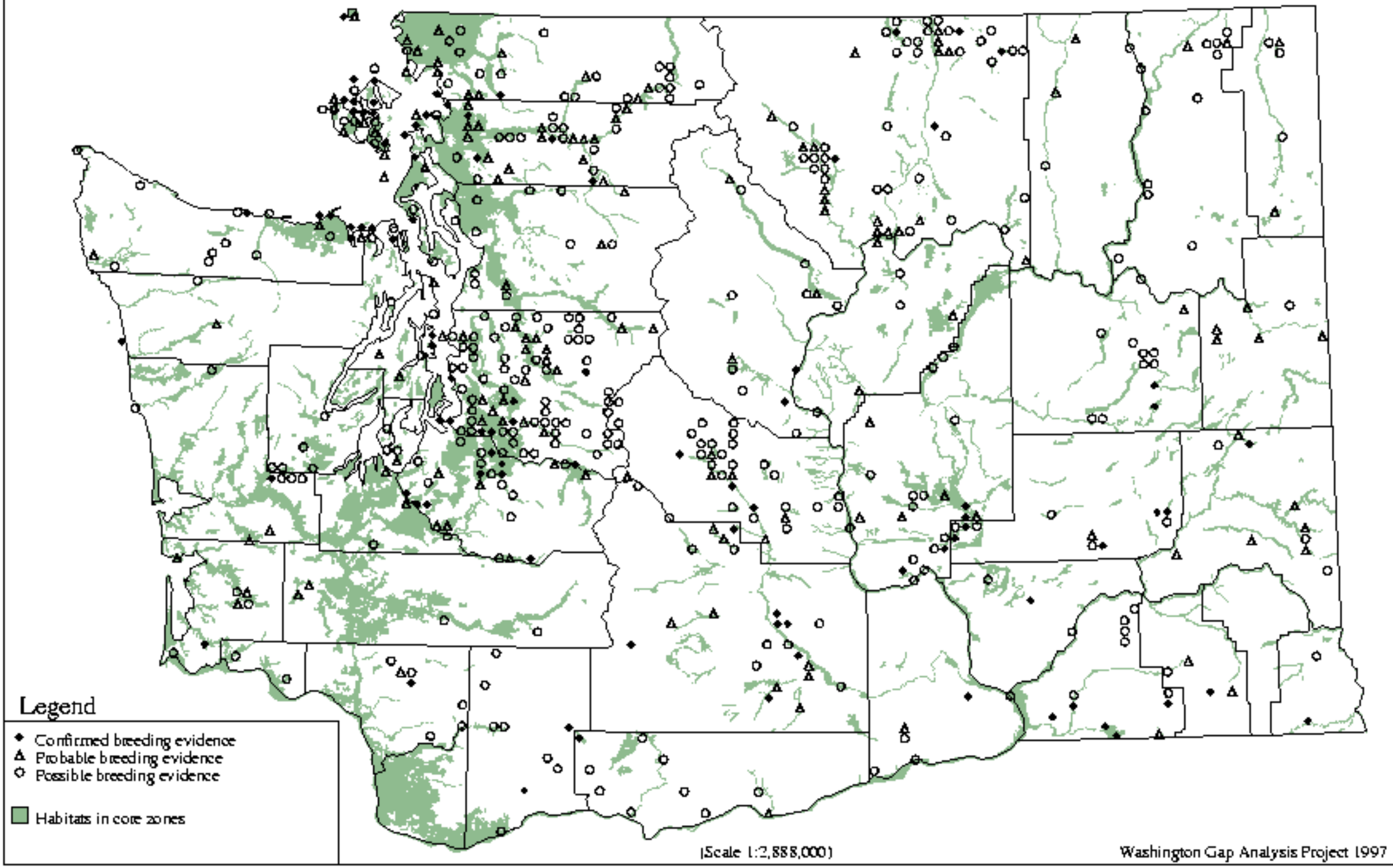
Tree Swallow - *Tachycineta bicolor*



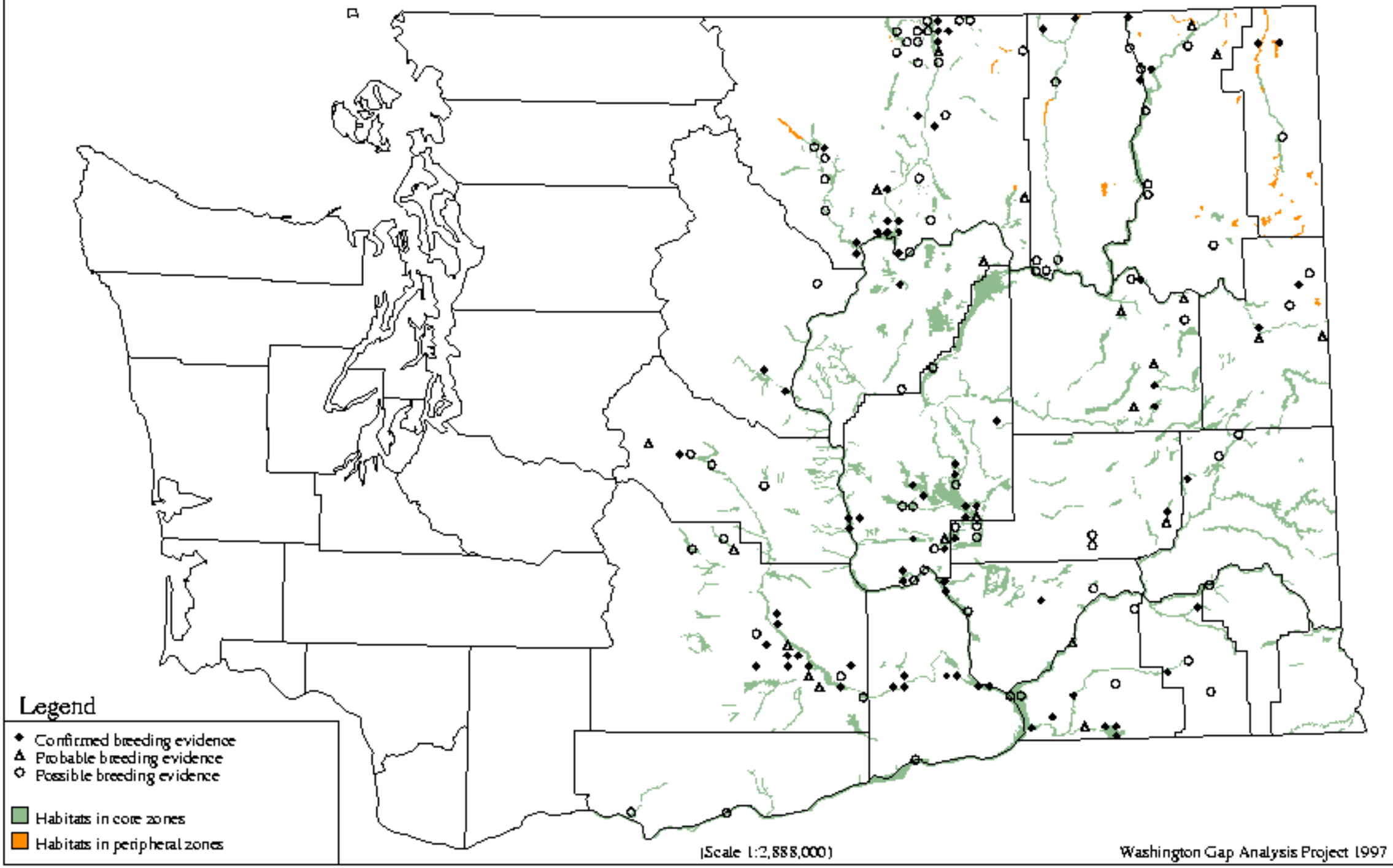
Violet-green Swallow - *Tachycineta thalassina*



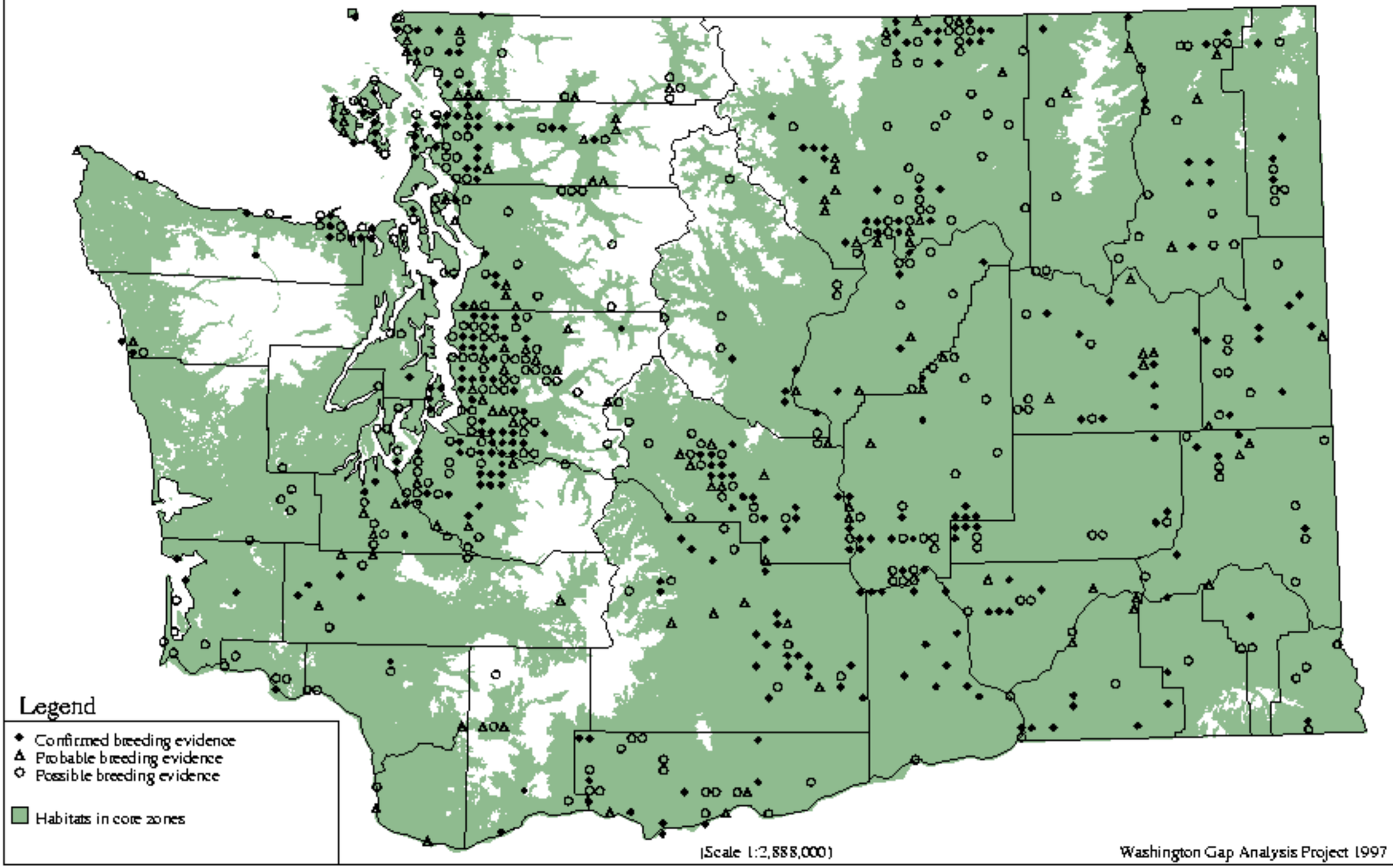
Northern Rough-winged Swallow - *Stelgidopteryx serripennis*



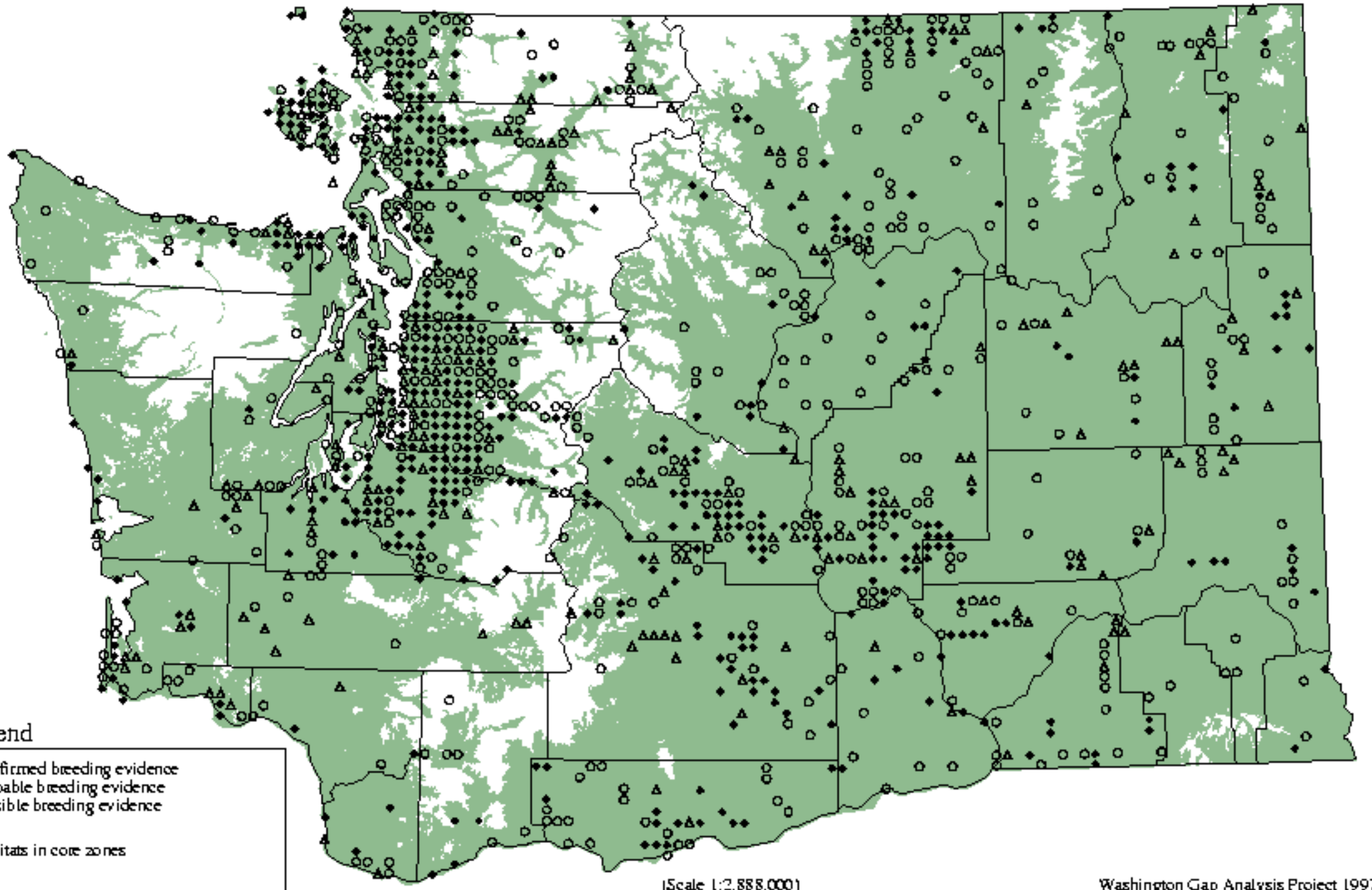
Bank Swallow - *Riparia riparia*



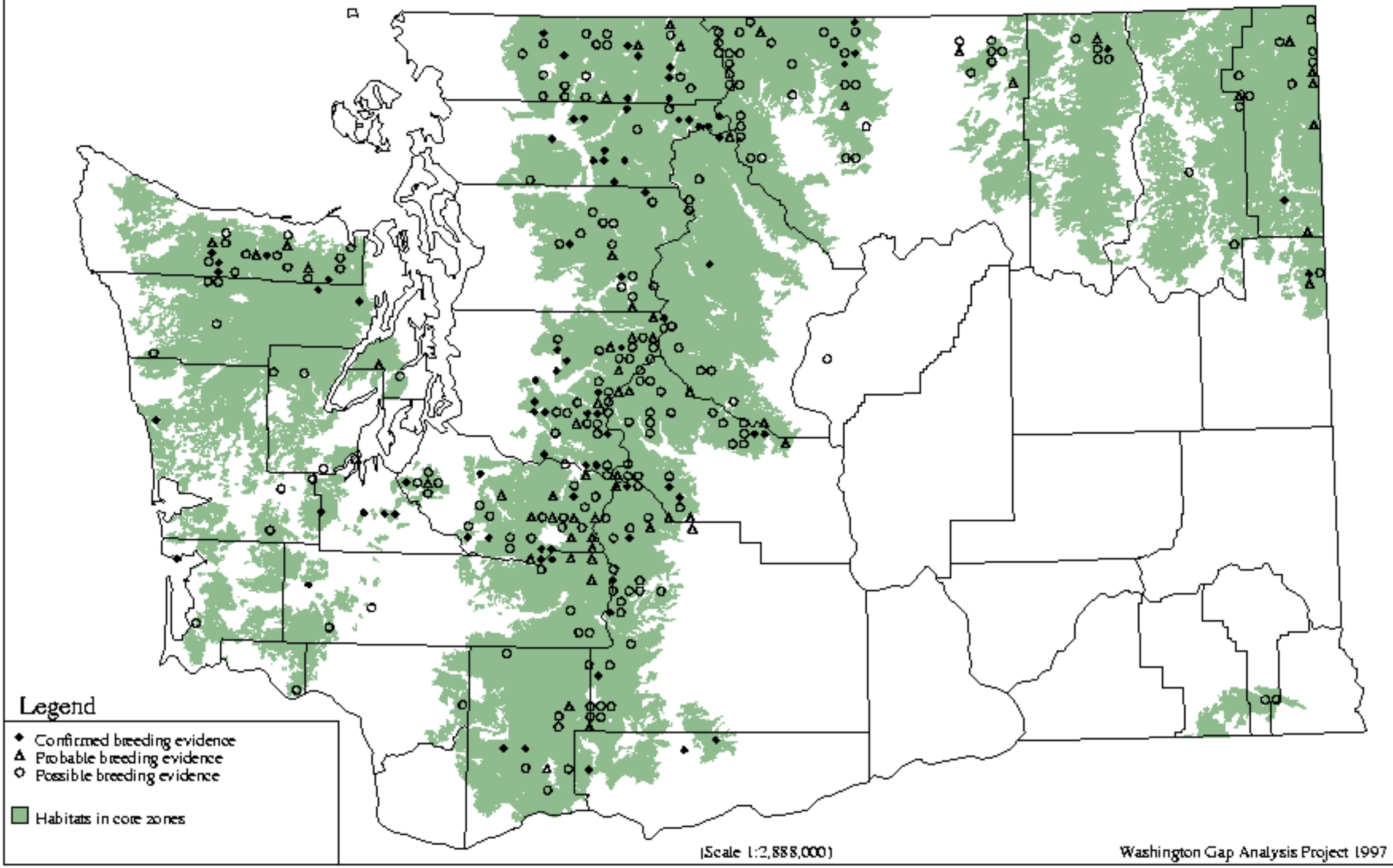
Cliff Swallow - *Hirundo pyrrhonota*



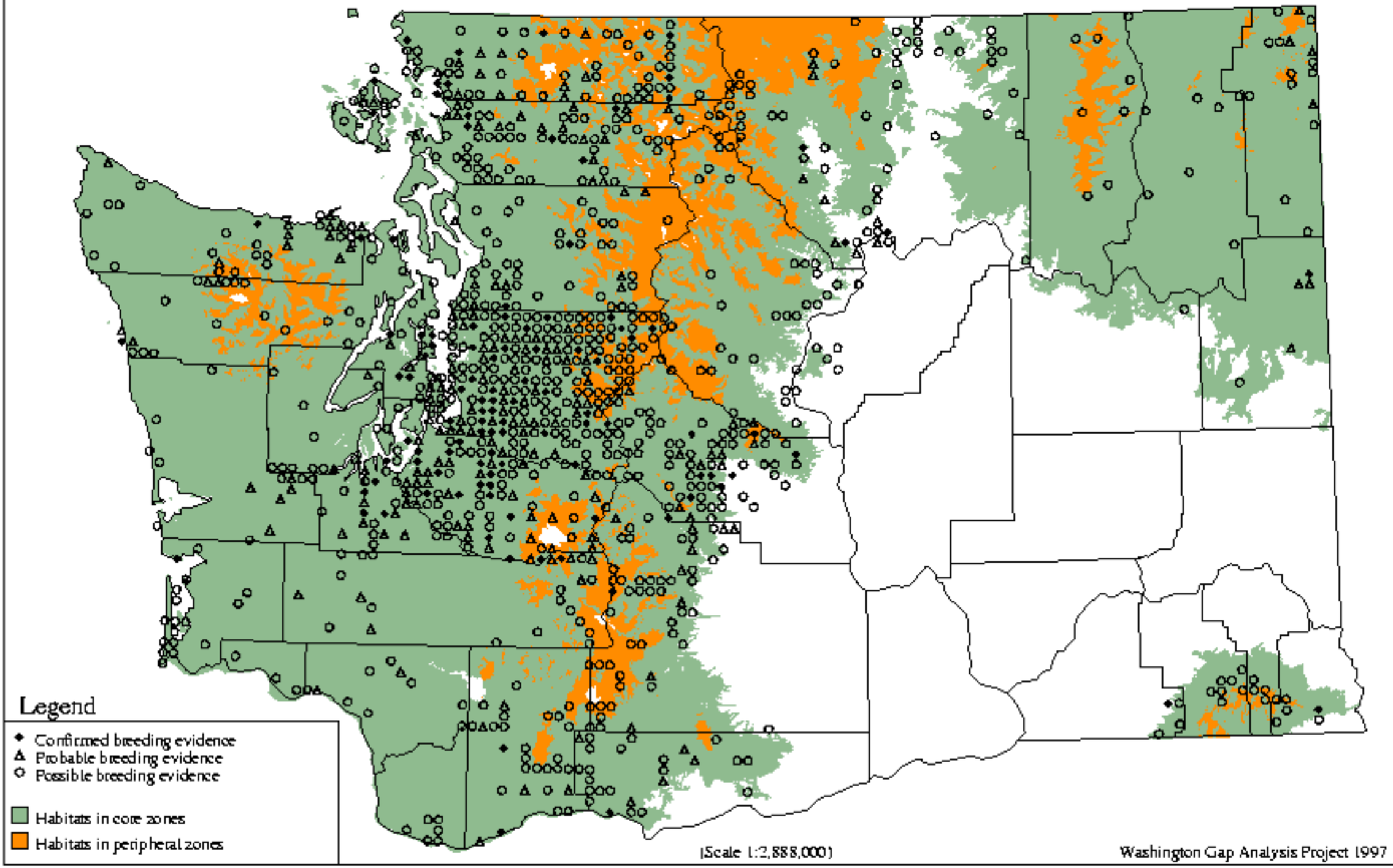
Barn Swallow - *Hirundo rustica*



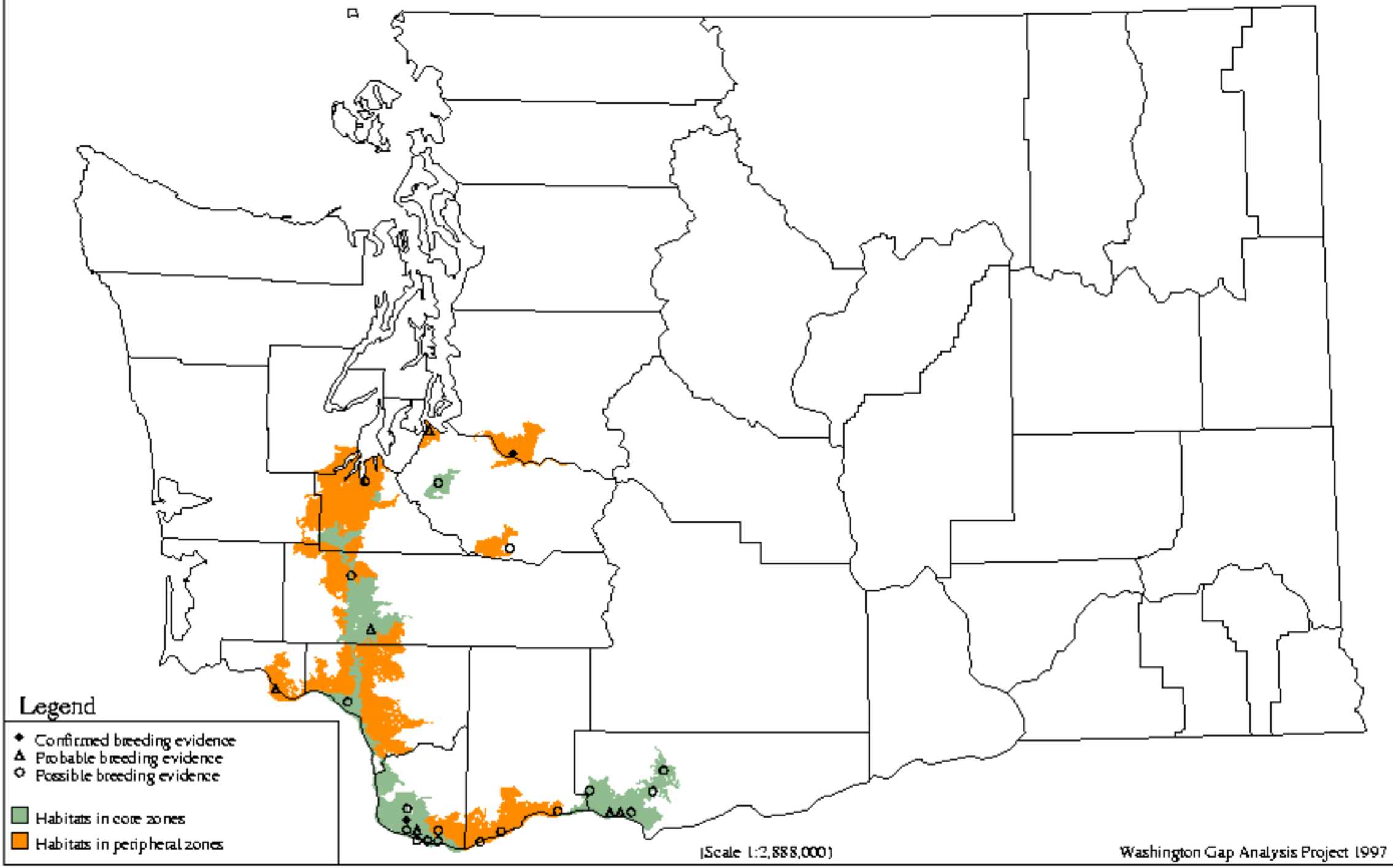
Gray Jay - *Perisoreus canadensis*



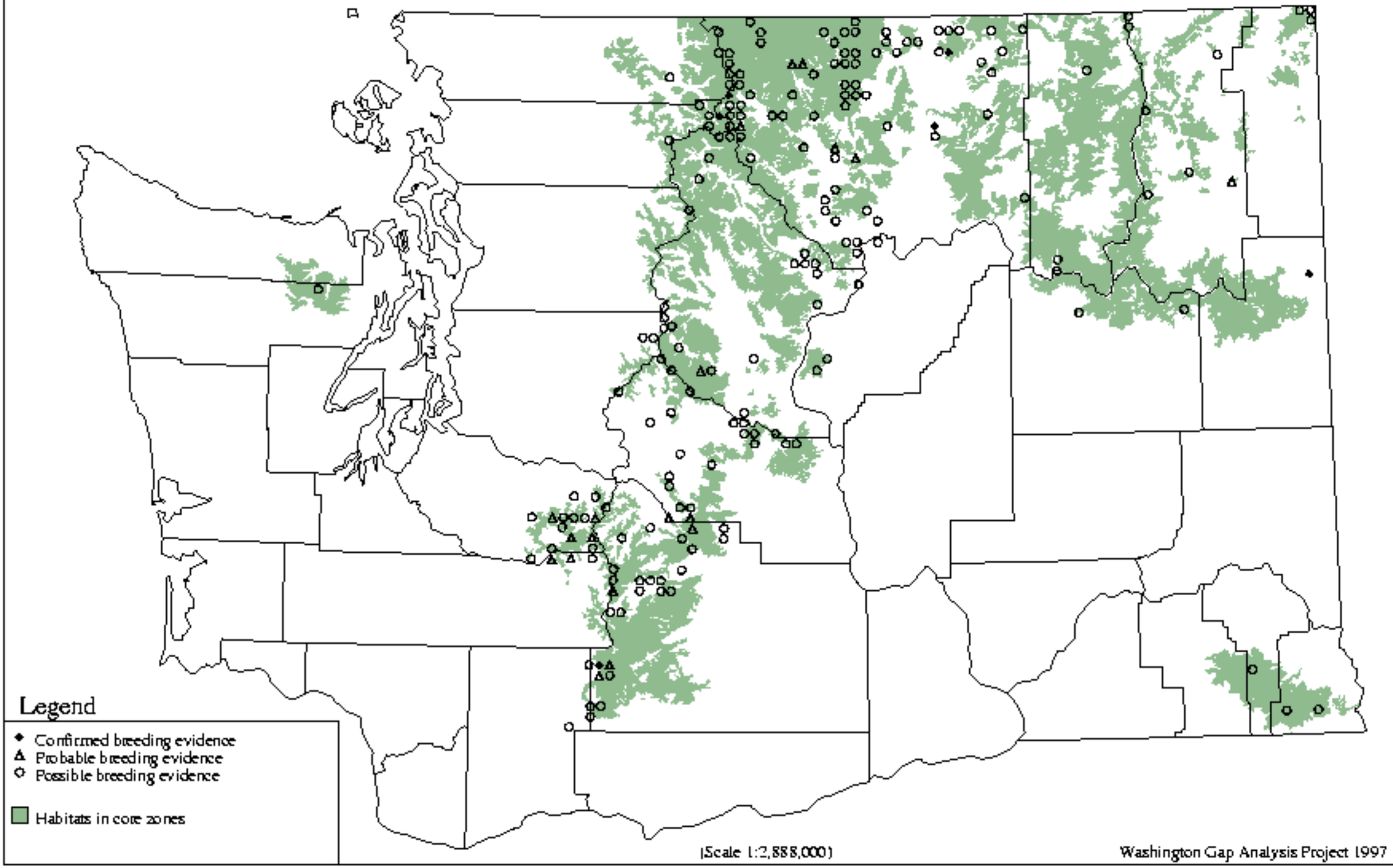
Steller`s Jay - *Cyanocitta stelleri*



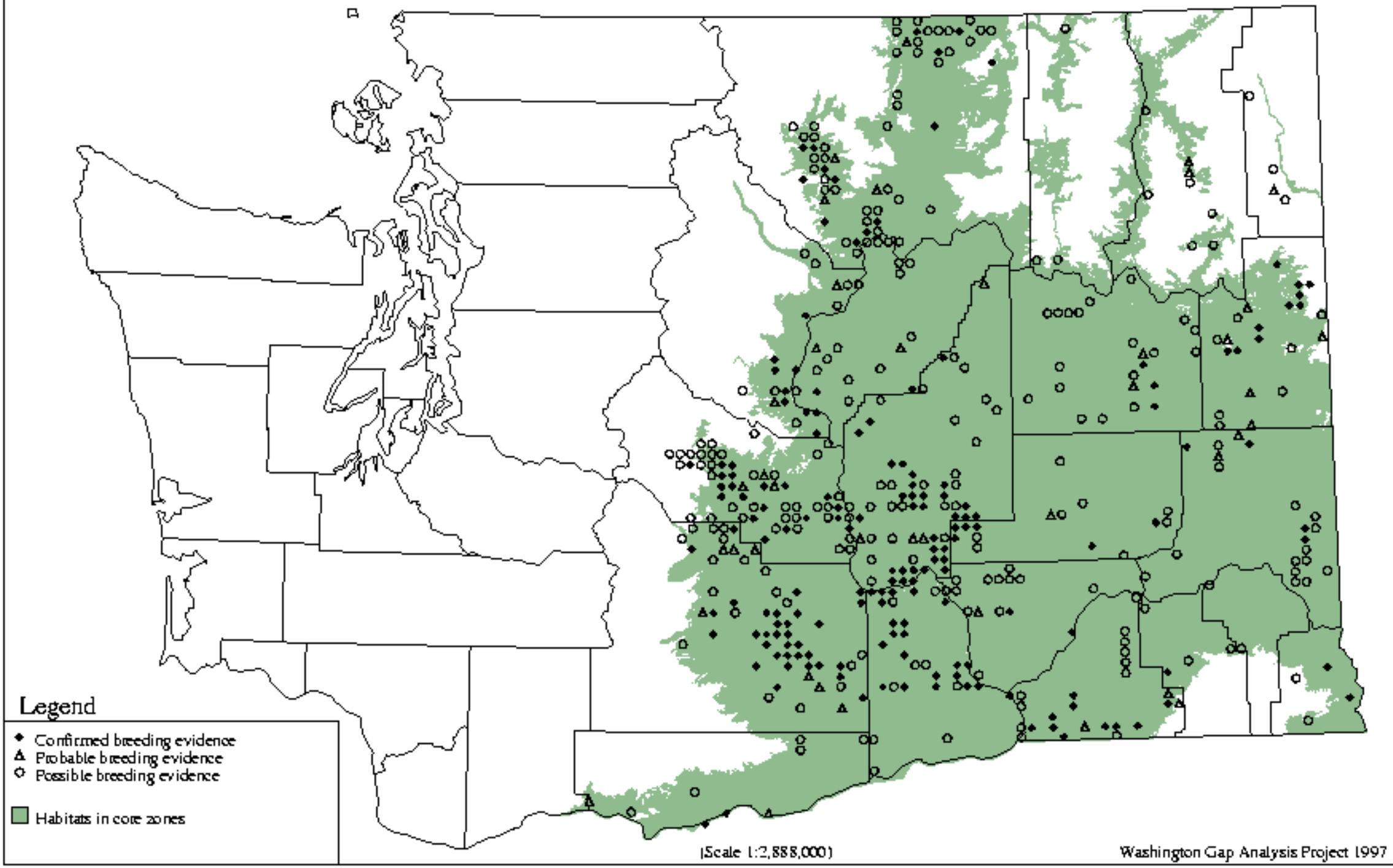
Western Scrub-Jay - *Aphelocoma californica*



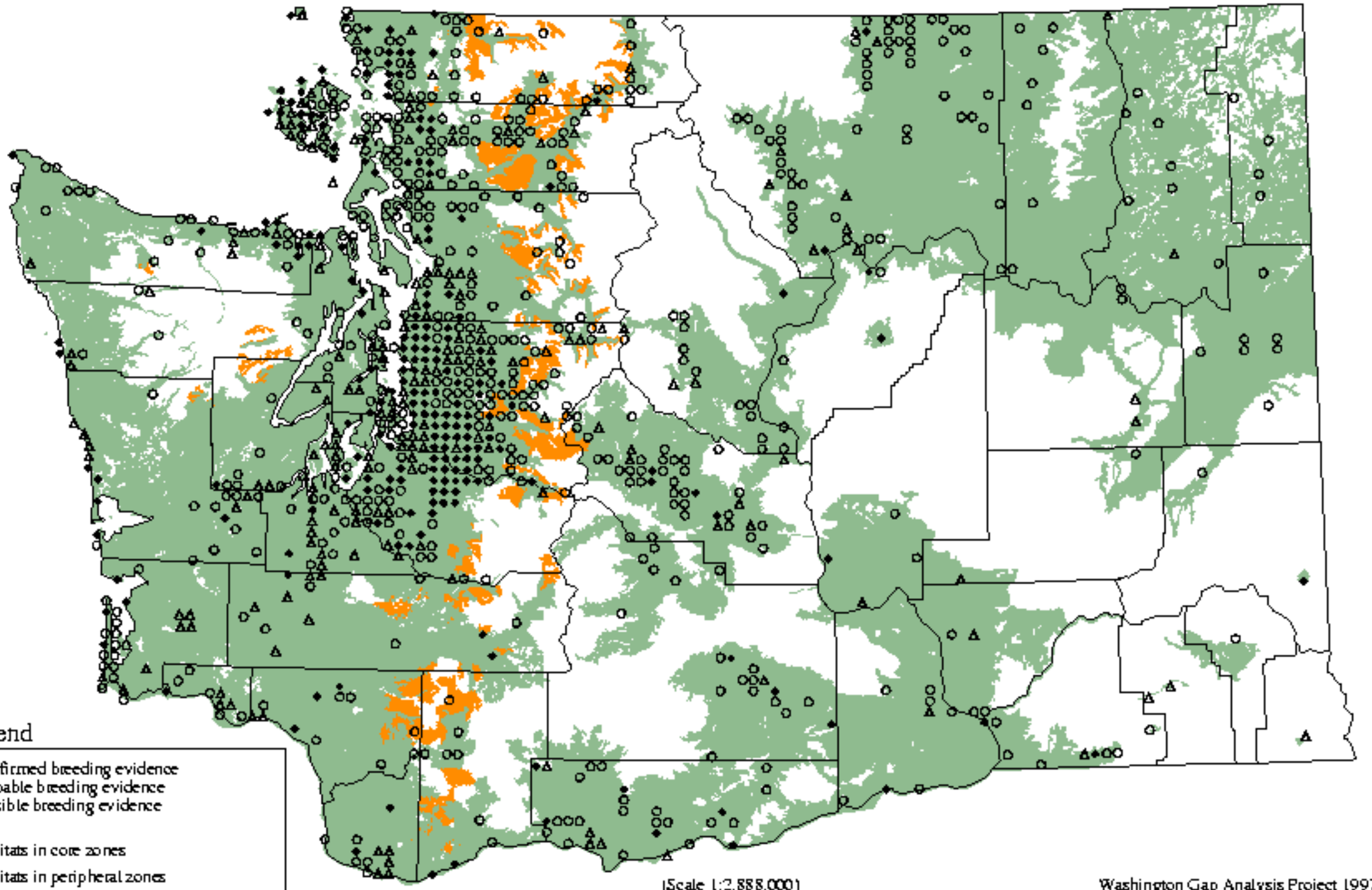
Clark`s Nutcracker - *Nucifraga columbiana*



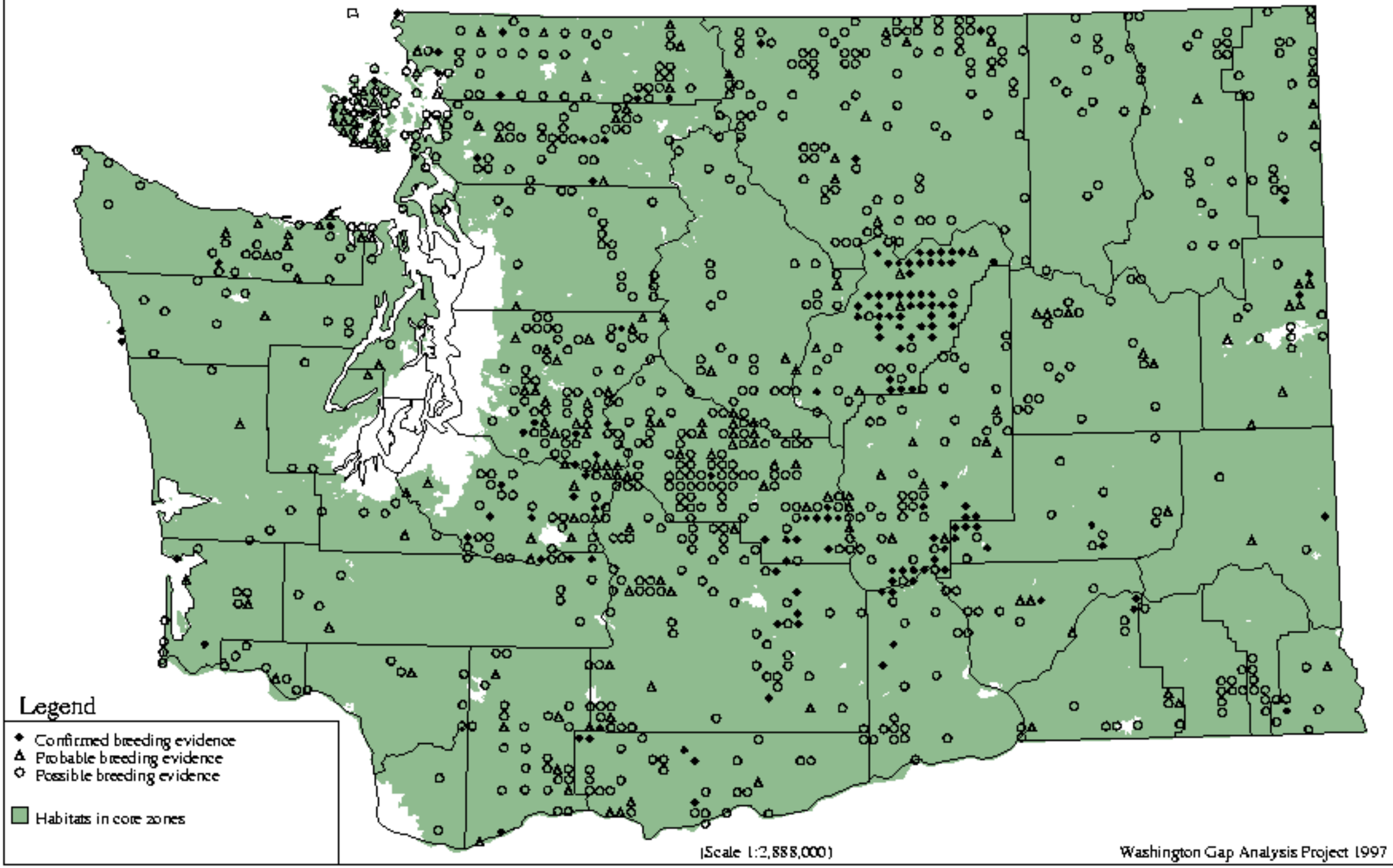
Black-billed Magpie - *Pica pica*



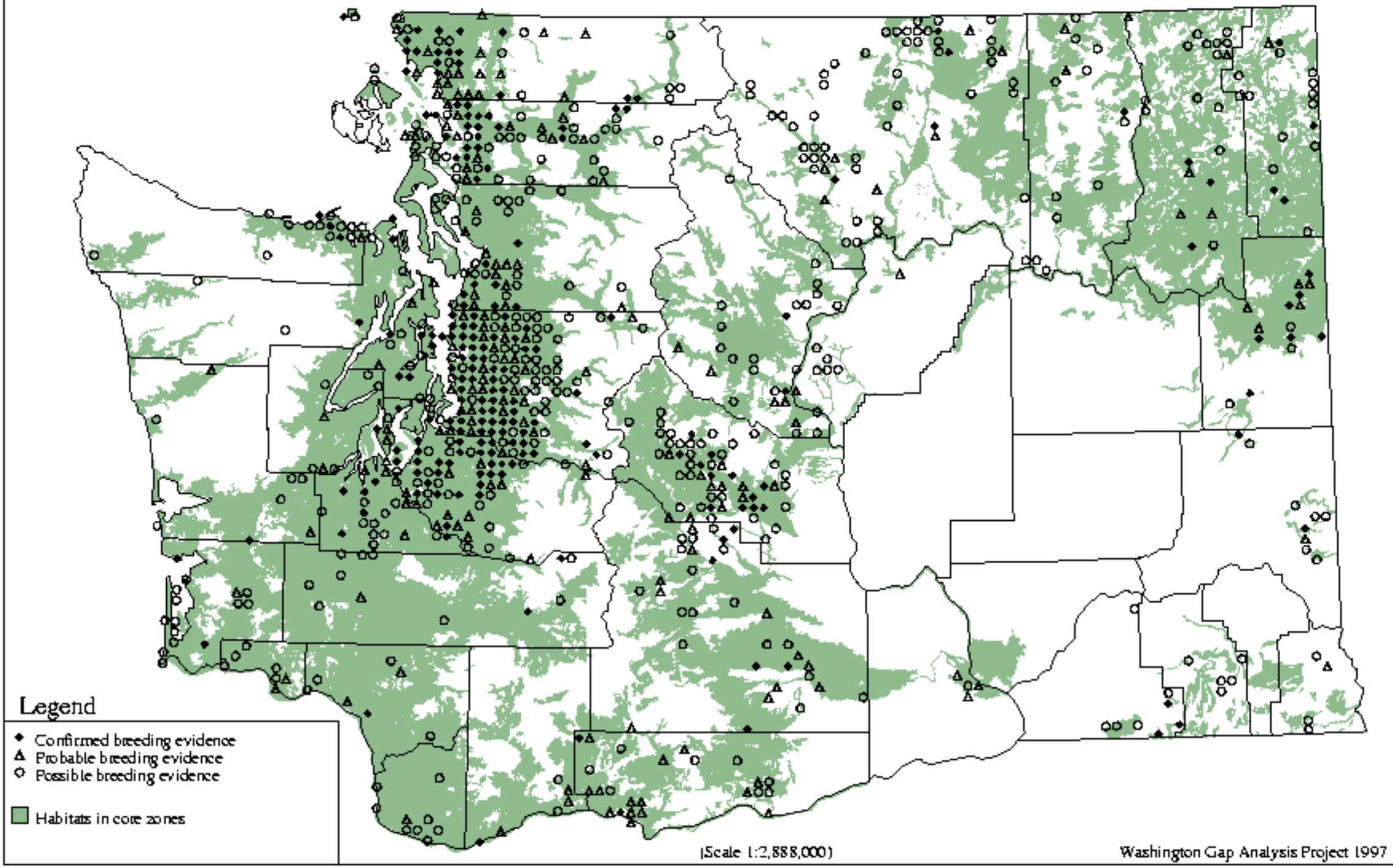
American/Northwestern Crow - *Corvus brachyrhynchos/caurinus*



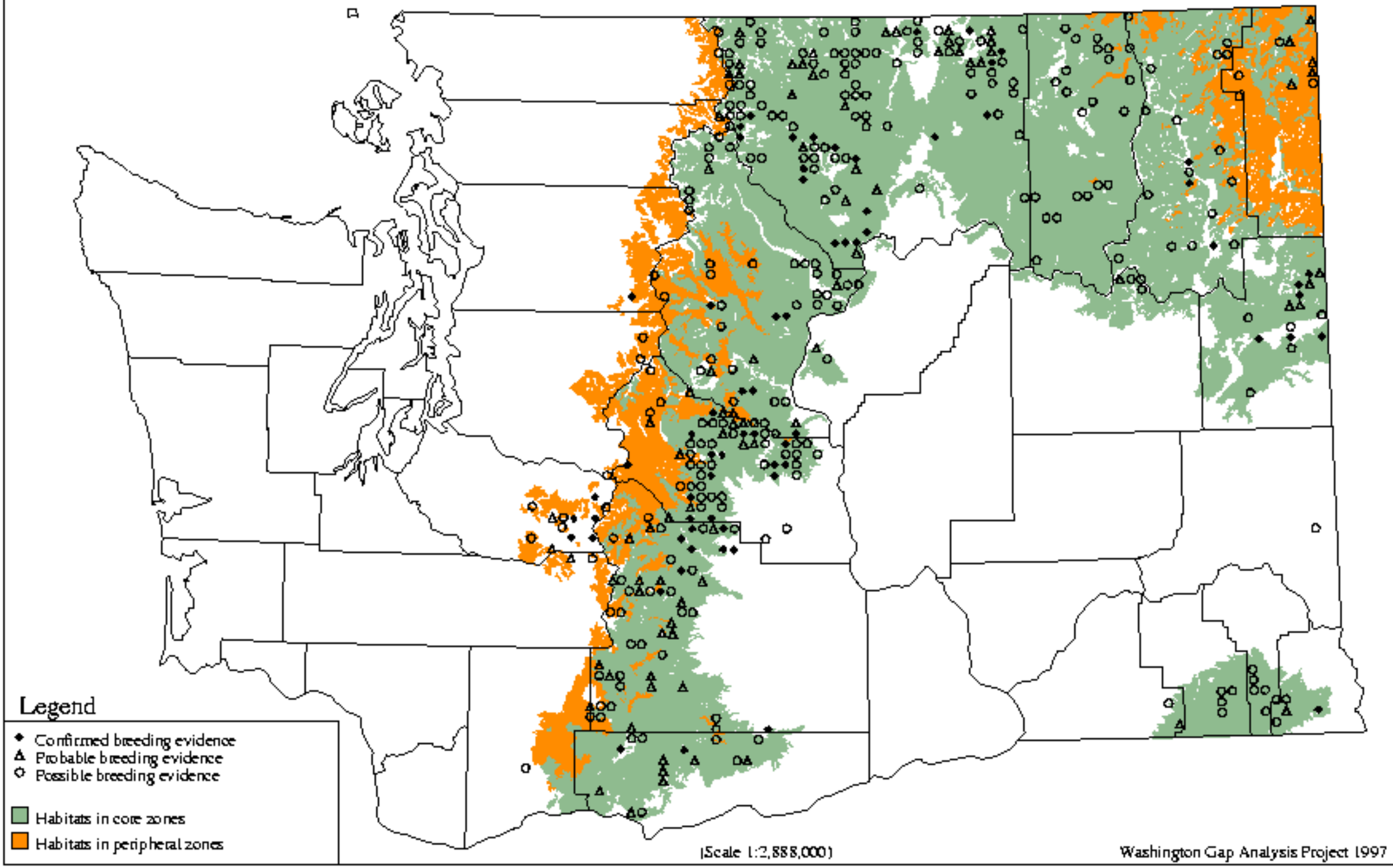
Common Raven - *Corvus corax*



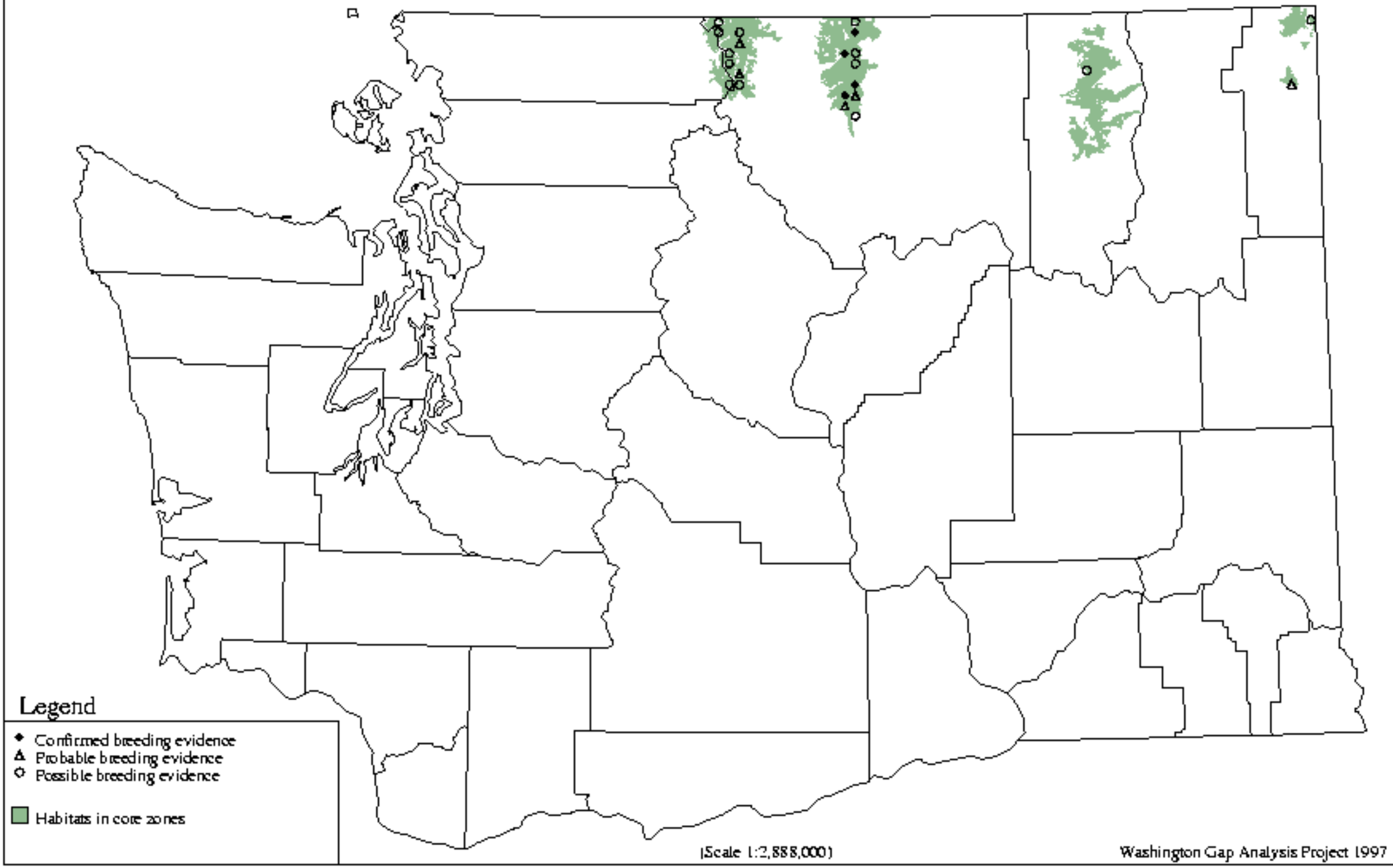
Black-capped Chickadee - *Parus atricapillus*



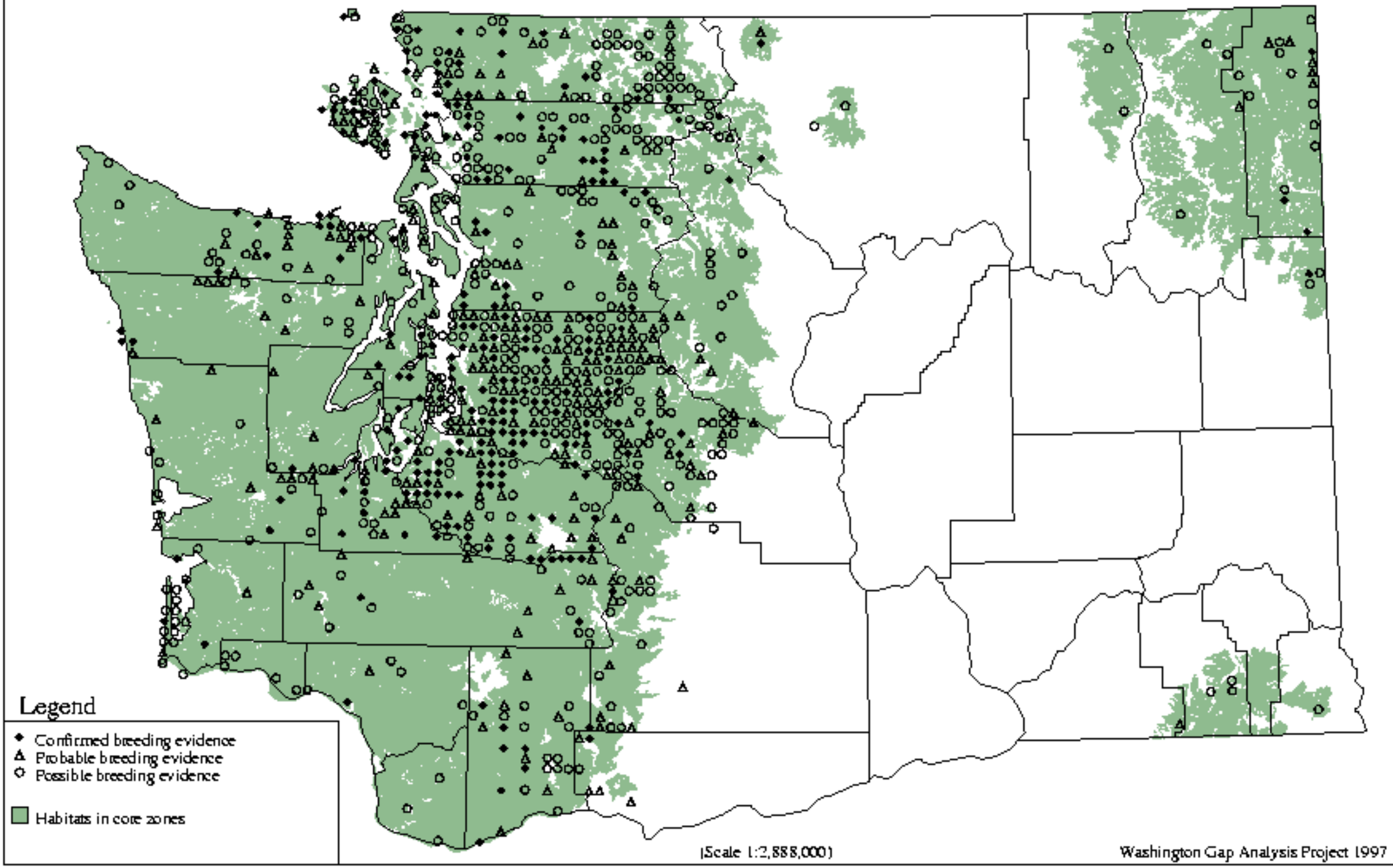
Mountain Chickadee - *Parus gambeli*



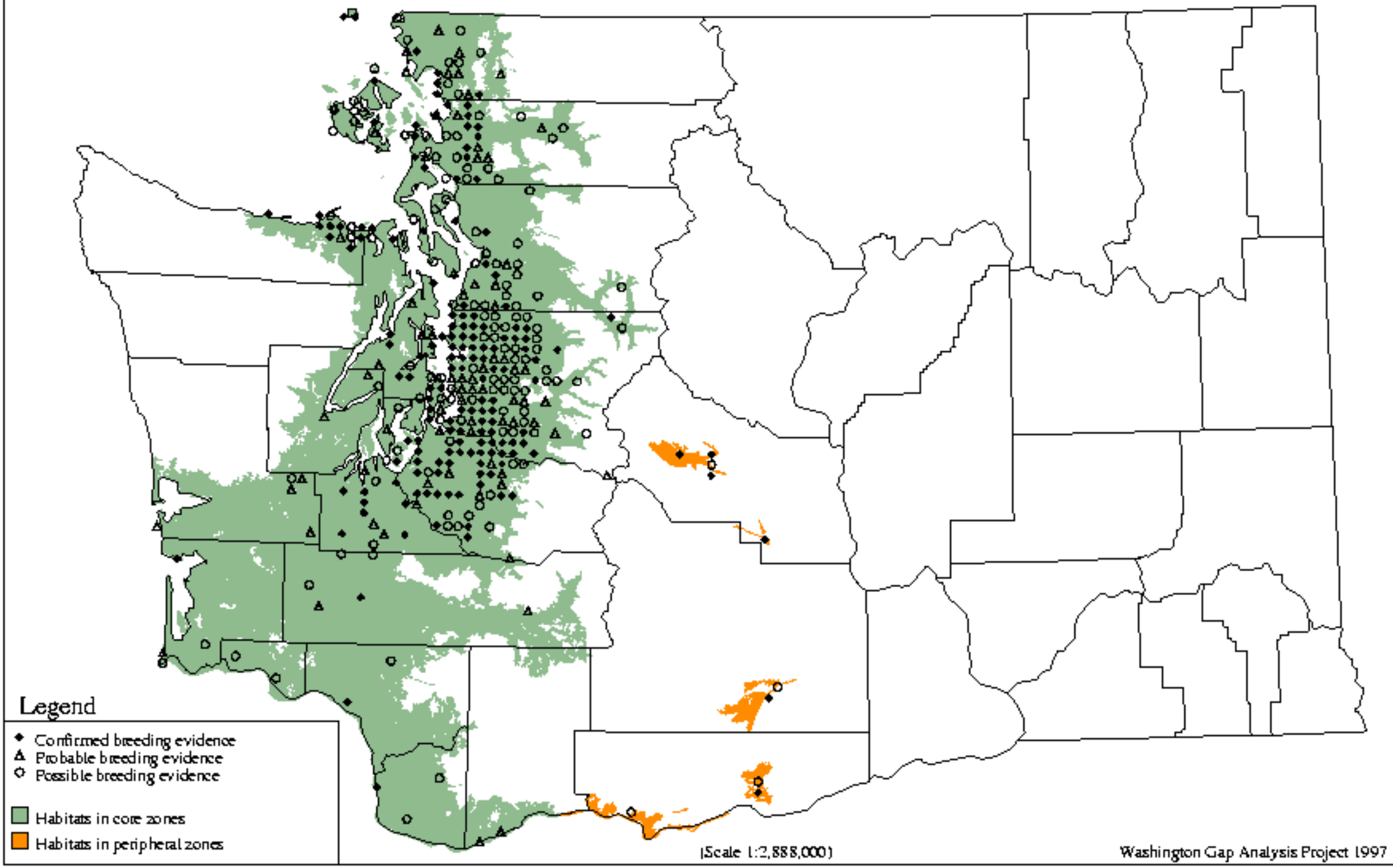
Boreal Chickadee - *Parus hudsonicus*



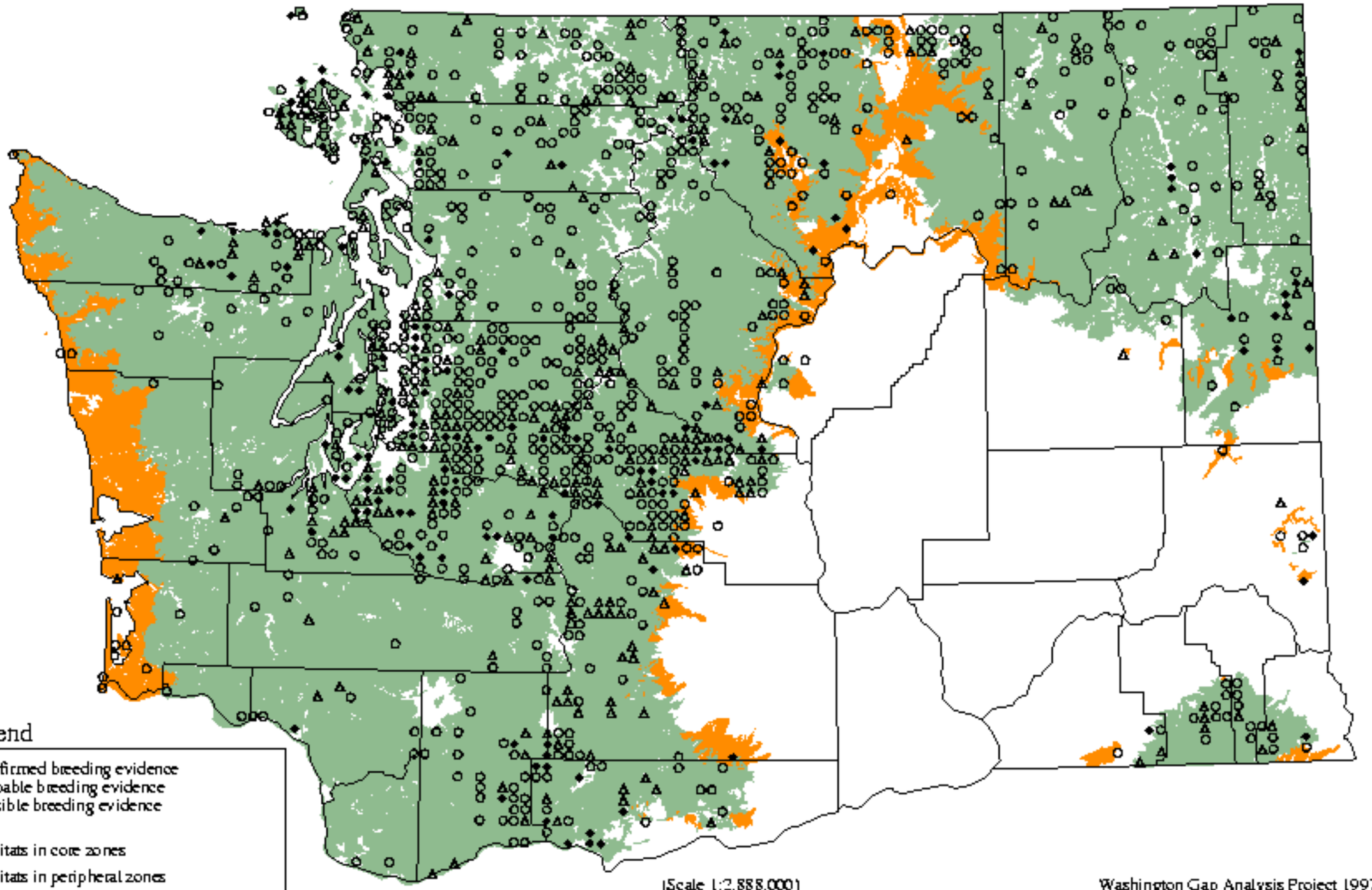
Chestnut-backed Chickadee - *Parus rufescens*



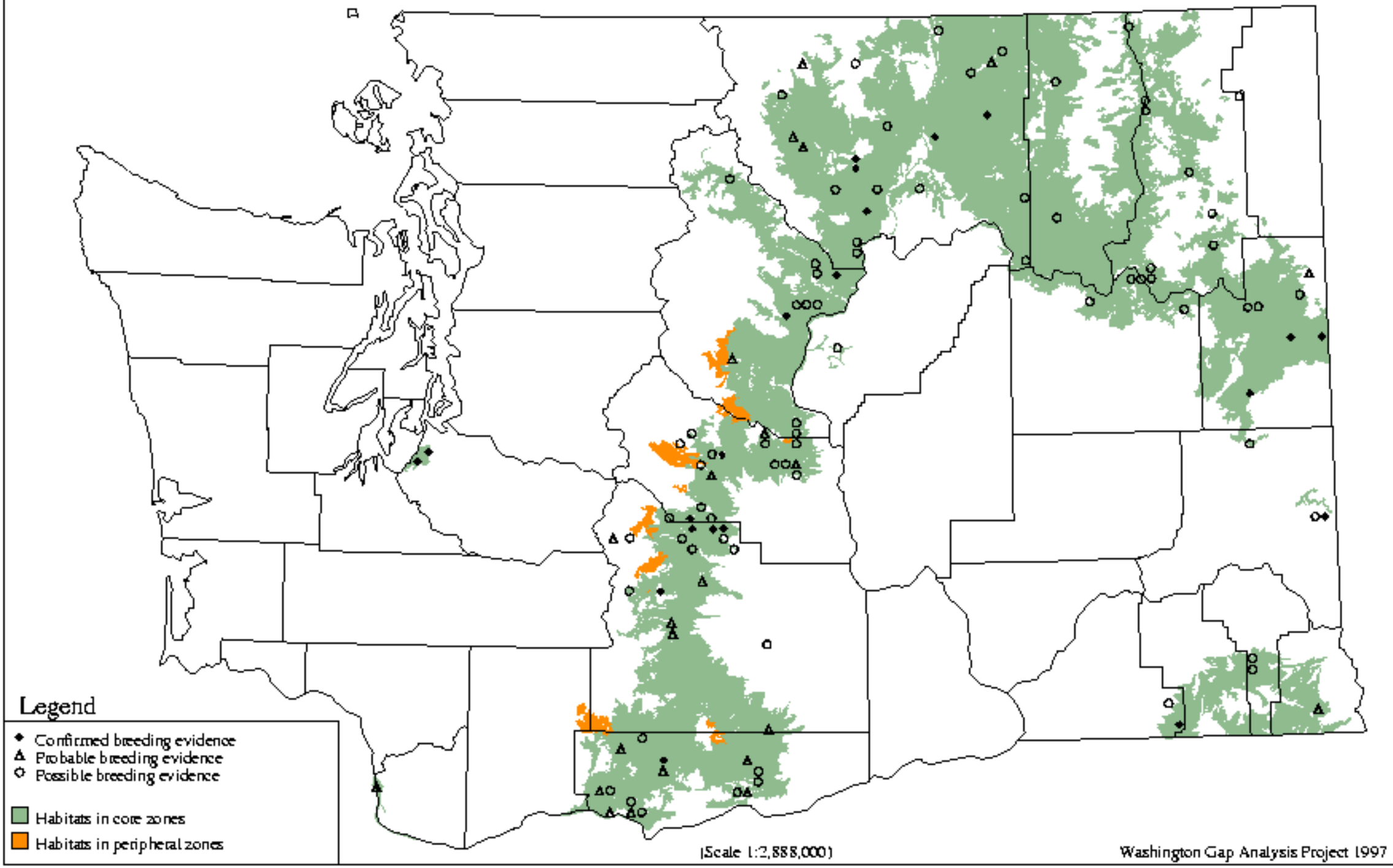
Bushtit - *Psaltriparus minimus*



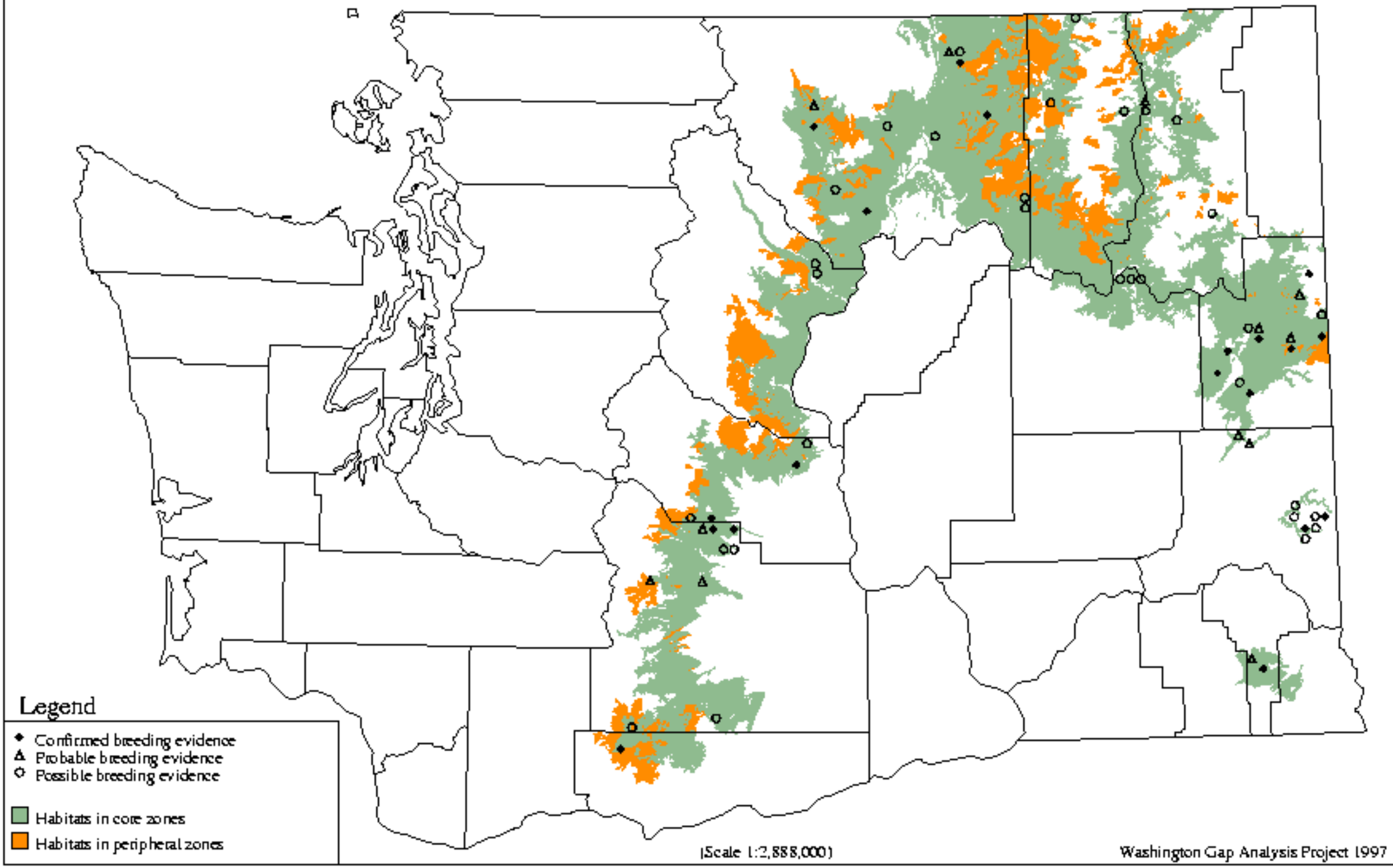
Red-breasted Nuthatch - *Sitta canadensis*



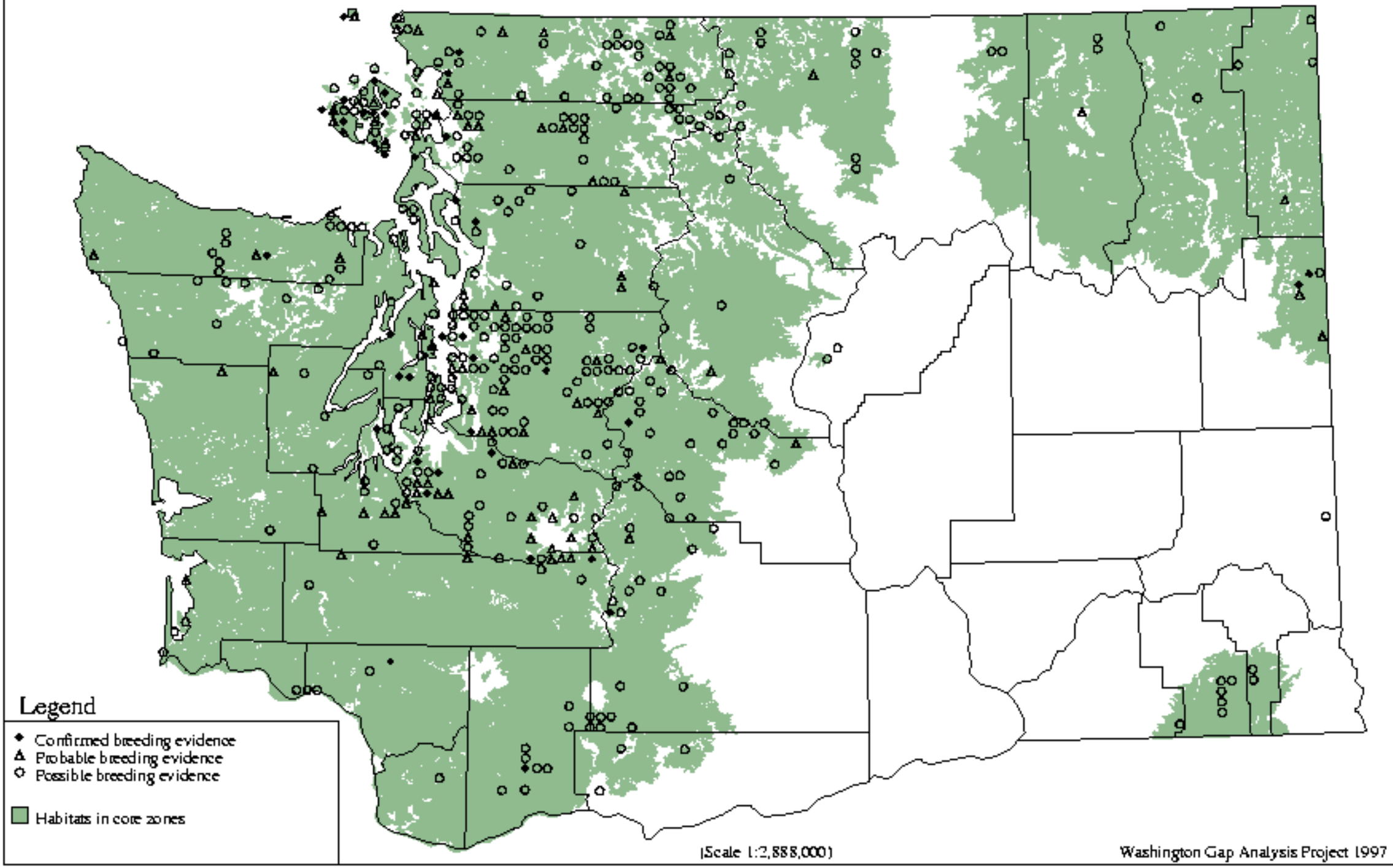
White-breasted Nuthatch - *Sitta carolinensis*



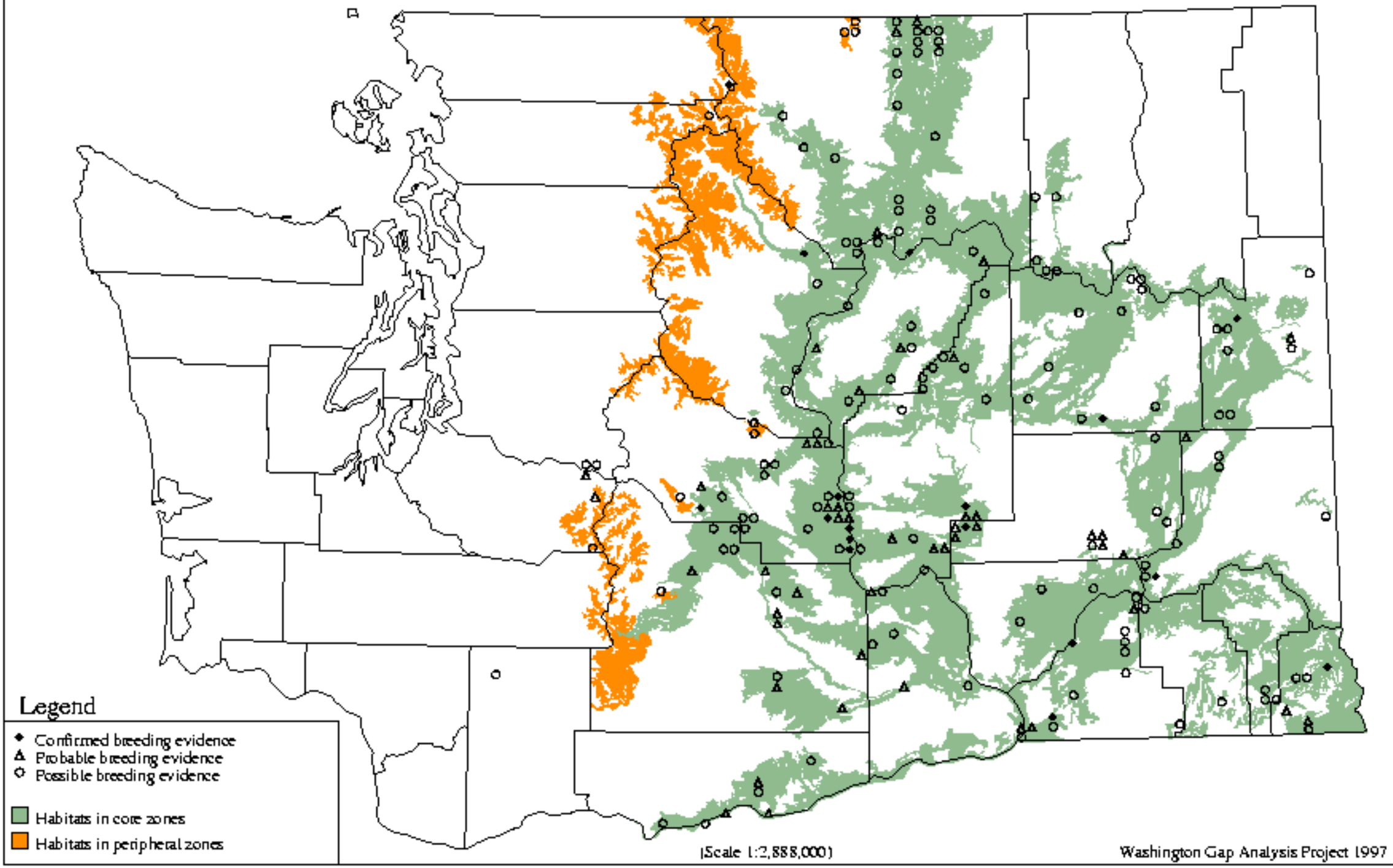
Pygmy Nuthatch - *Sitta pygmaea*



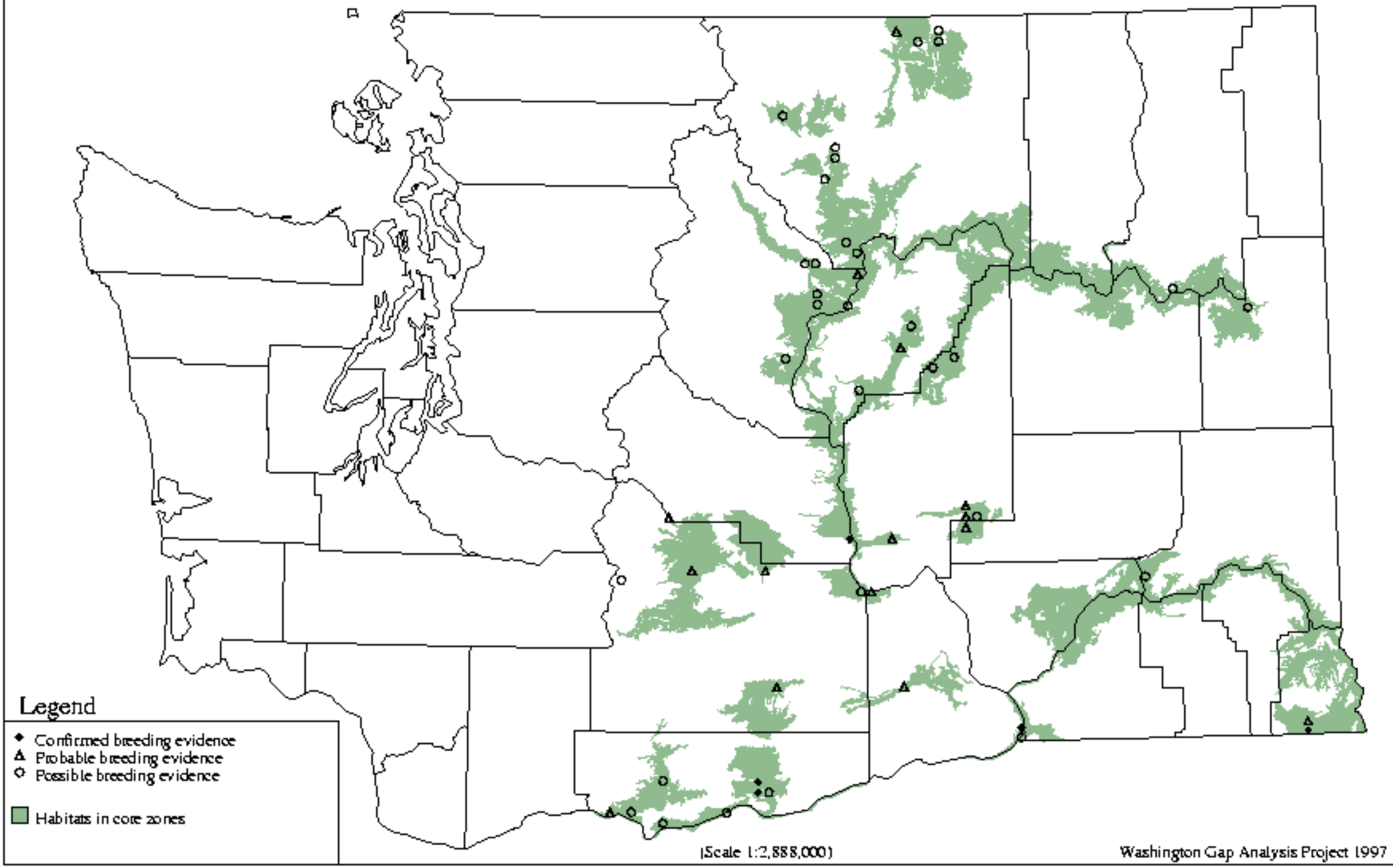
Brown Creeper - *Certhia americana*



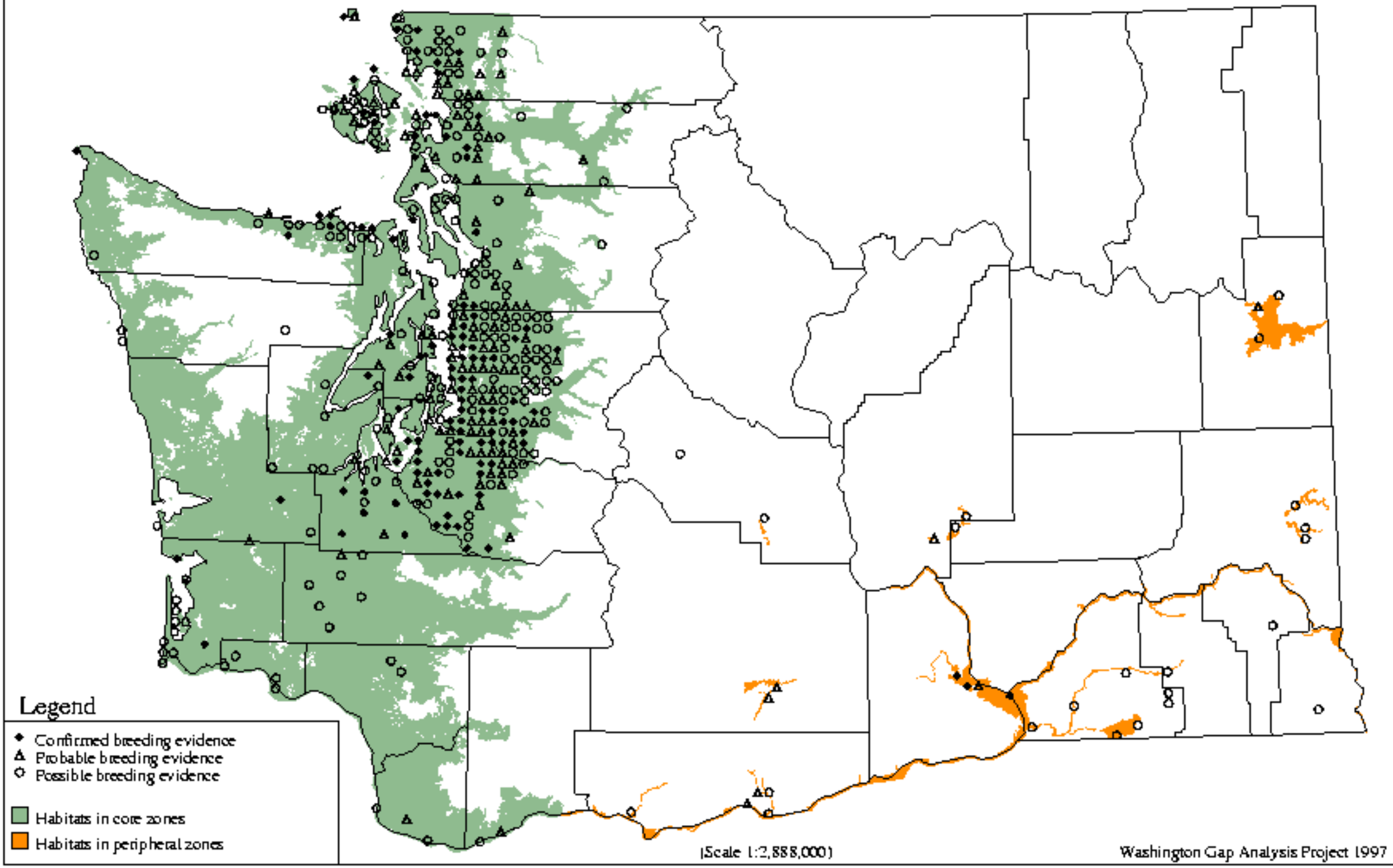
Rock Wren - *Salpinctes obsoletus*



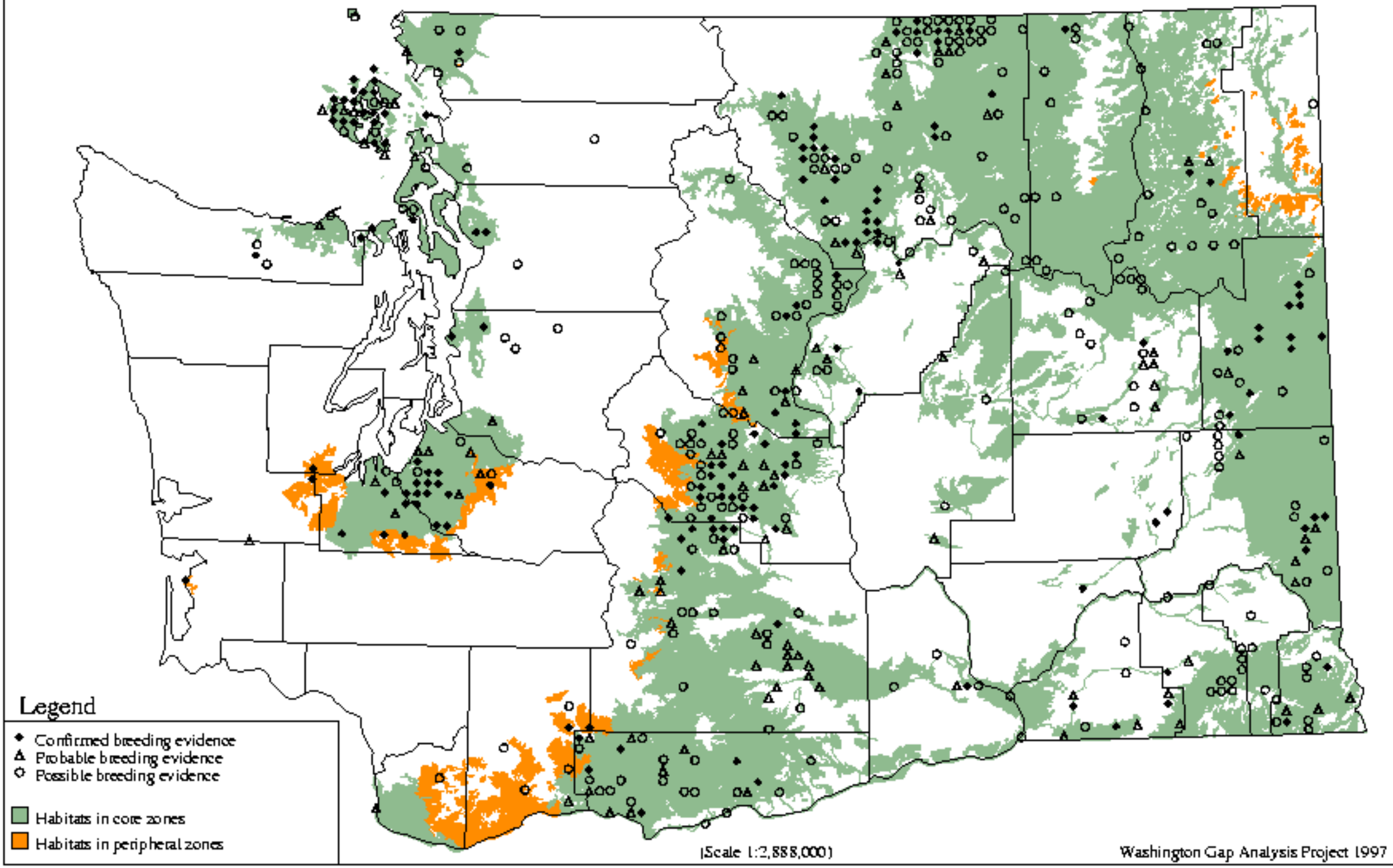
Canyon Wren - *Catherpes mexicanus*



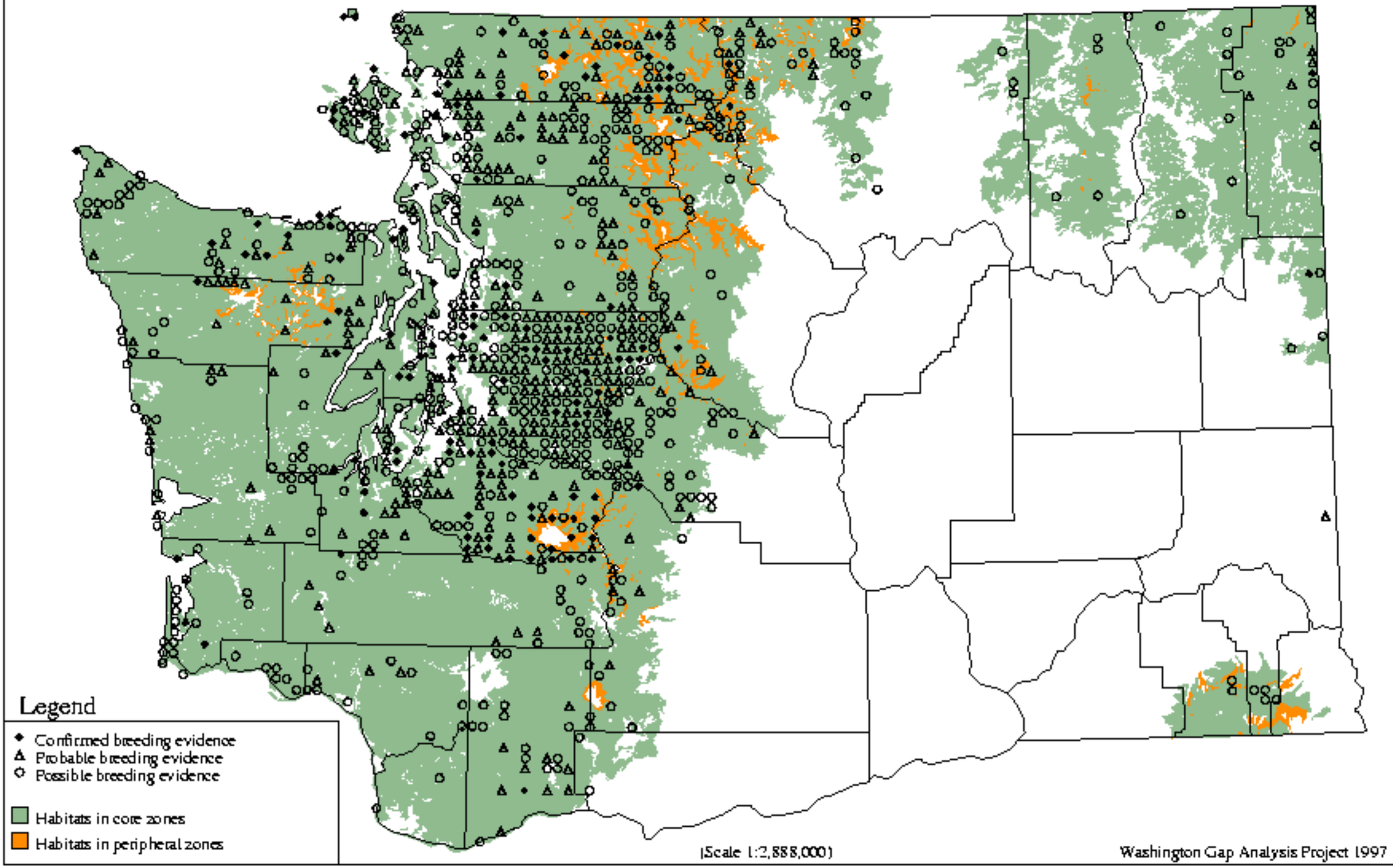
Bewick`s Wren - *Thryomanes bewickii*



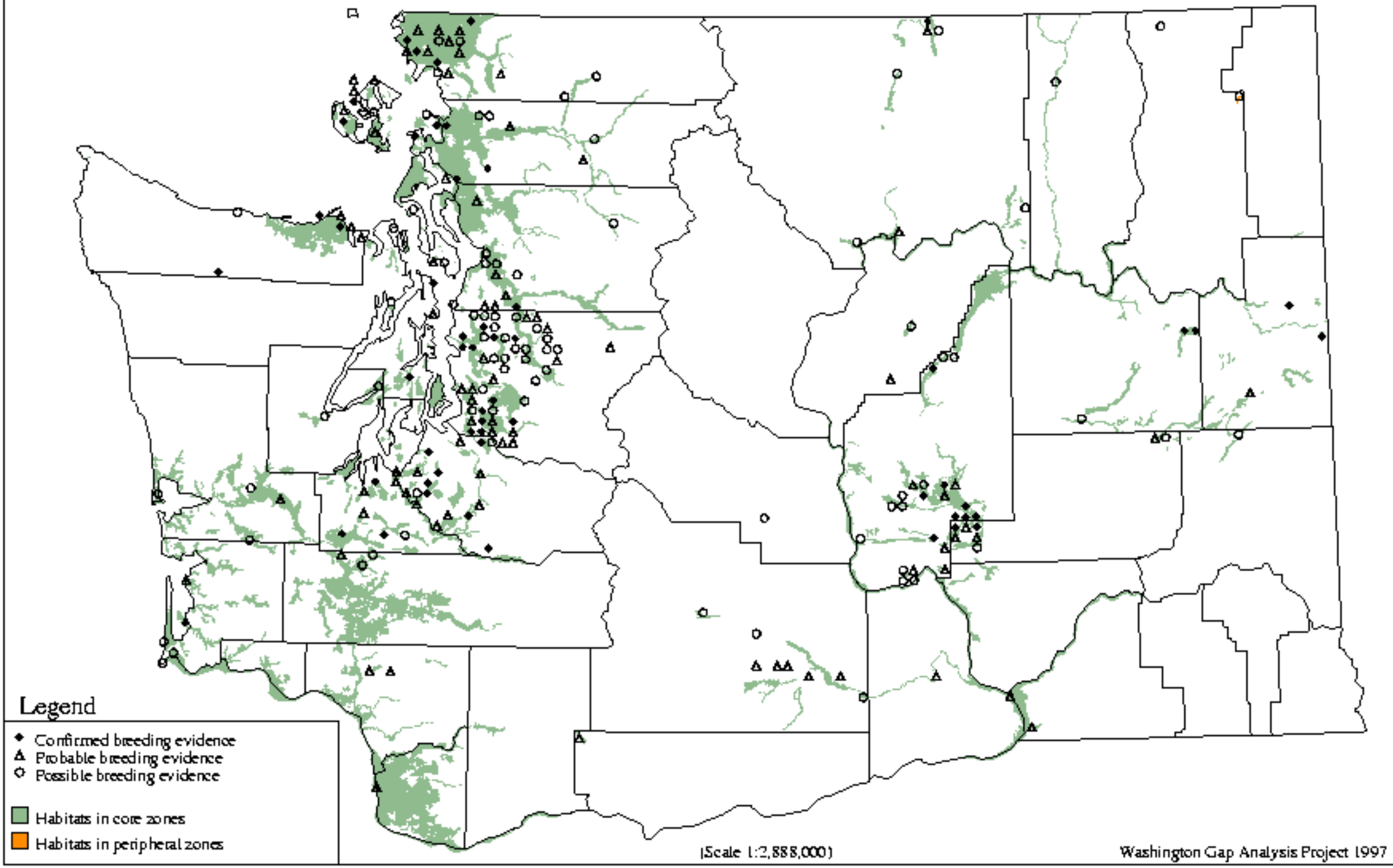
House Wren - *Troglodytes aedon*



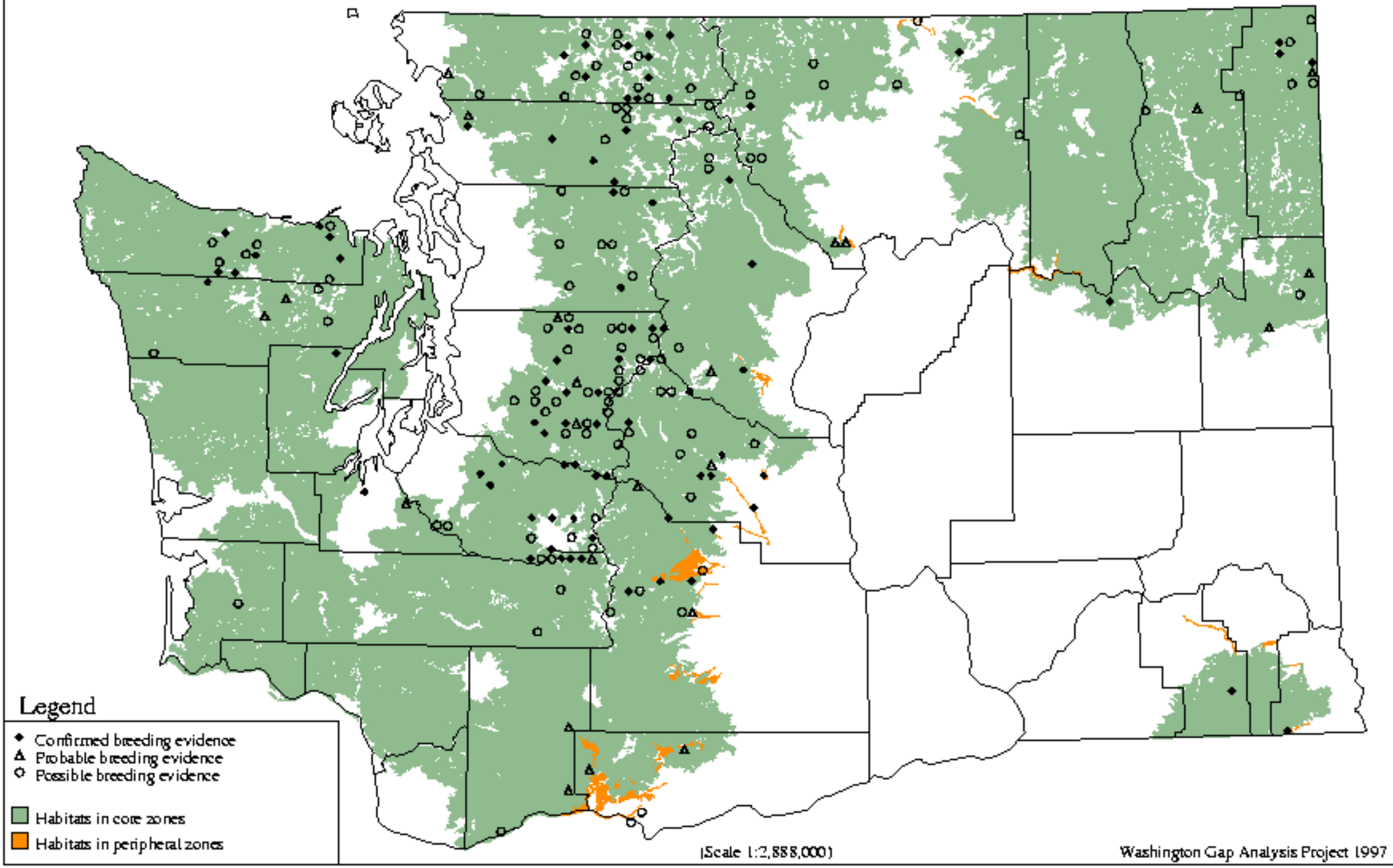
Winter Wren - *Troglodytes troglodytes*



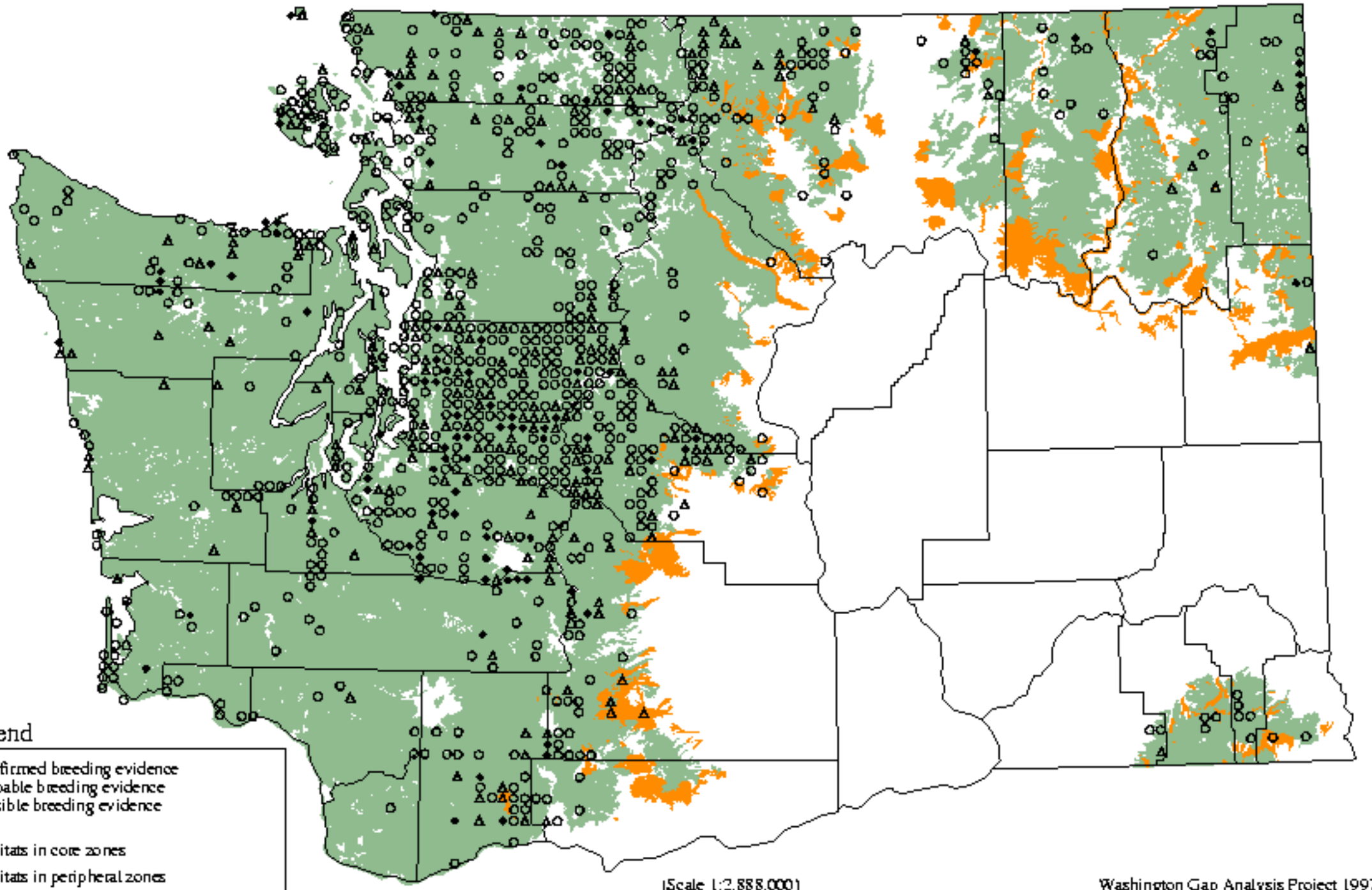
Marsh Wren - *Cistothorus palustris*



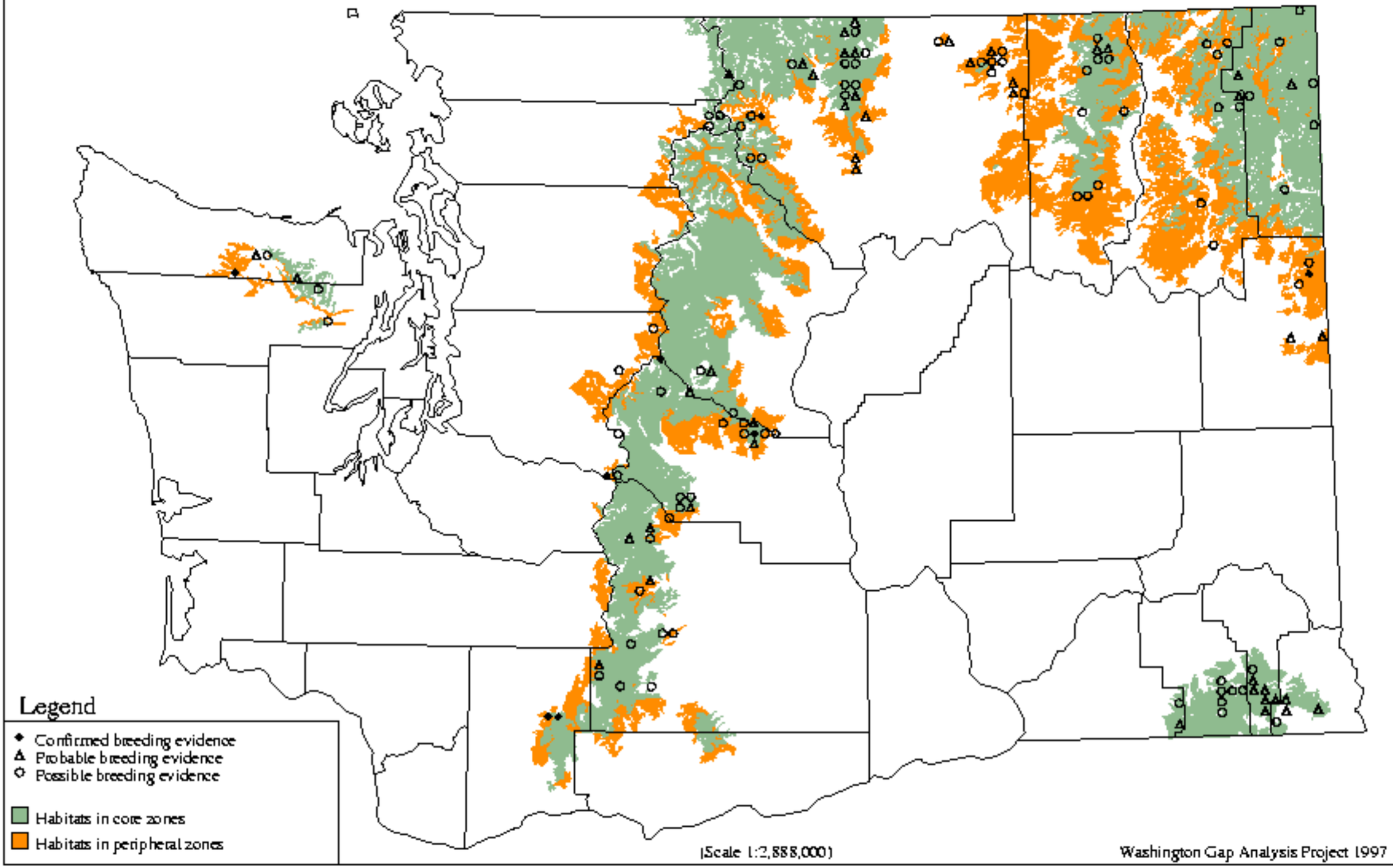
American Dipper - *Cinclus mexicanus*



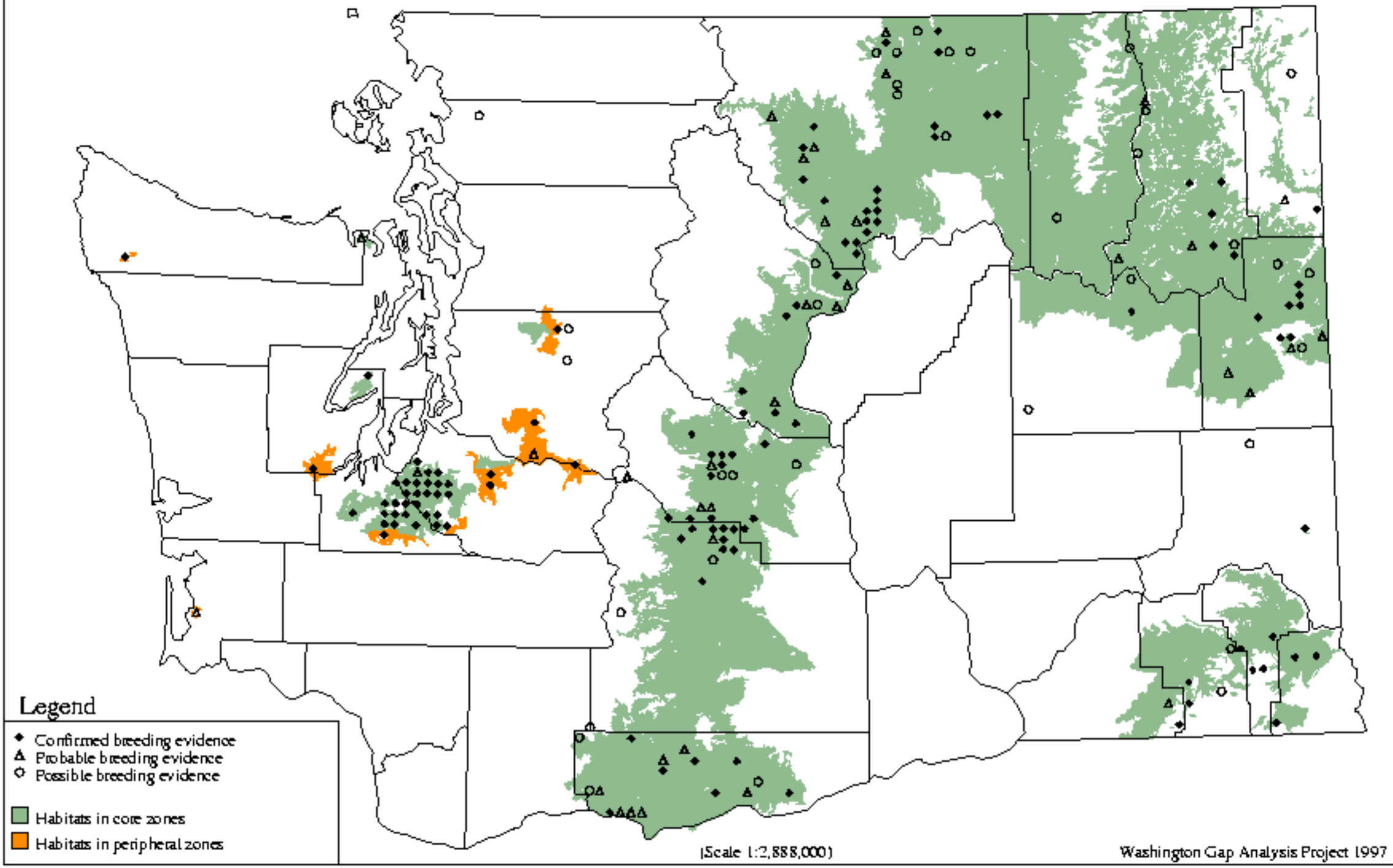
Golden-crowned Kinglet - *Regulus satrapa*



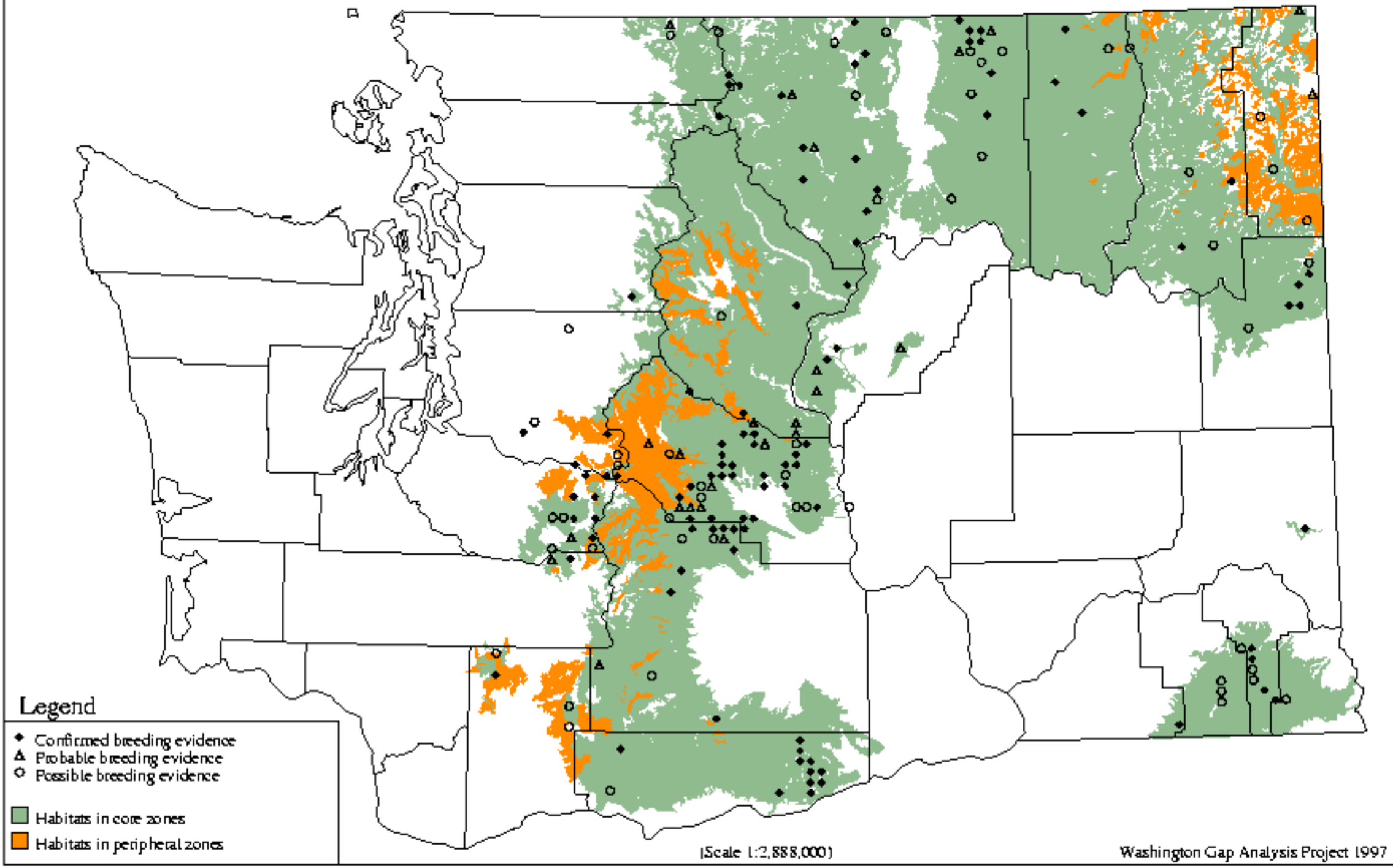
Ruby-crowned Kinglet - *Regulus calendula*



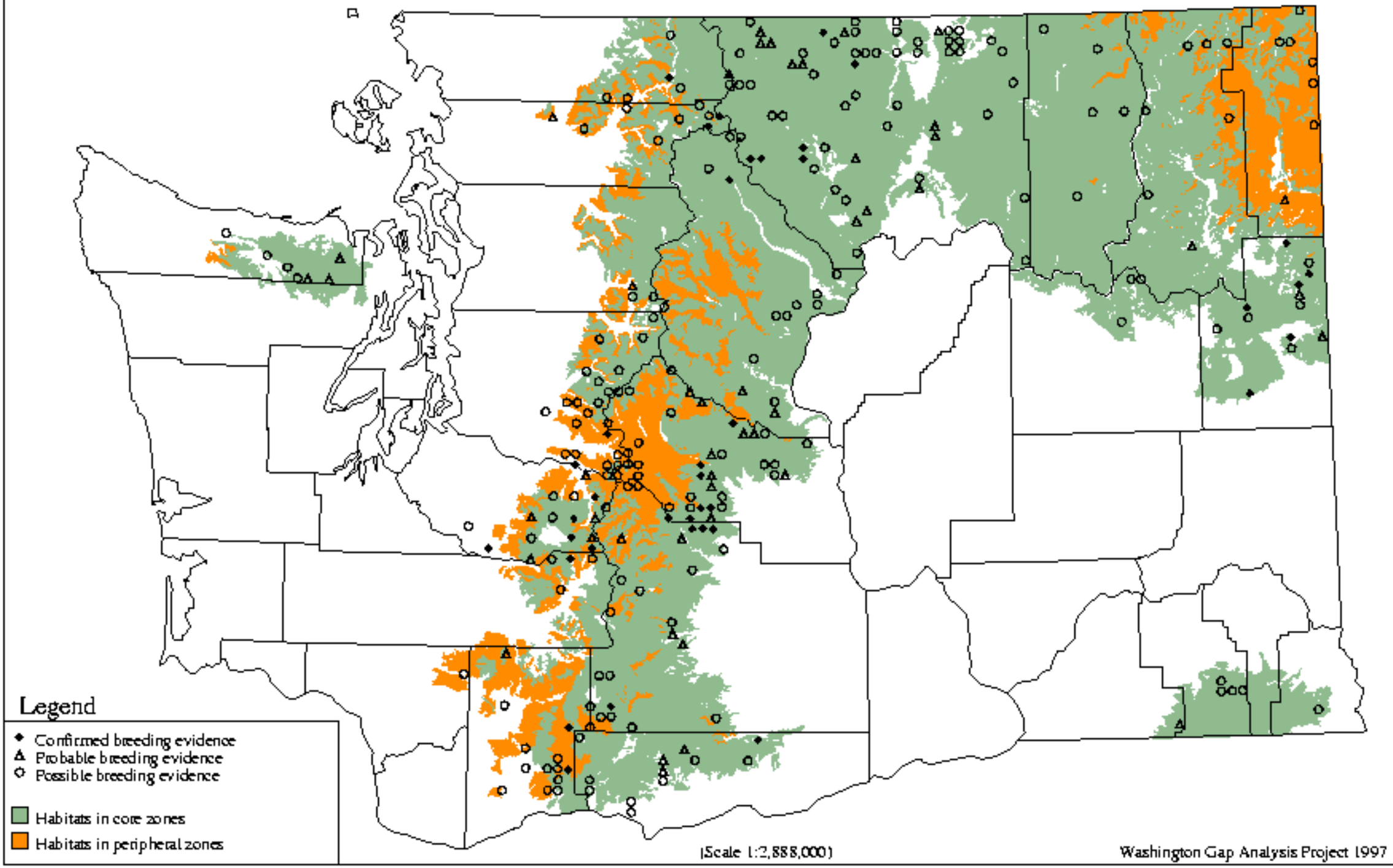
Western Bluebird - *Sialia mexicana*



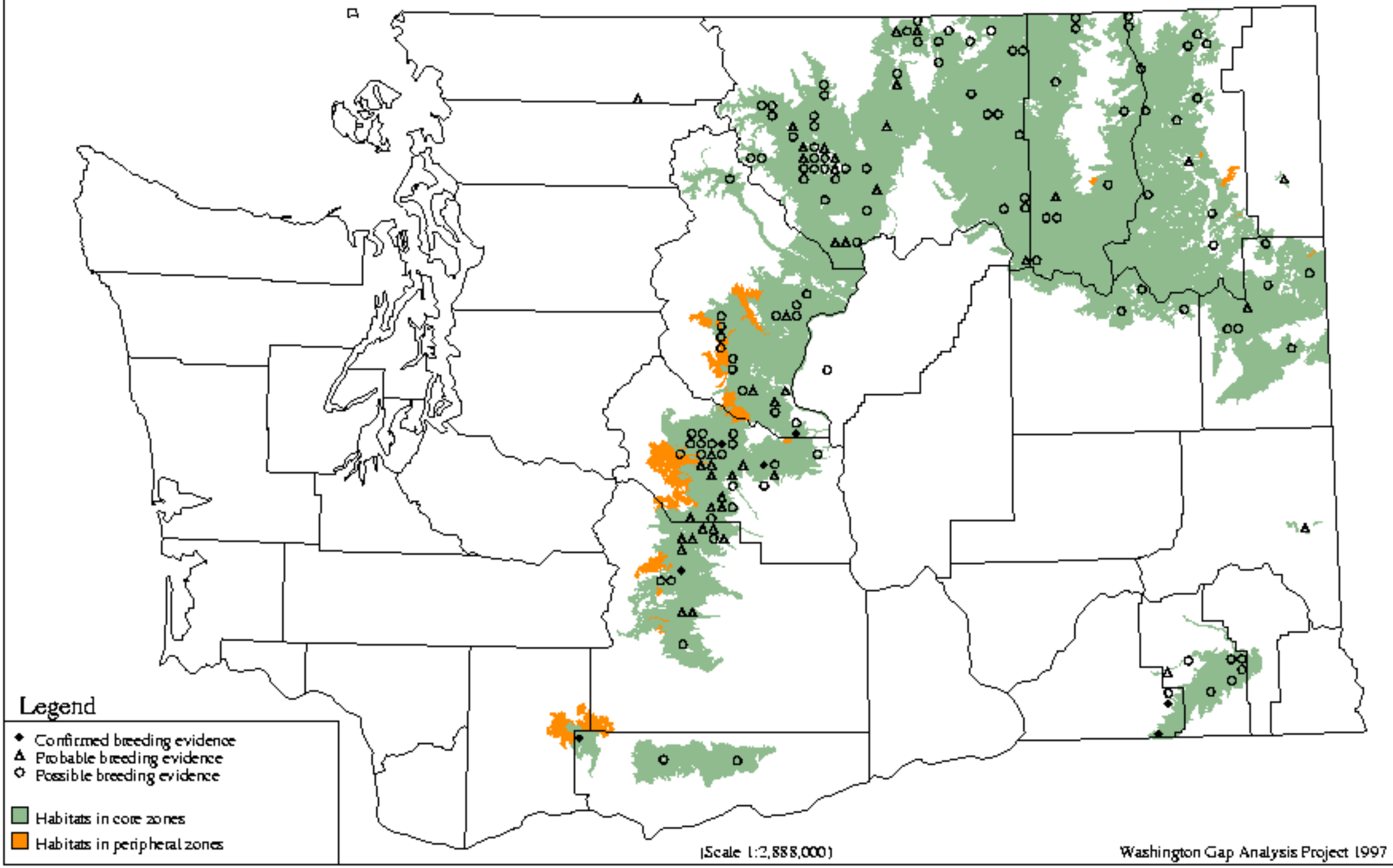
Mountain Bluebird - *Sialia currucoides*



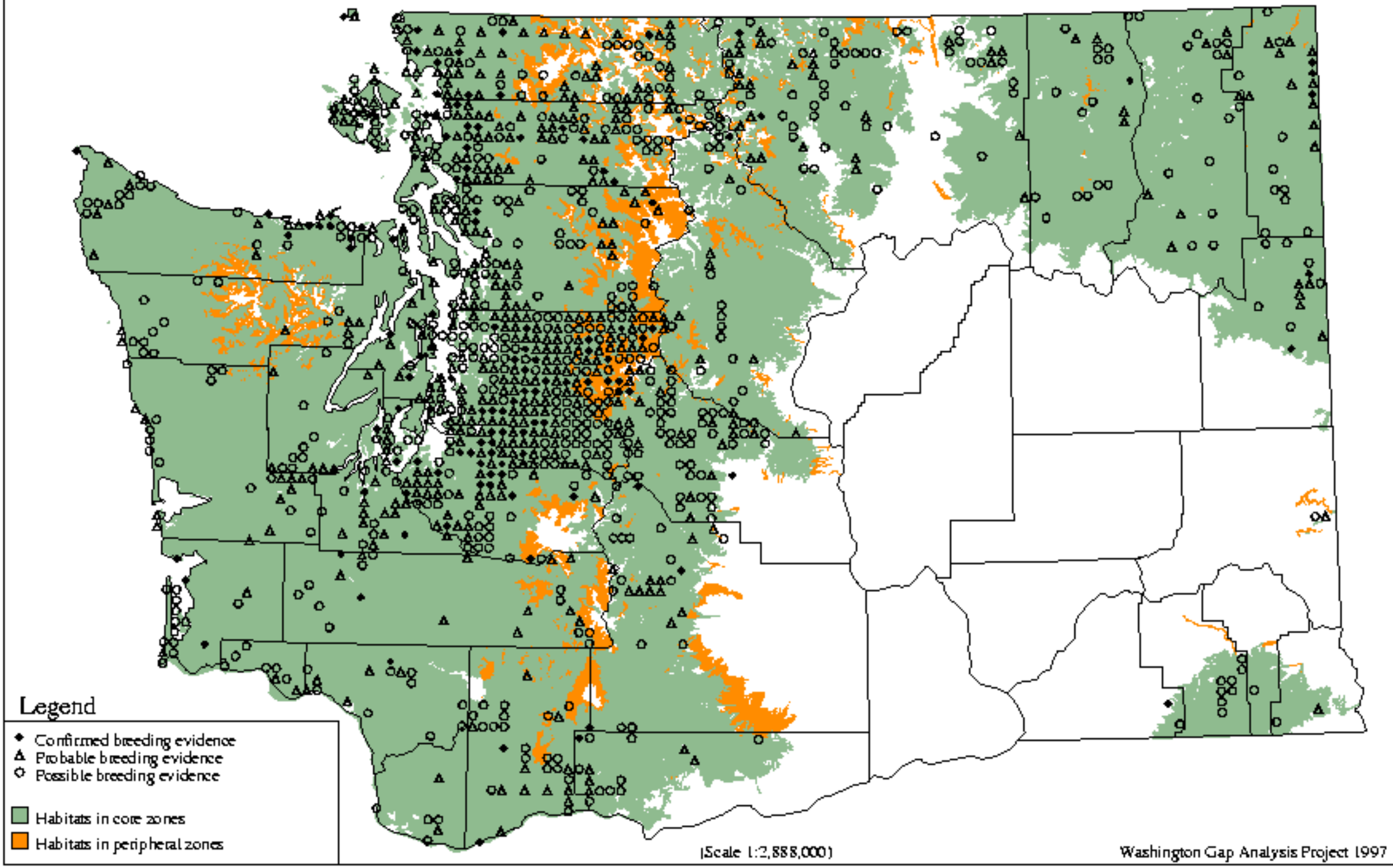
Townsend`s Solitaire - *Myadestes townsendi*



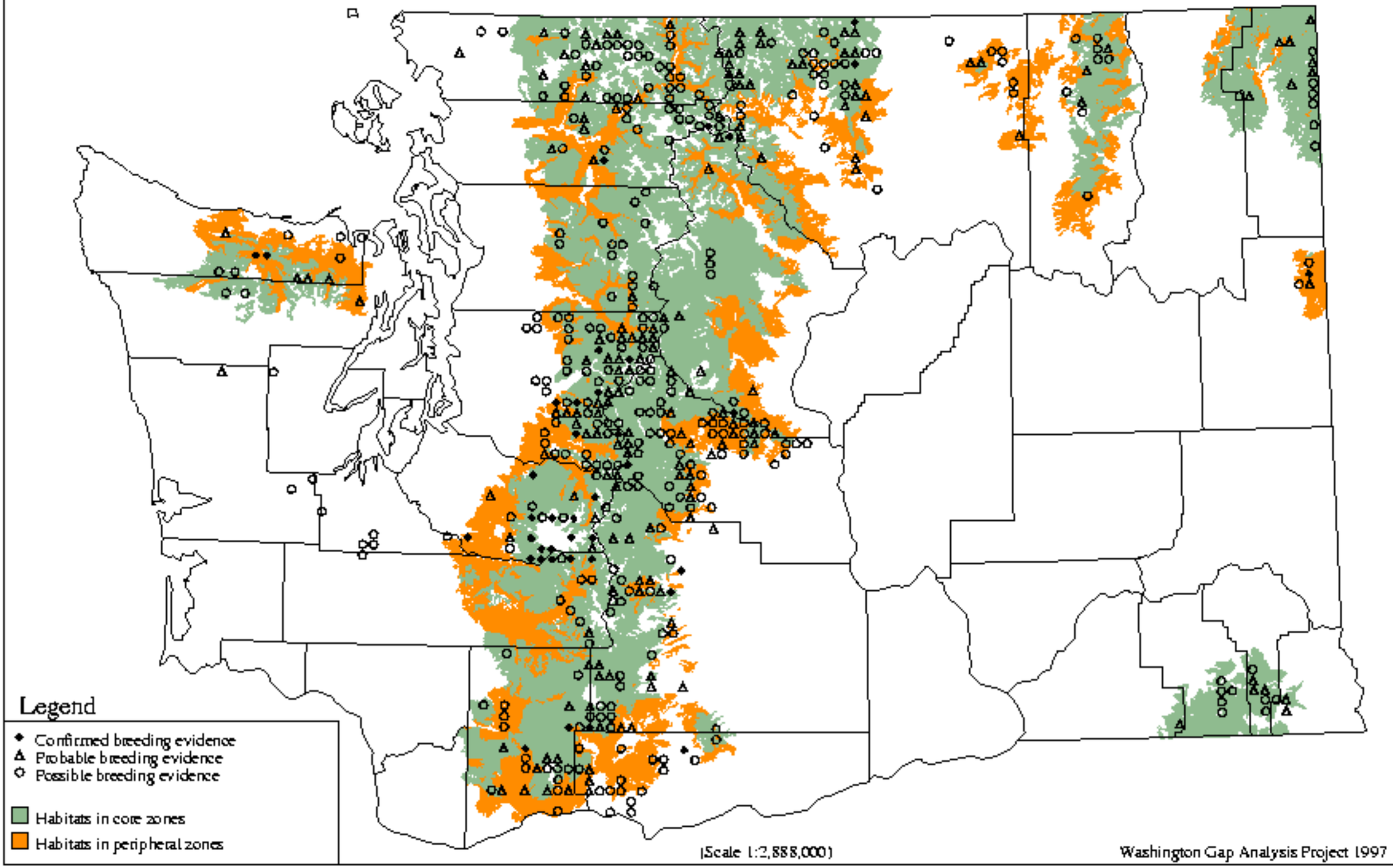
Veery - *Catharus fuscescens*



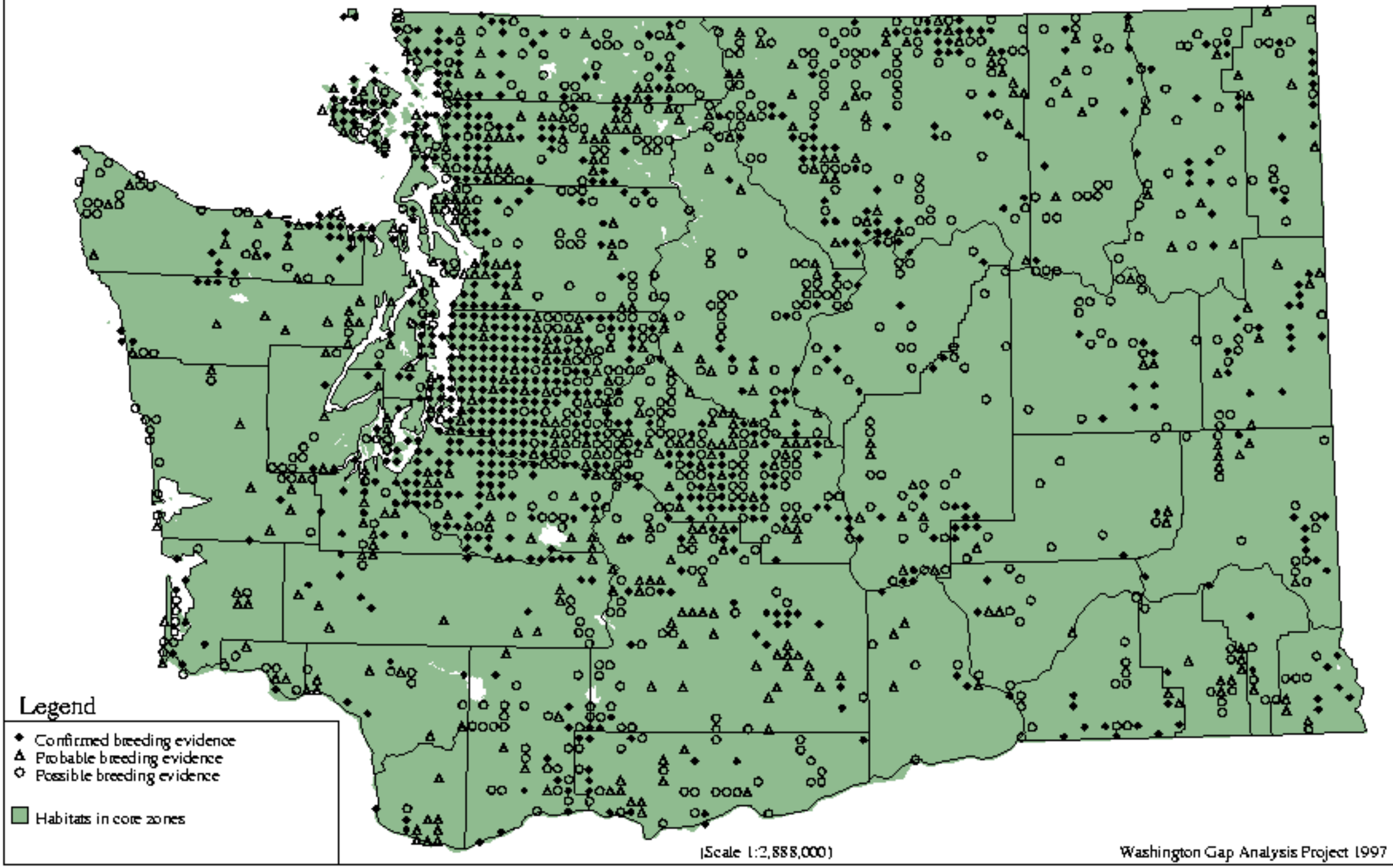
Swainson`s Thrush - *Catharus ustulatus*



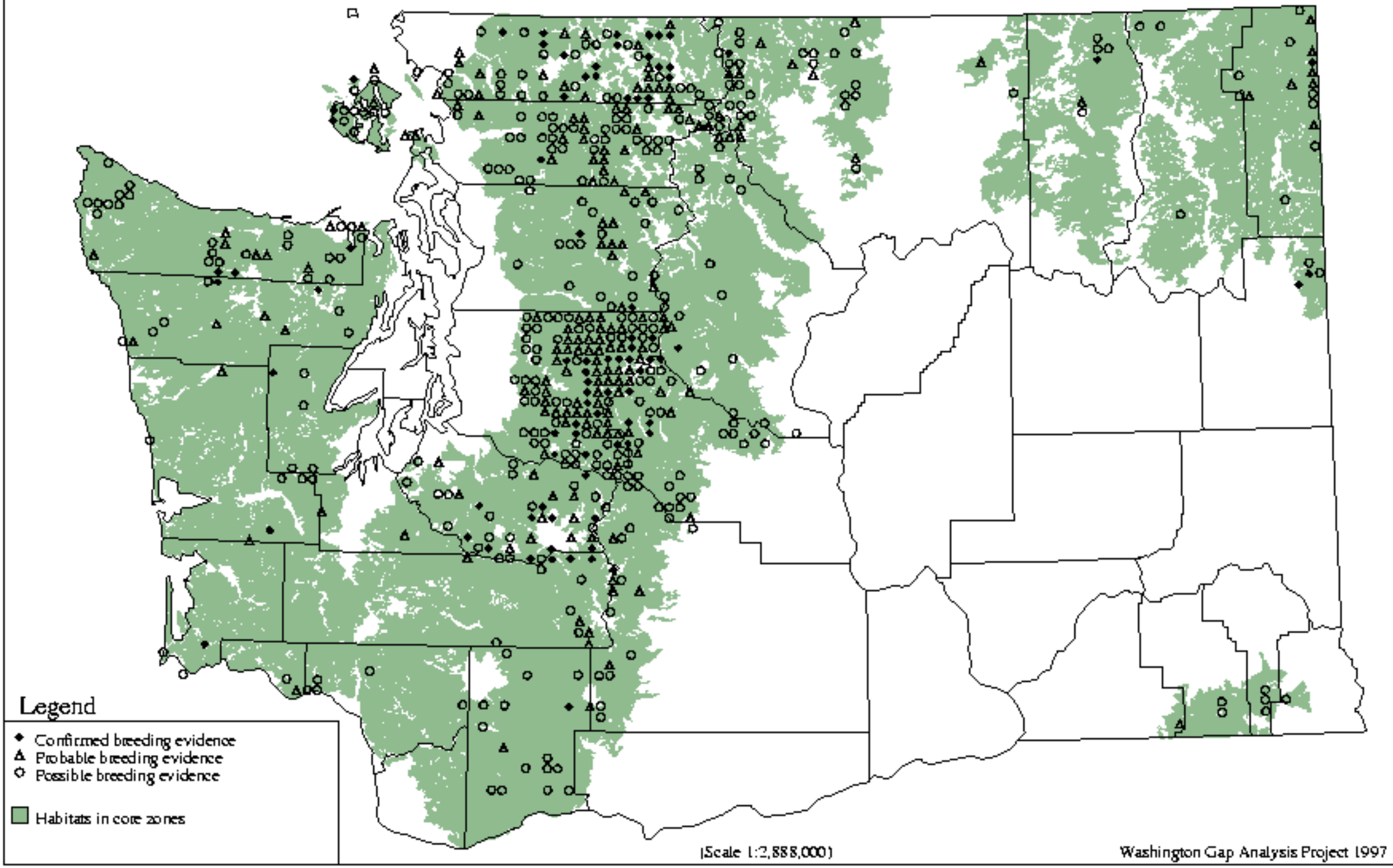
Hermit Thrush - *Catharus guttatus*



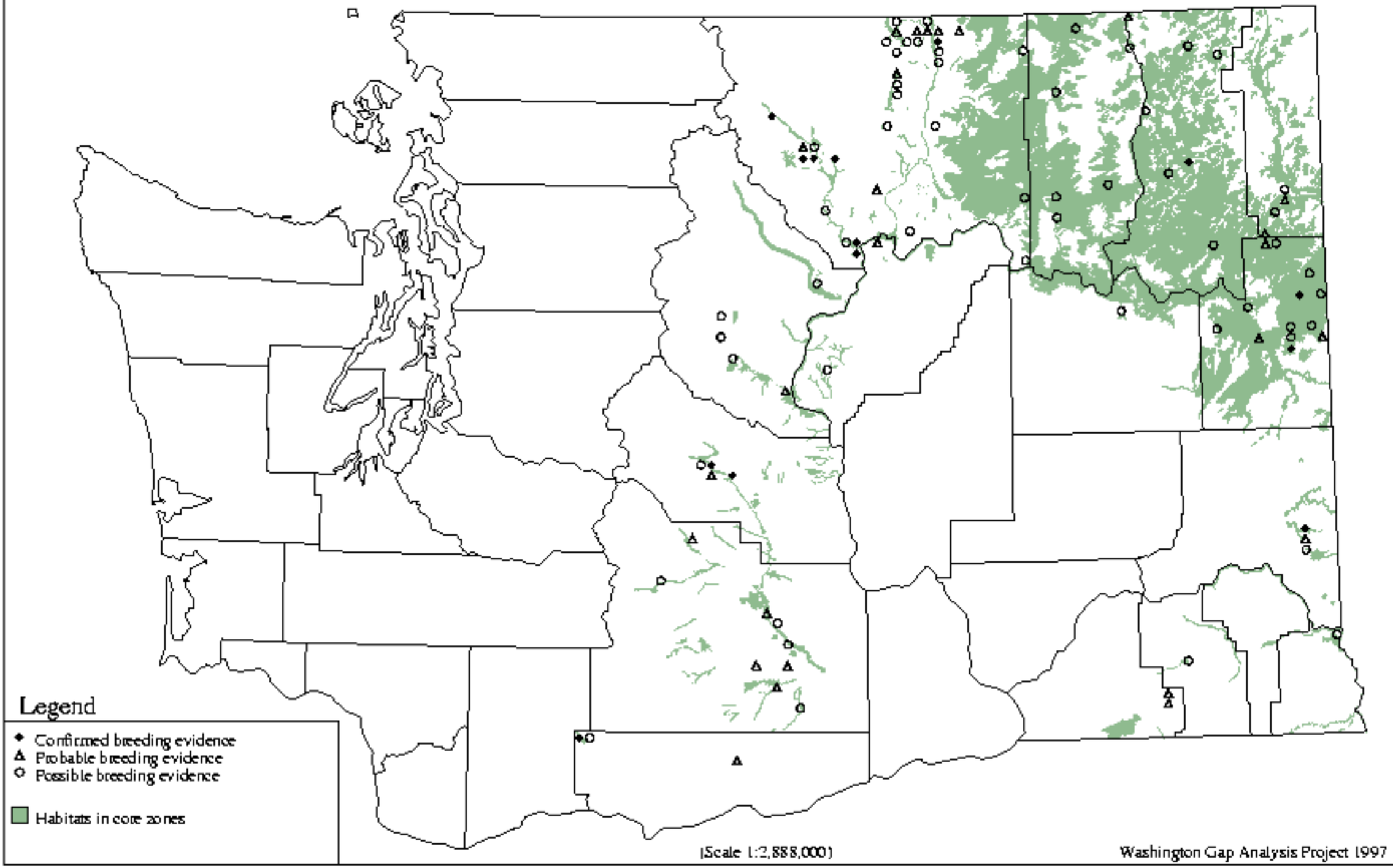
American Robin - *Turdus migratorius*



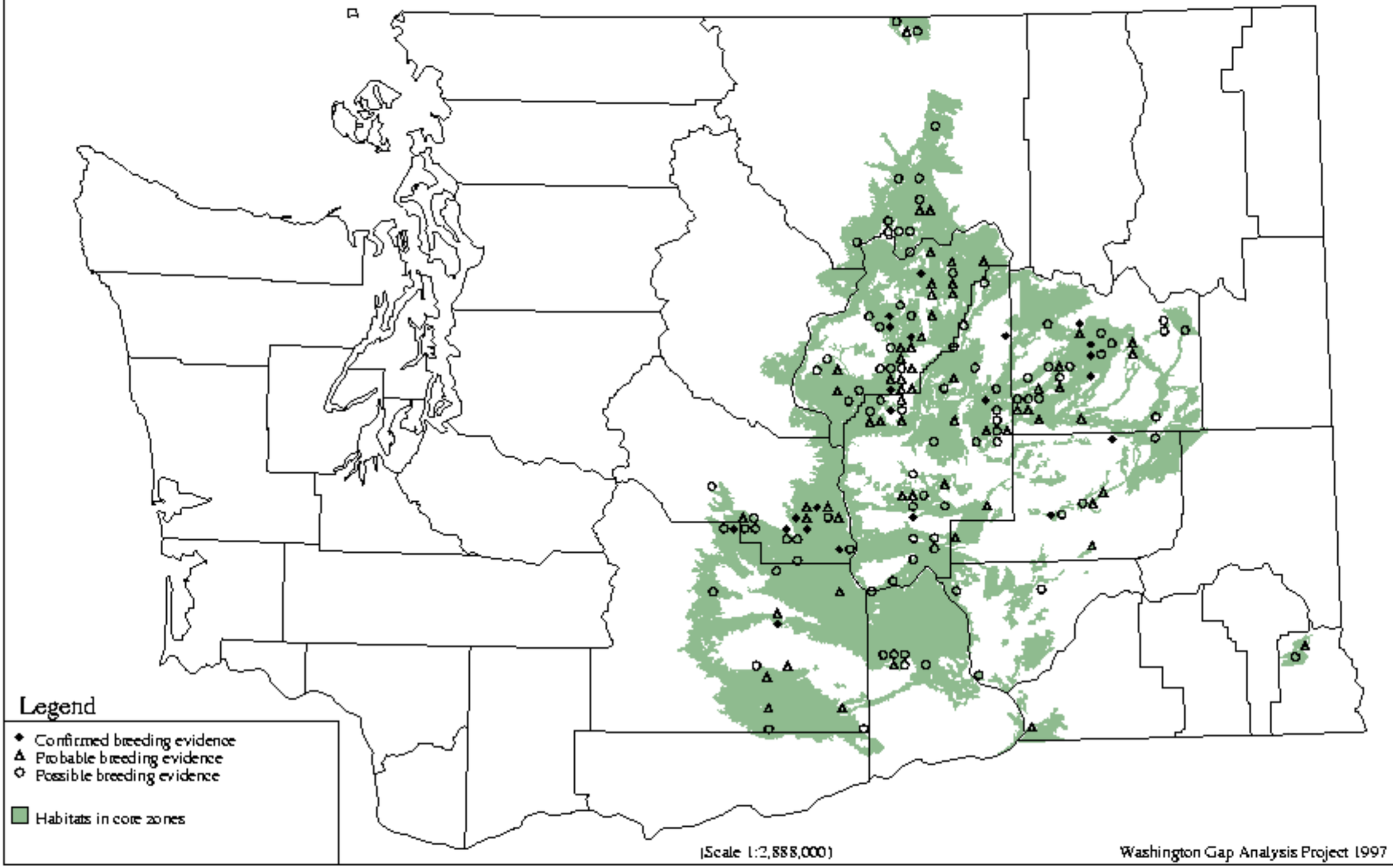
Varied Thrush - *Ixoreus naevius*



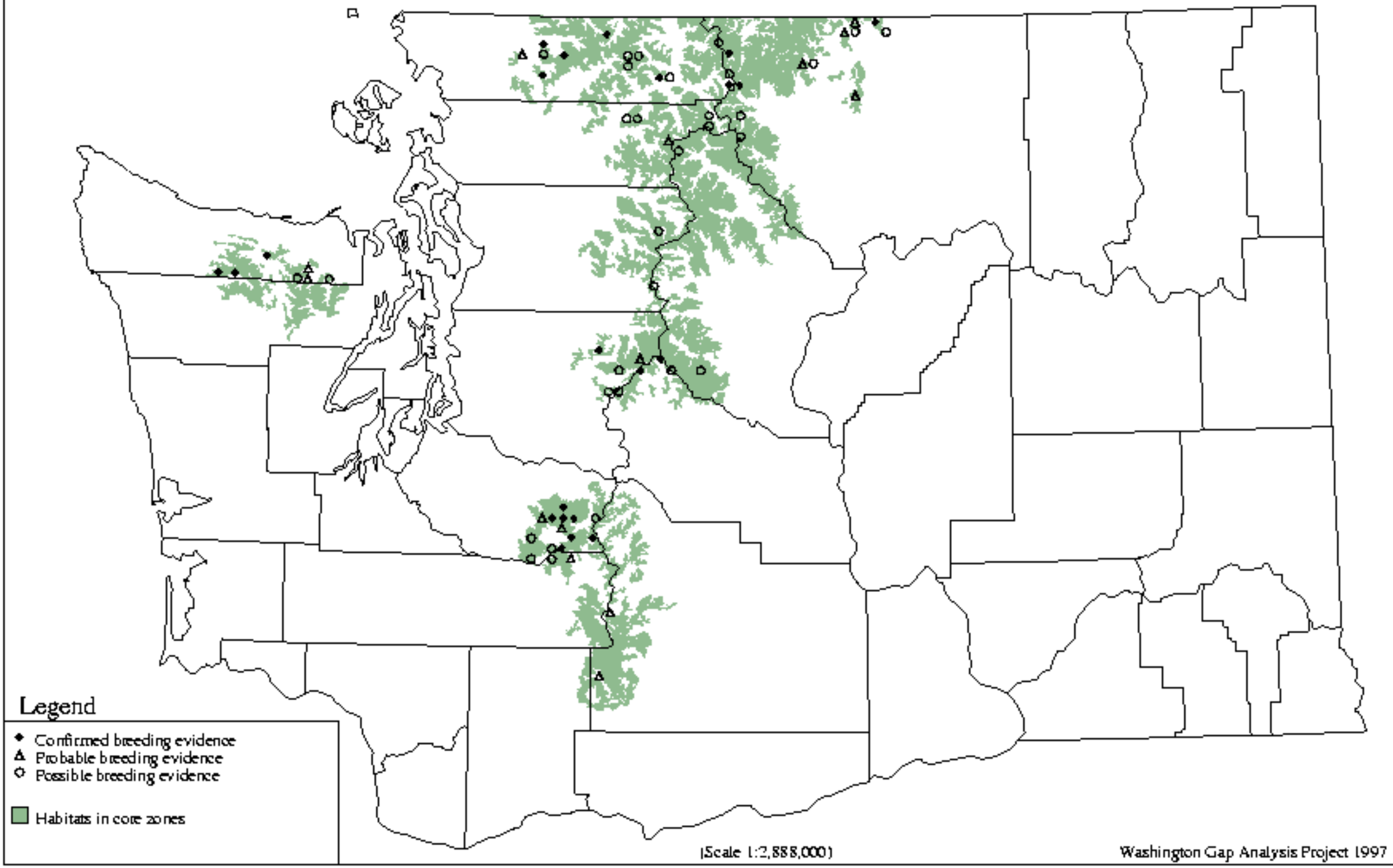
Gray Catbird - *Dumetella carolinensis*



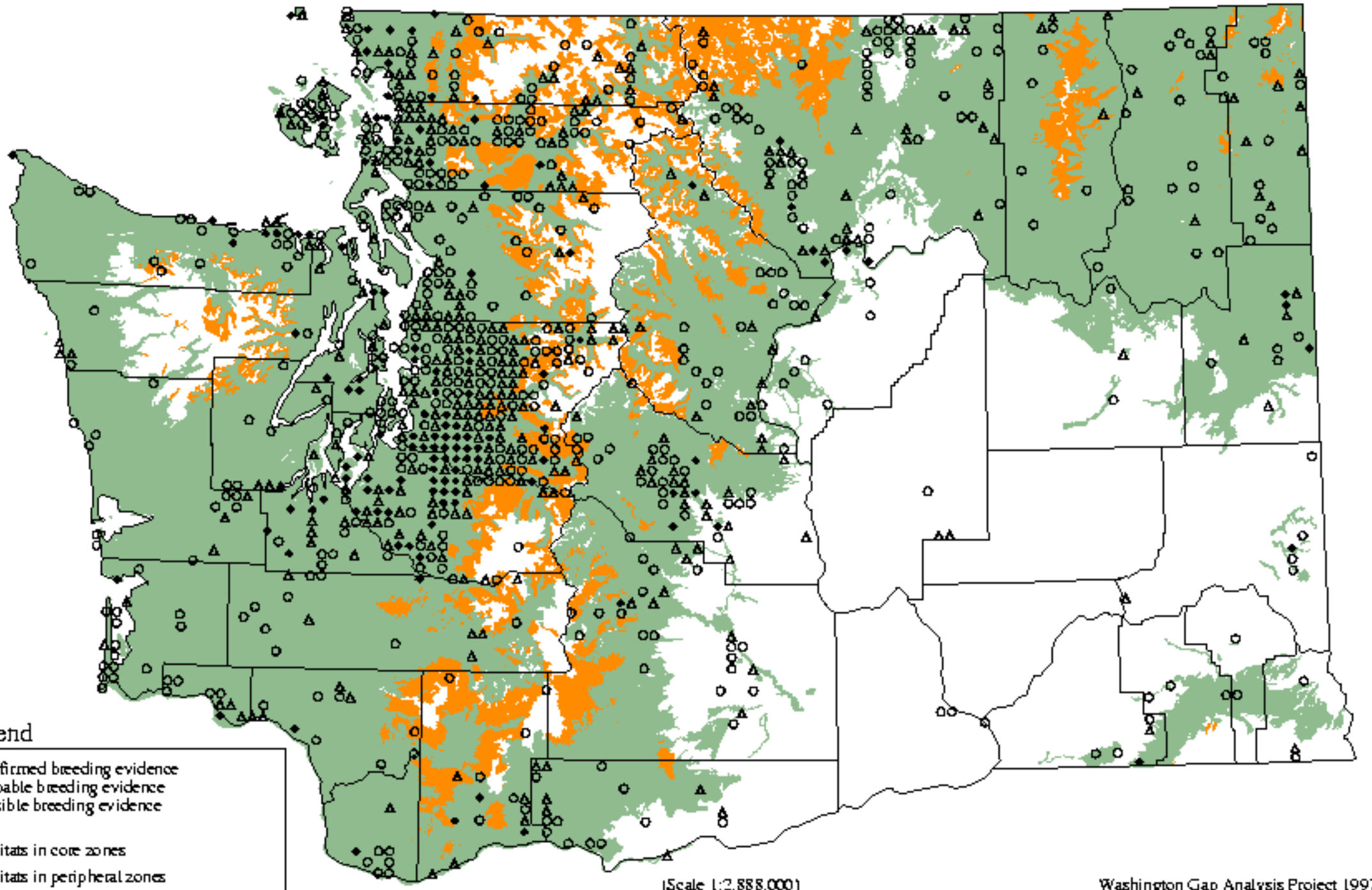
Sage Thrasher - *Oreoscoptes montanus*



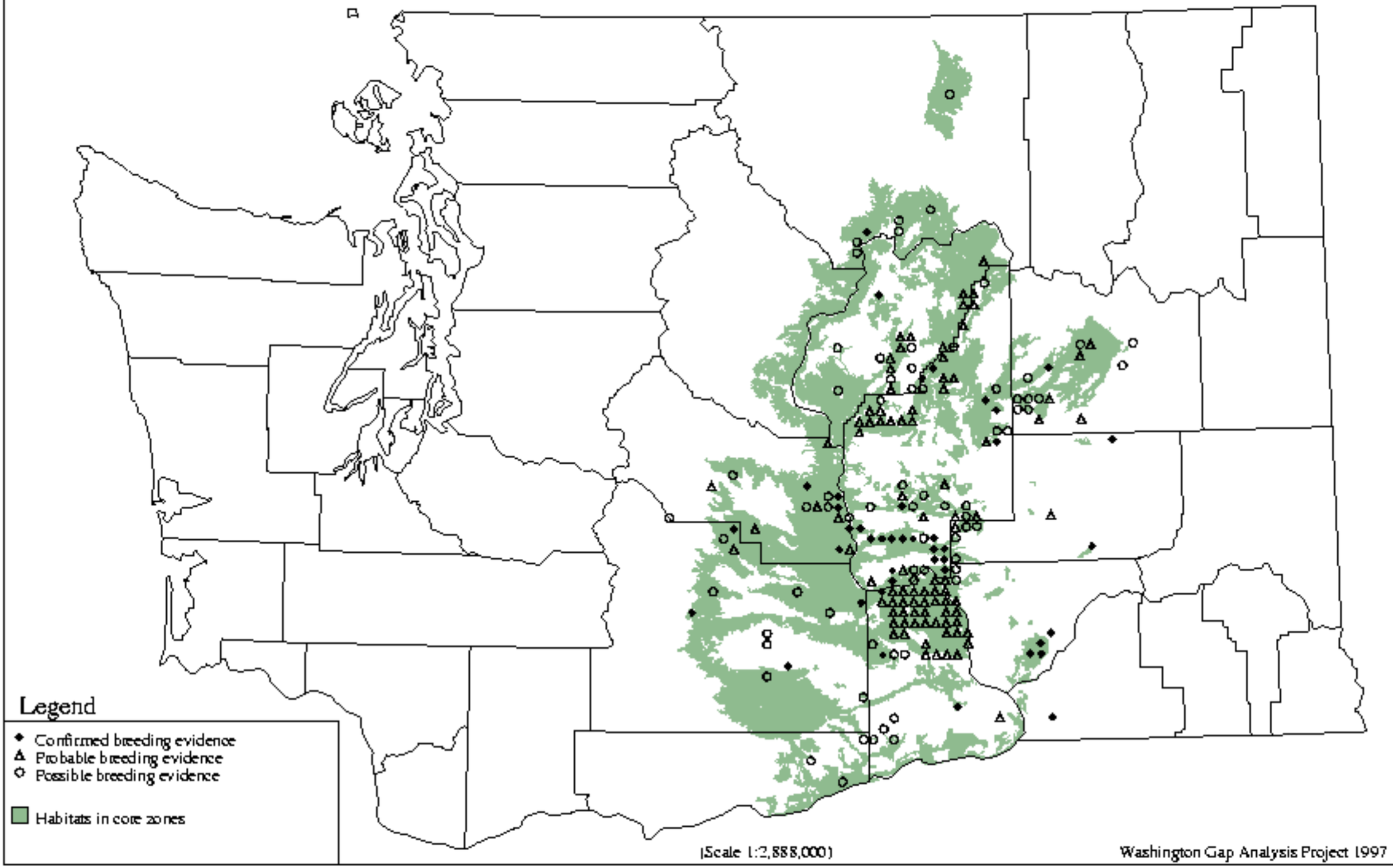
American Pipit - *Anthus rubescens*



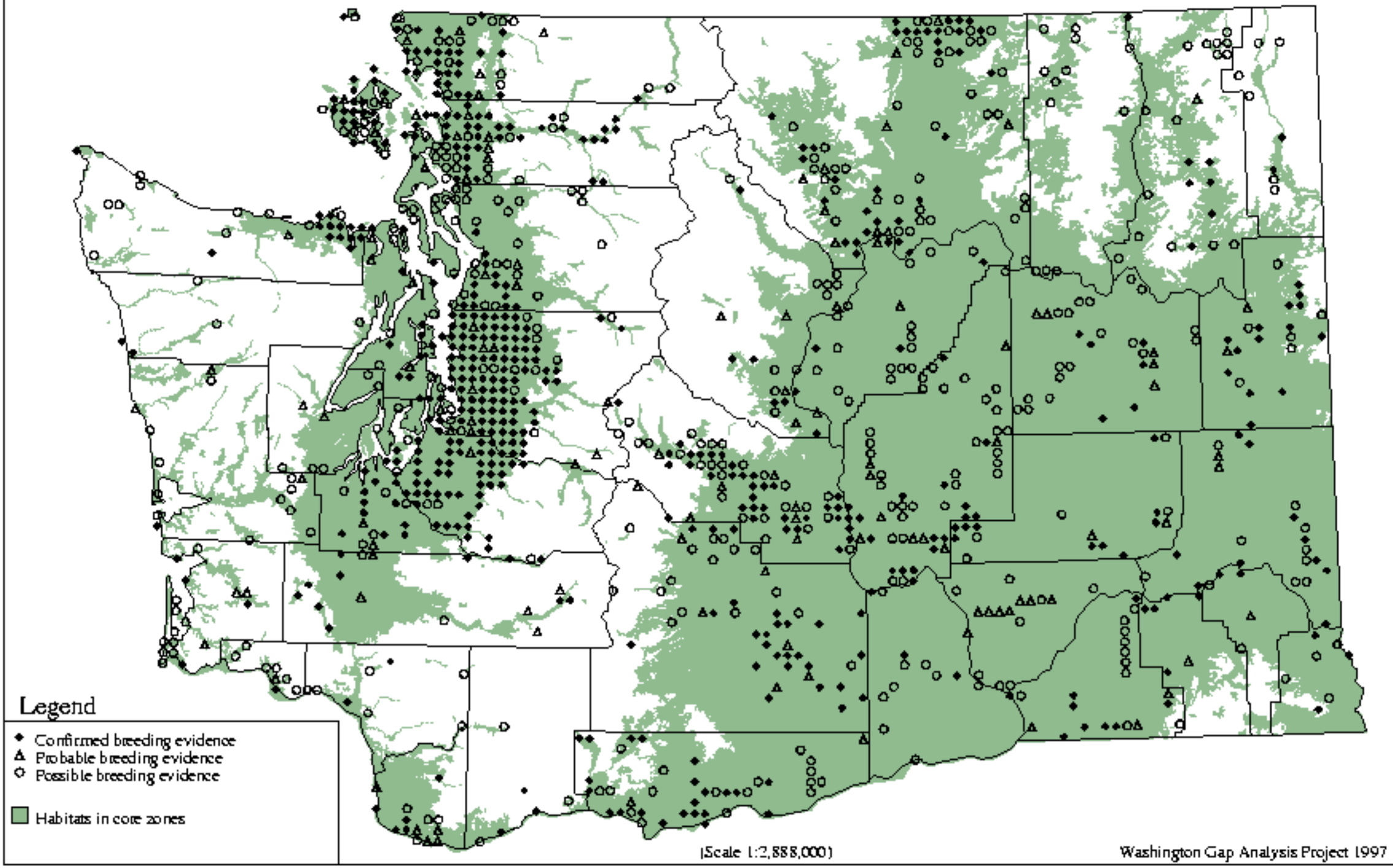
Cedar Waxwing - *Bombycilla cedrorum*



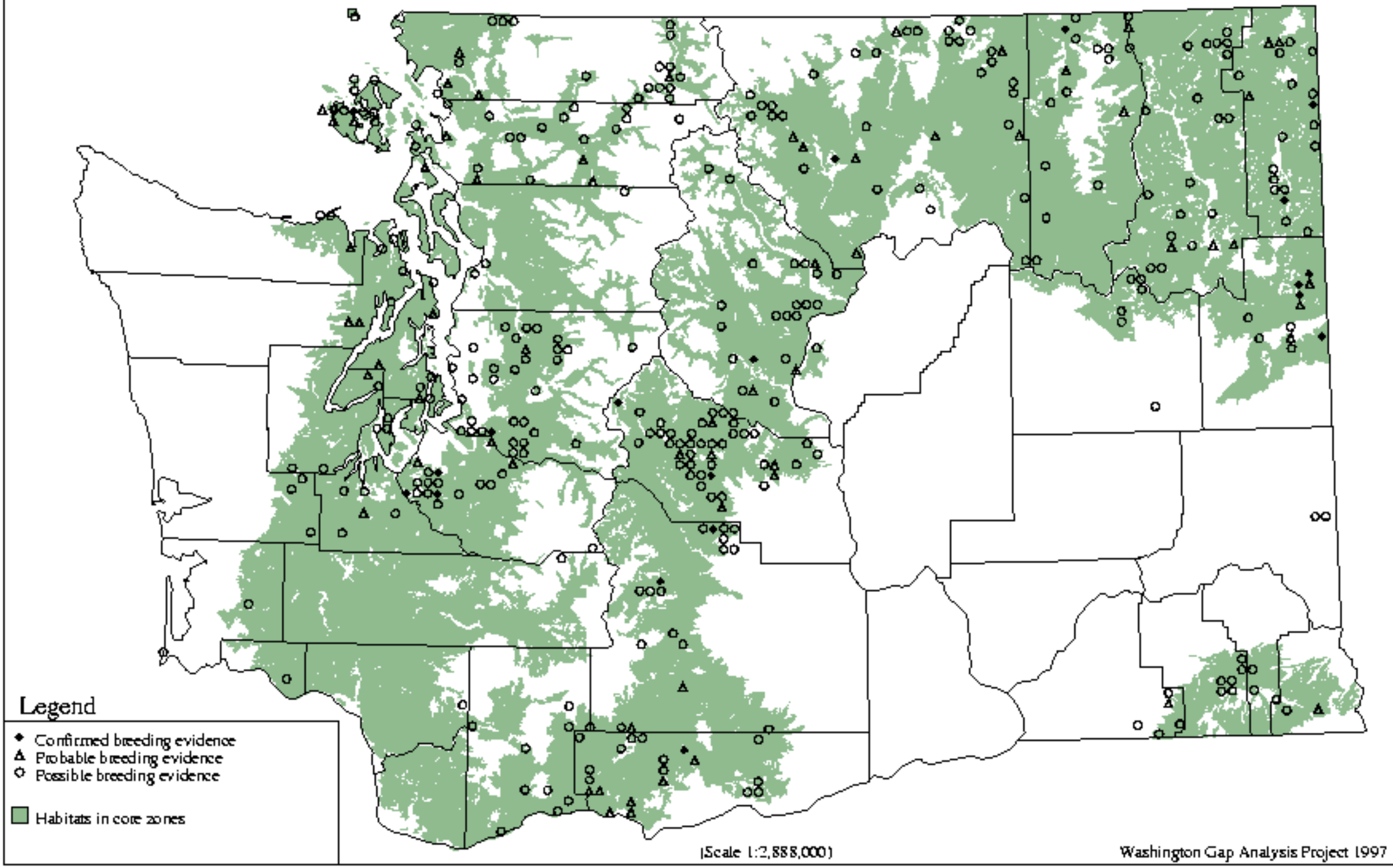
Loggerhead Shrike - *Lanius ludovicianus*



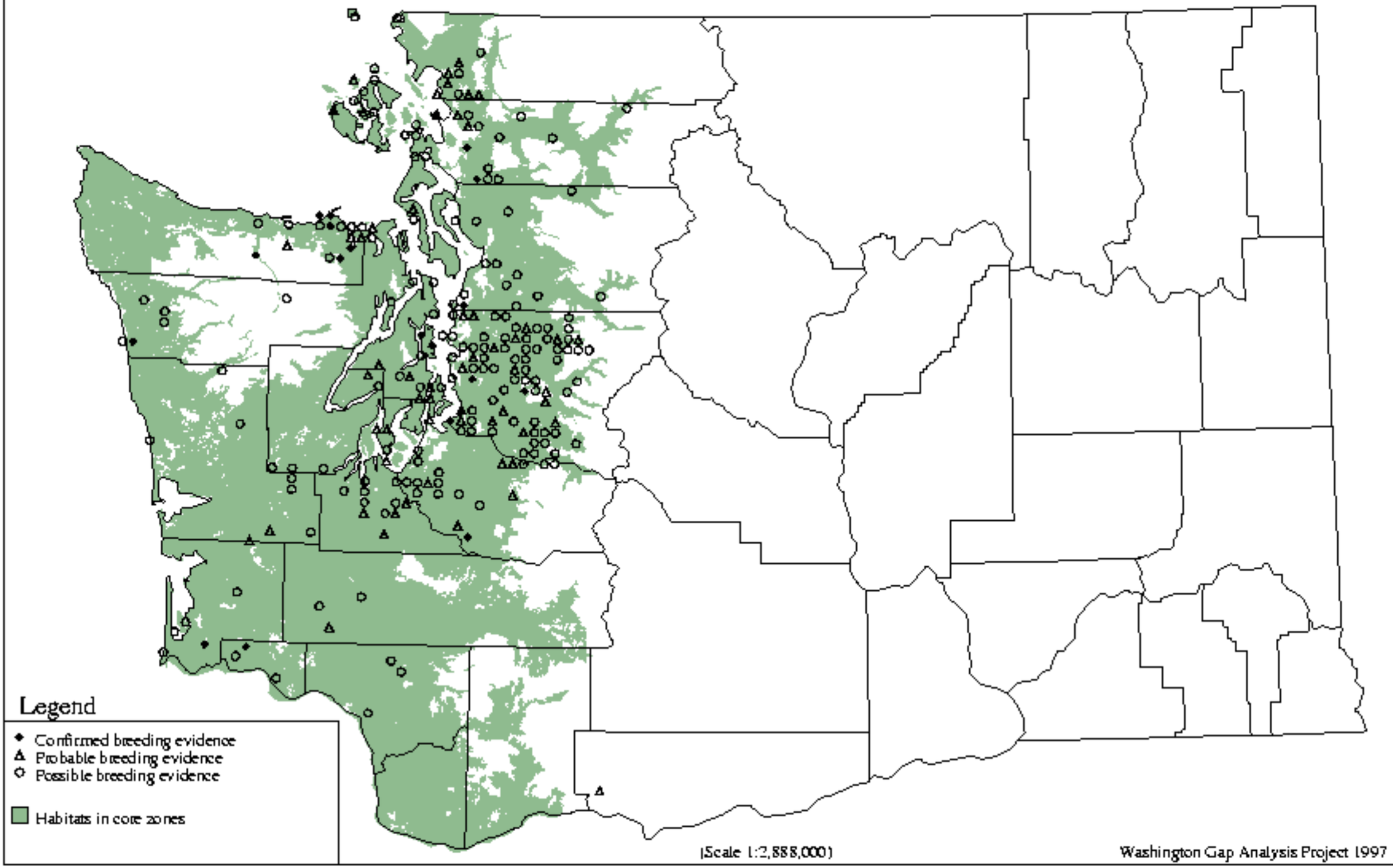
European Starling - *Sturnus vulgaris*



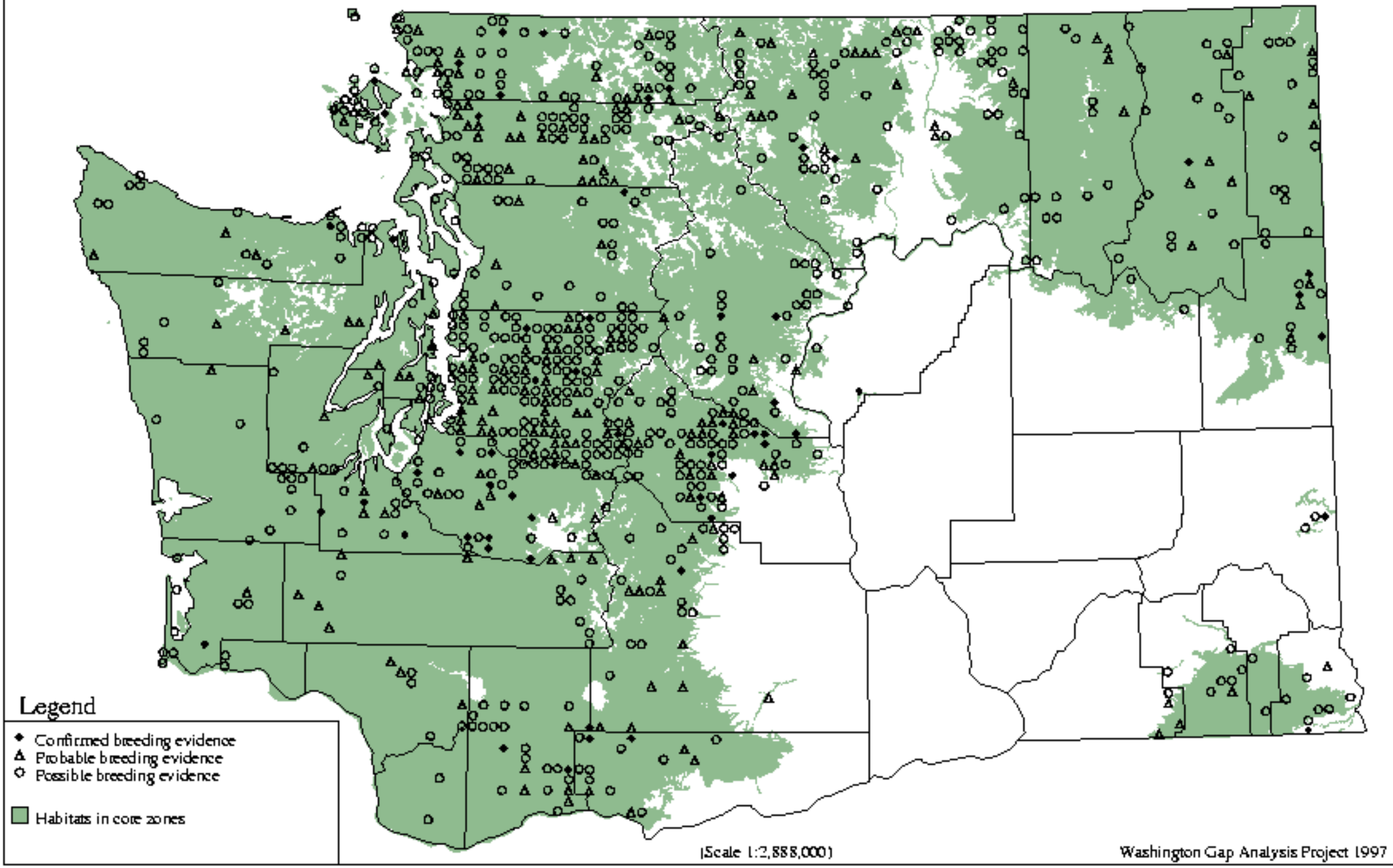
Solitary Vireo - *Vireo solitarius*



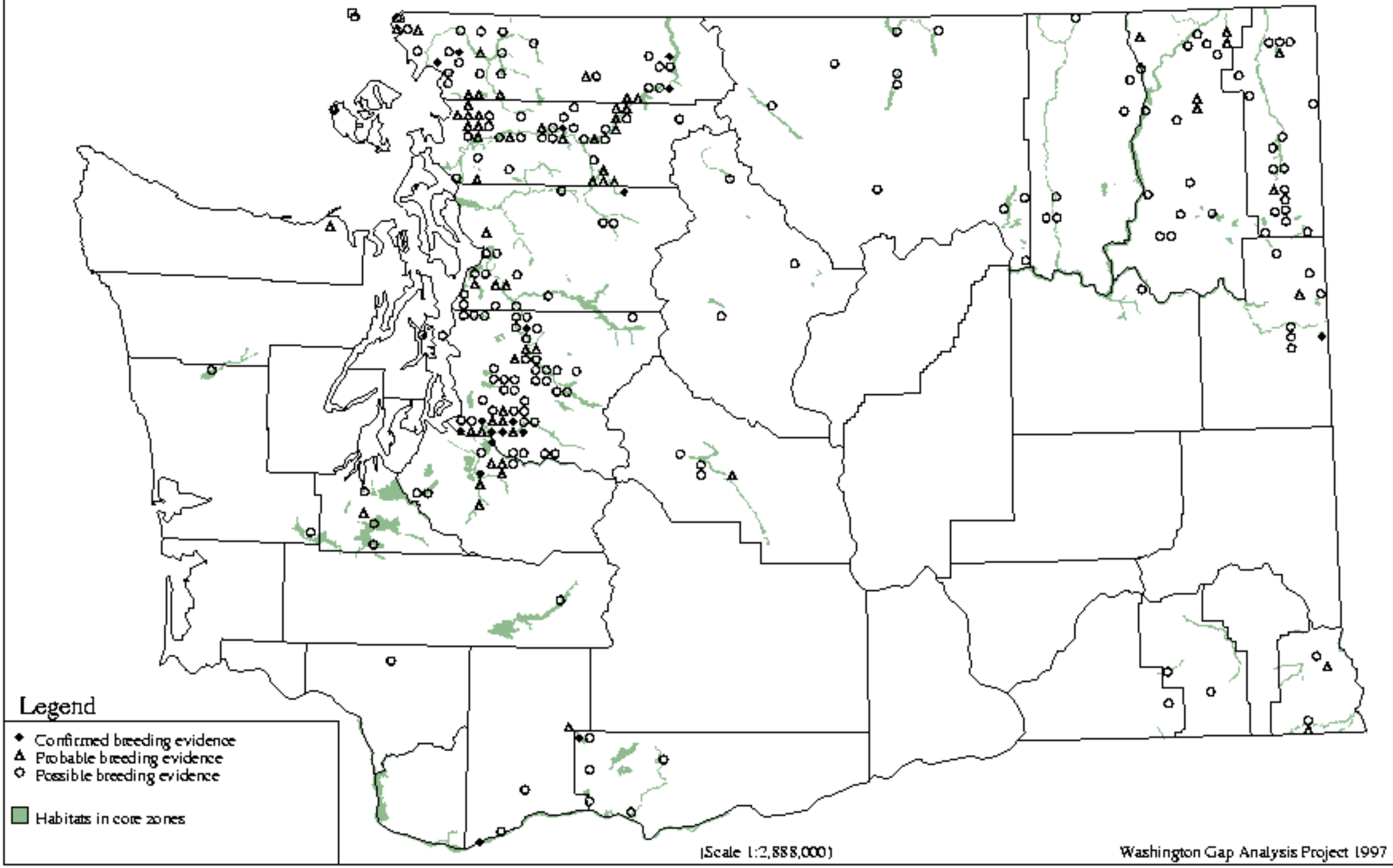
Hutton`s Vireo - *Vireo huttoni*



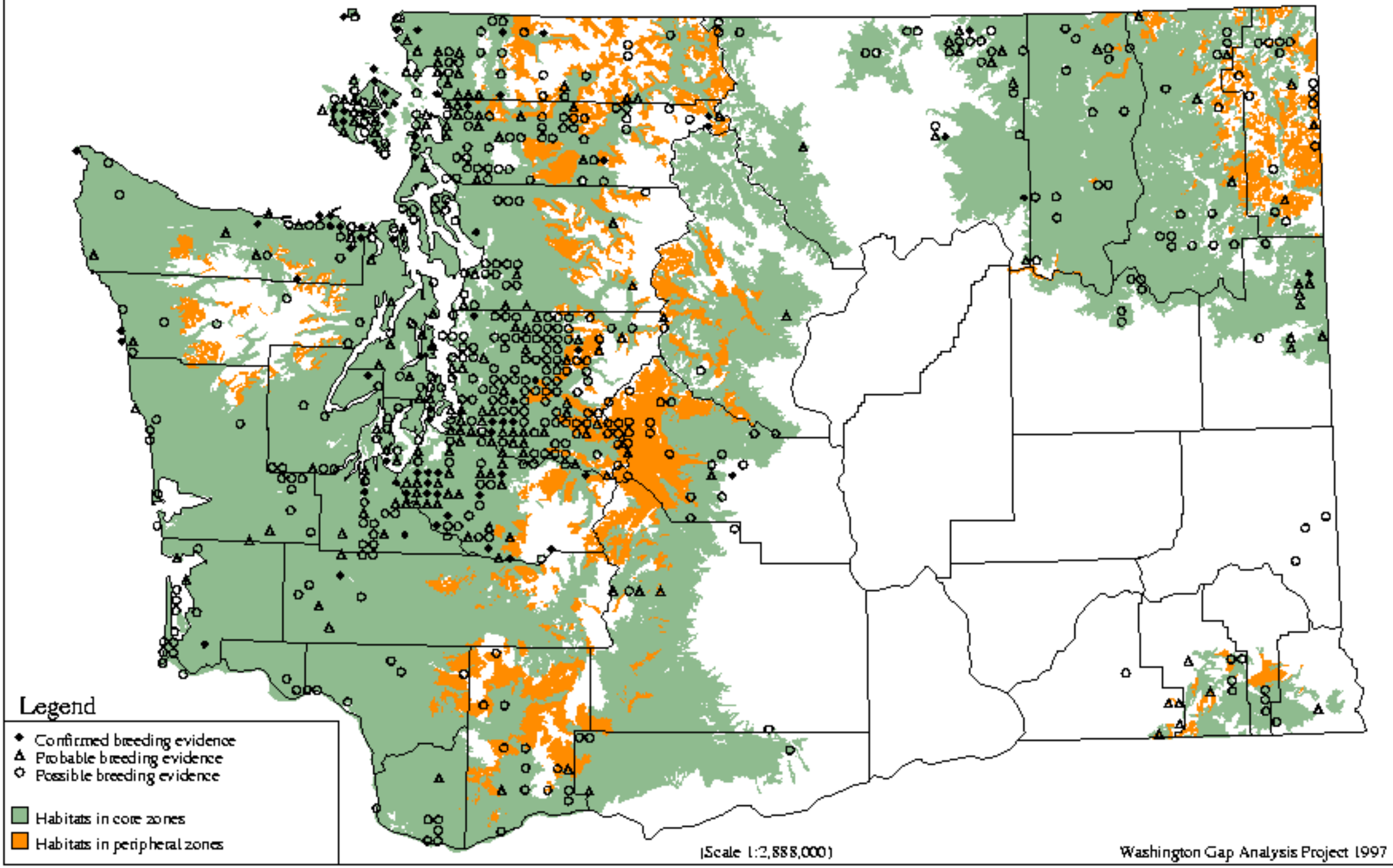
Warbling Vireo - *Vireo gilvus*



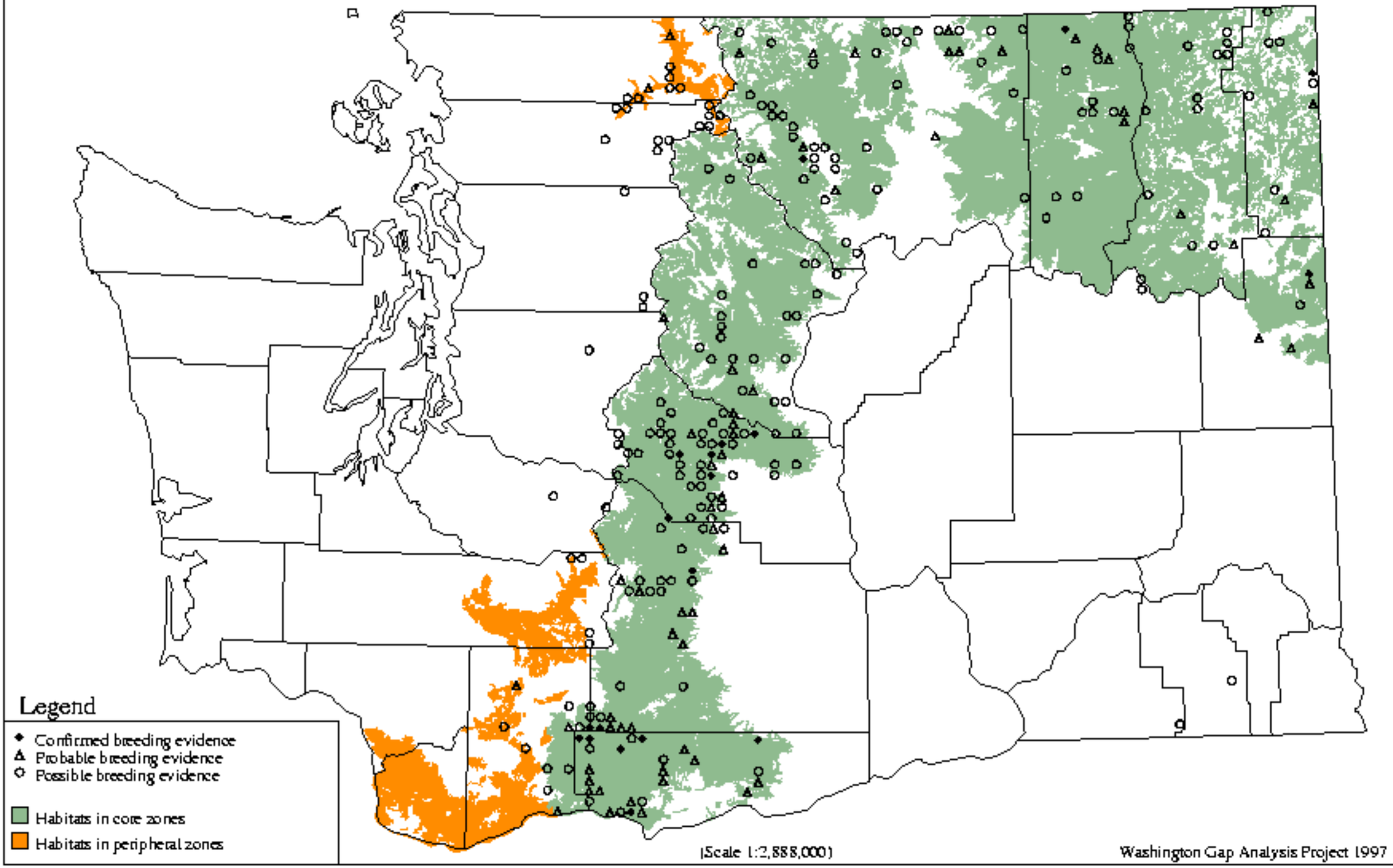
Red-eyed Vireo - *Vireo olivaceus*



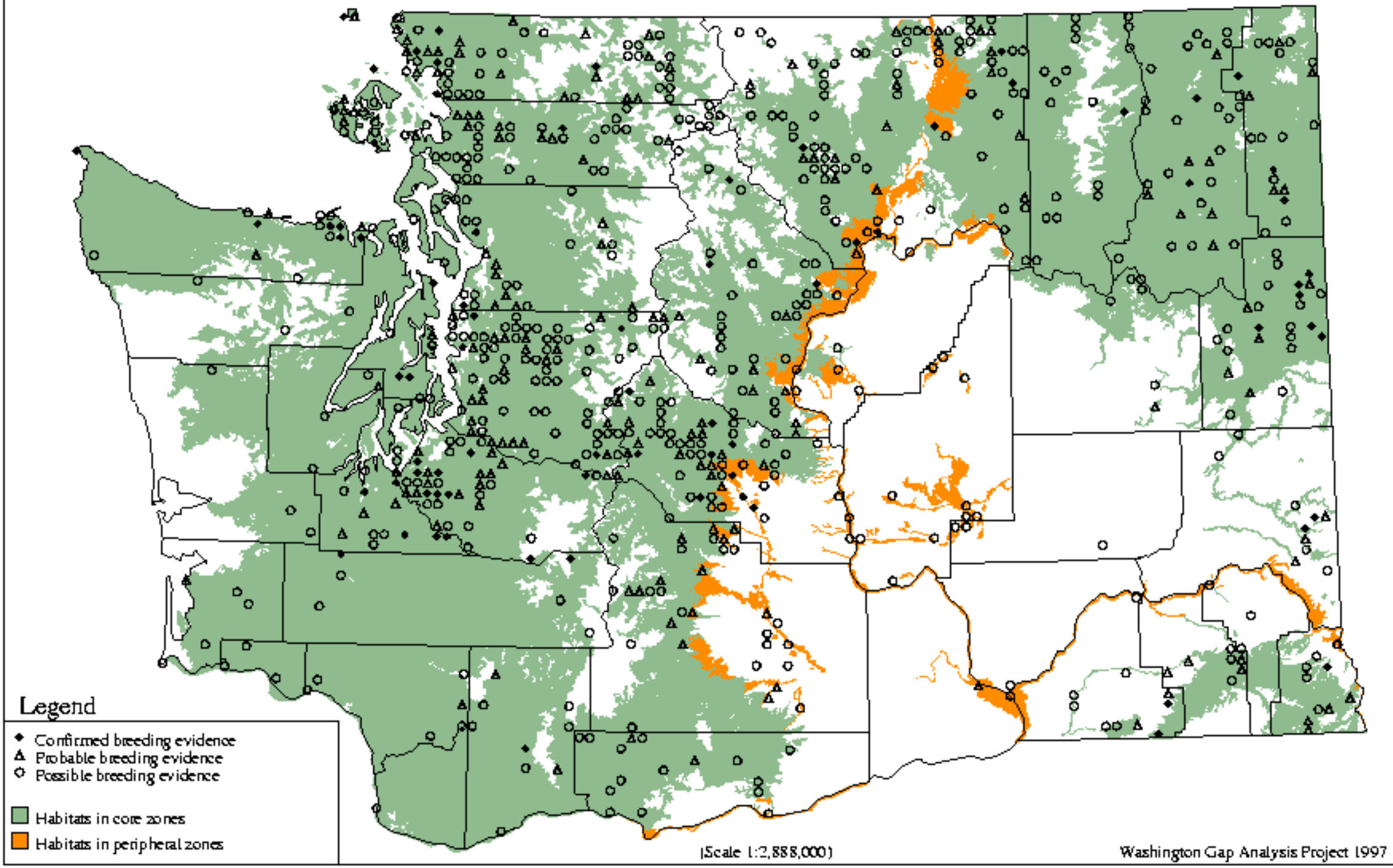
Orange-crowned Warbler - *Vermivora celata*



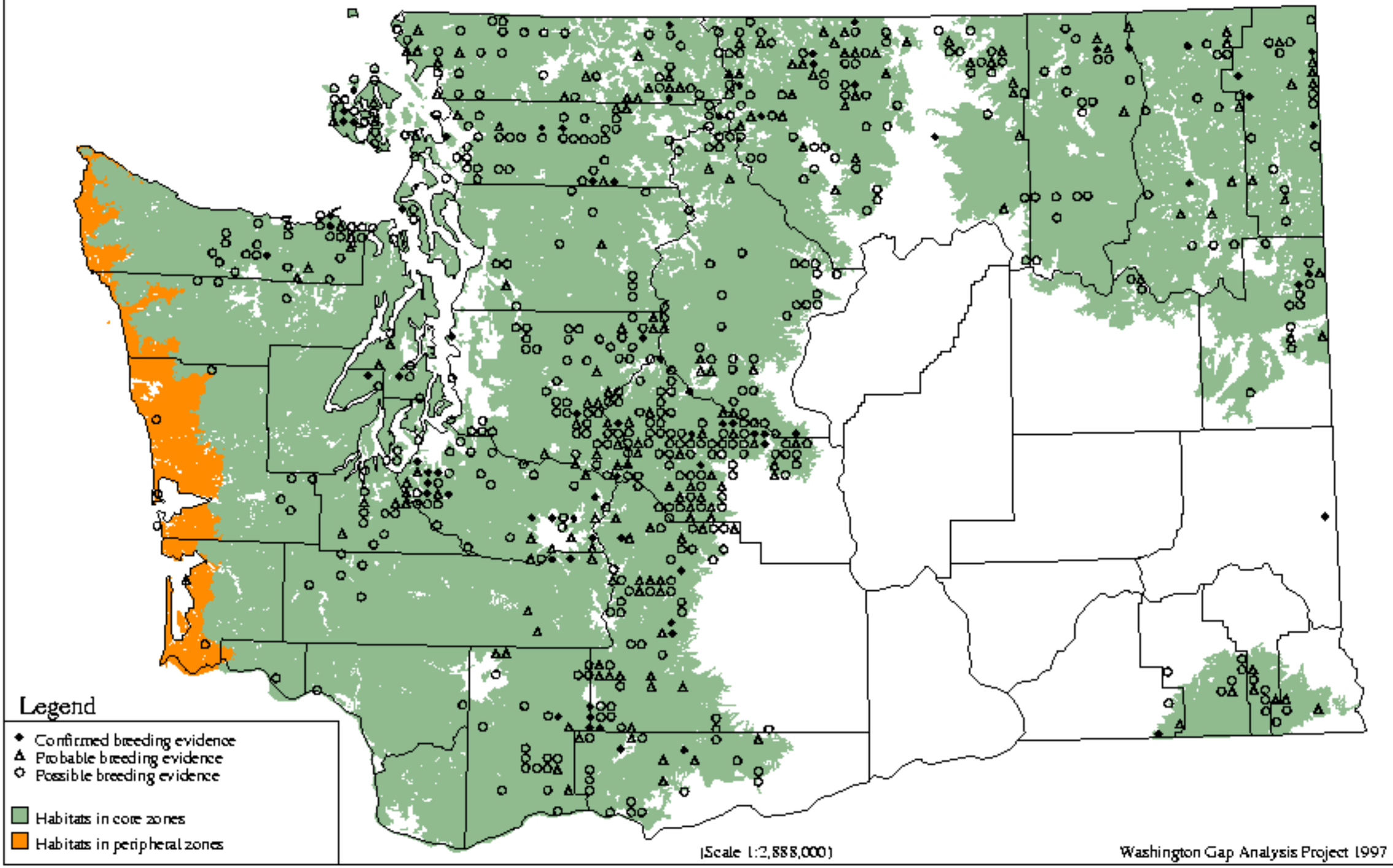
Nashville Warbler - *Vermivora ruficapilla*



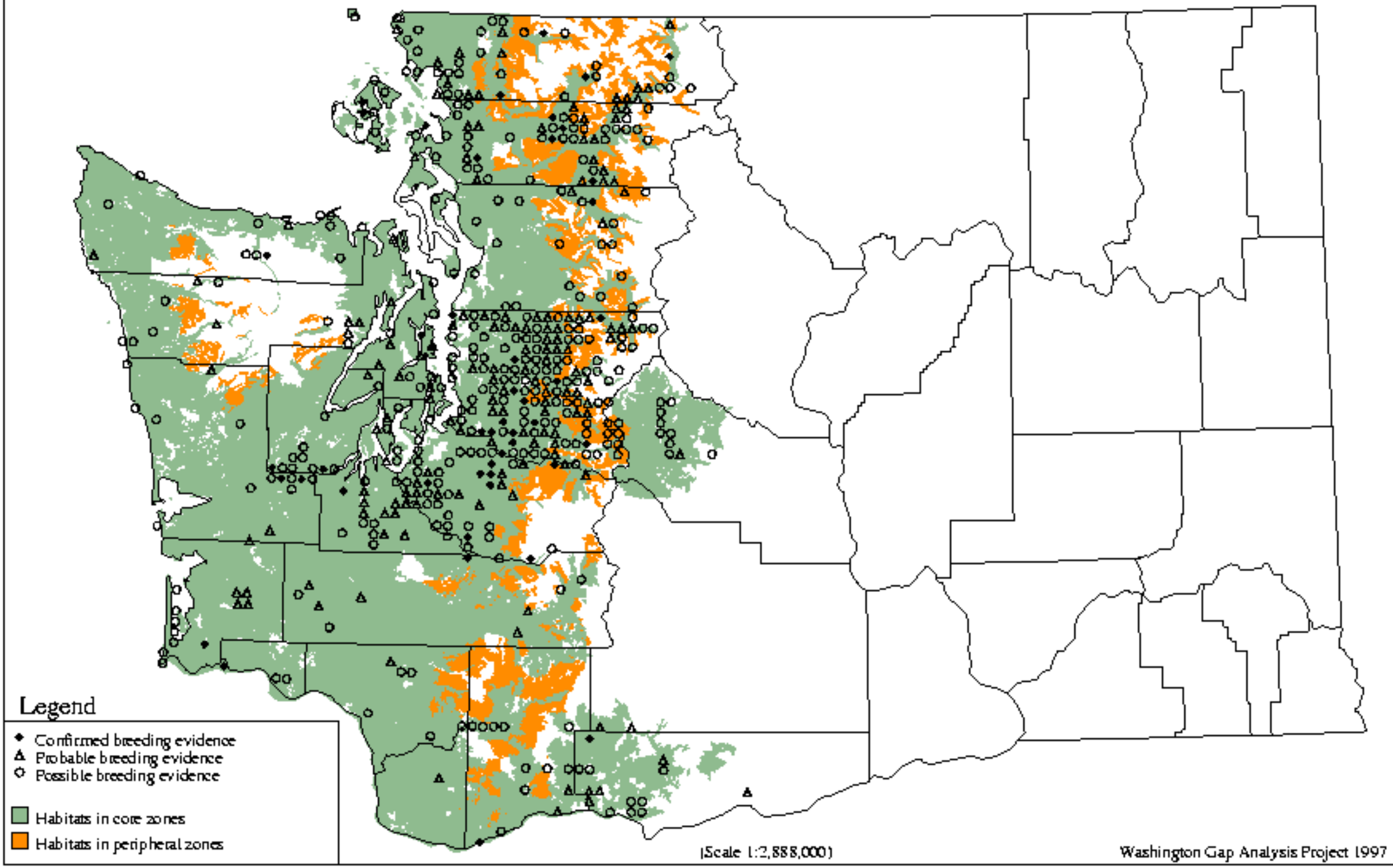
Yellow Warbler - *Dendroica petechia*



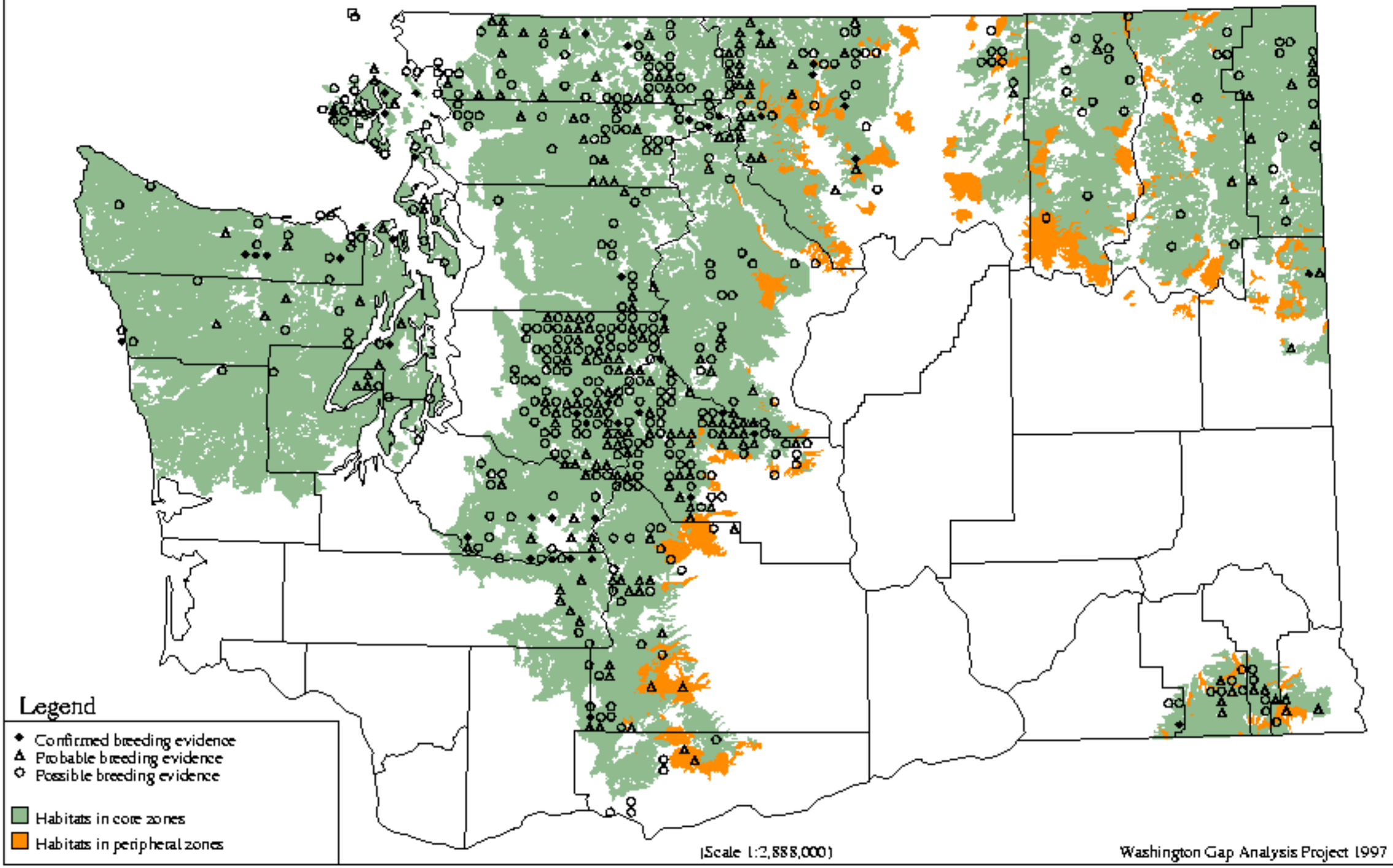
Yellow-rumped Warbler - *Dendroica coronata*



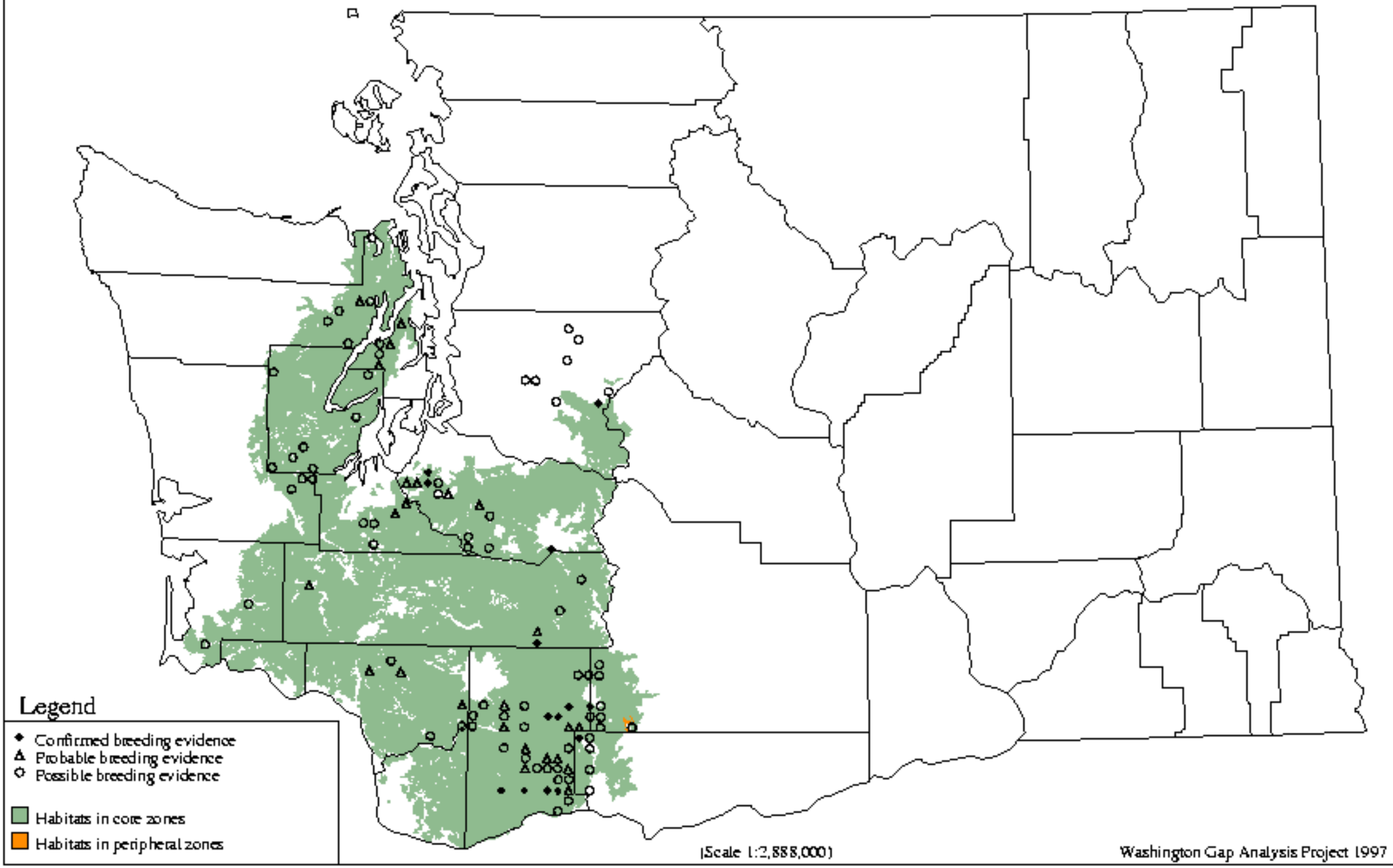
Black-throated Gray Warbler - *Dendroica nigrescens*



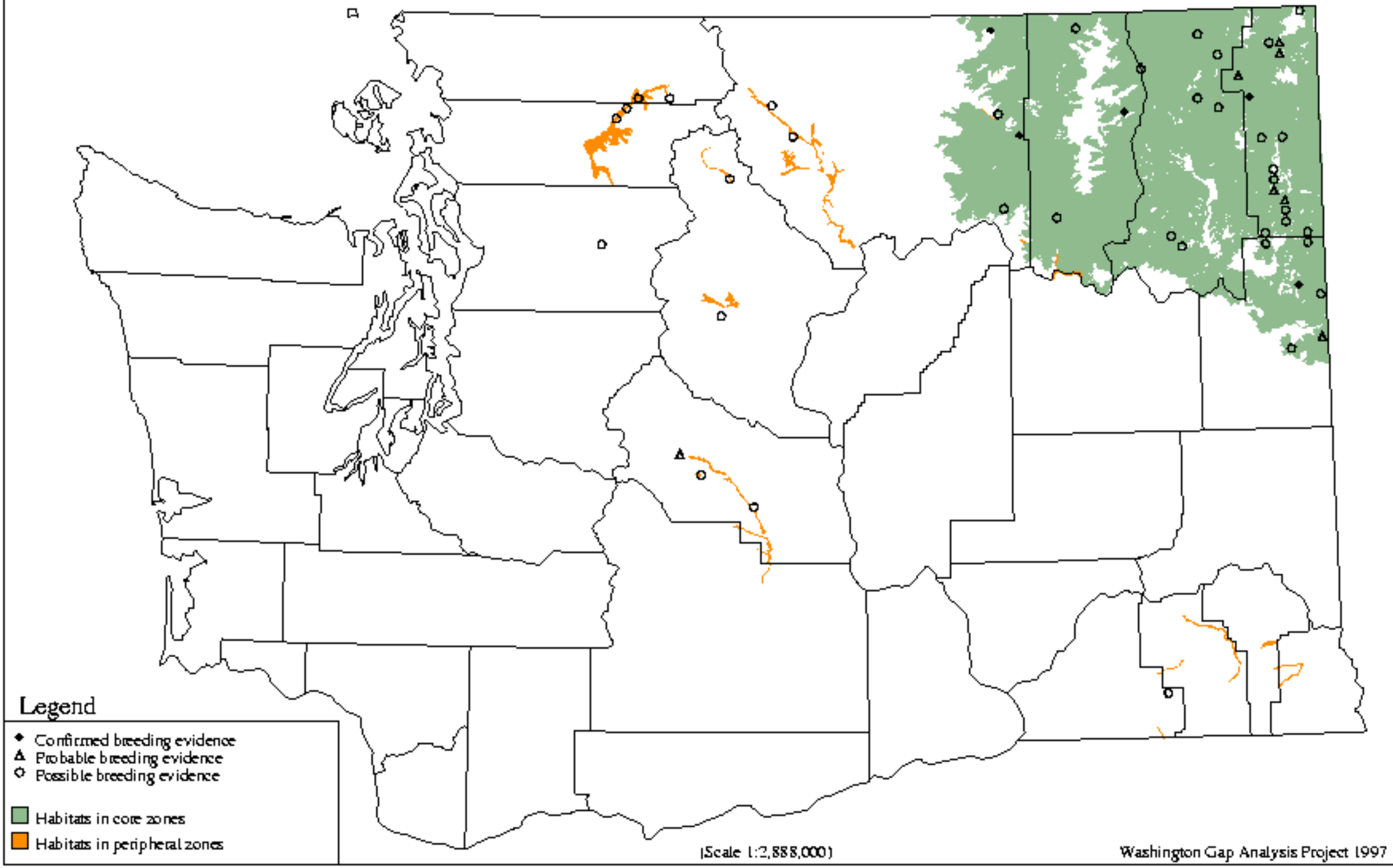
Townsend`s Warbler - *Dendroica townsendi*



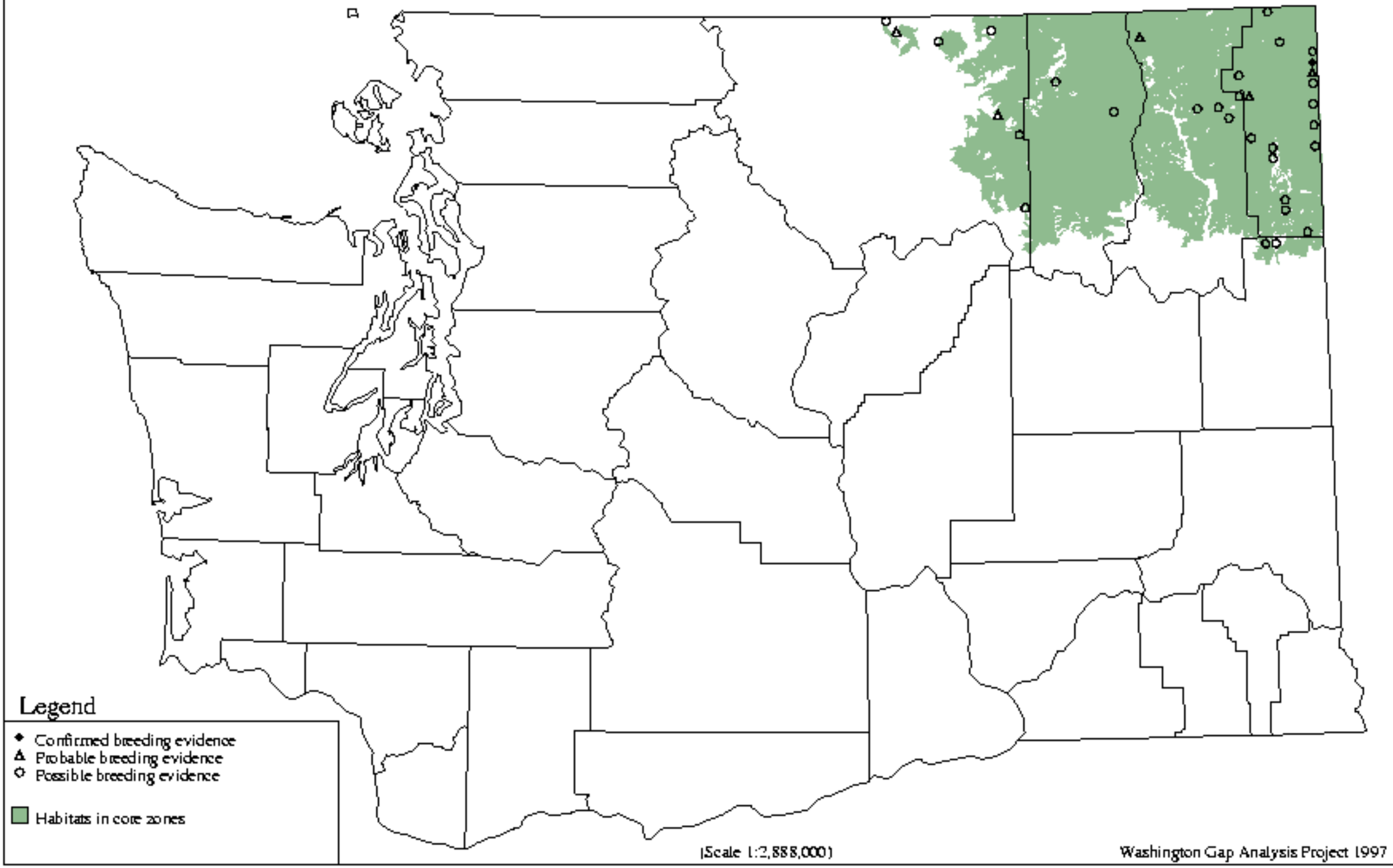
Hermit Warbler - *Dendroica occidentalis*



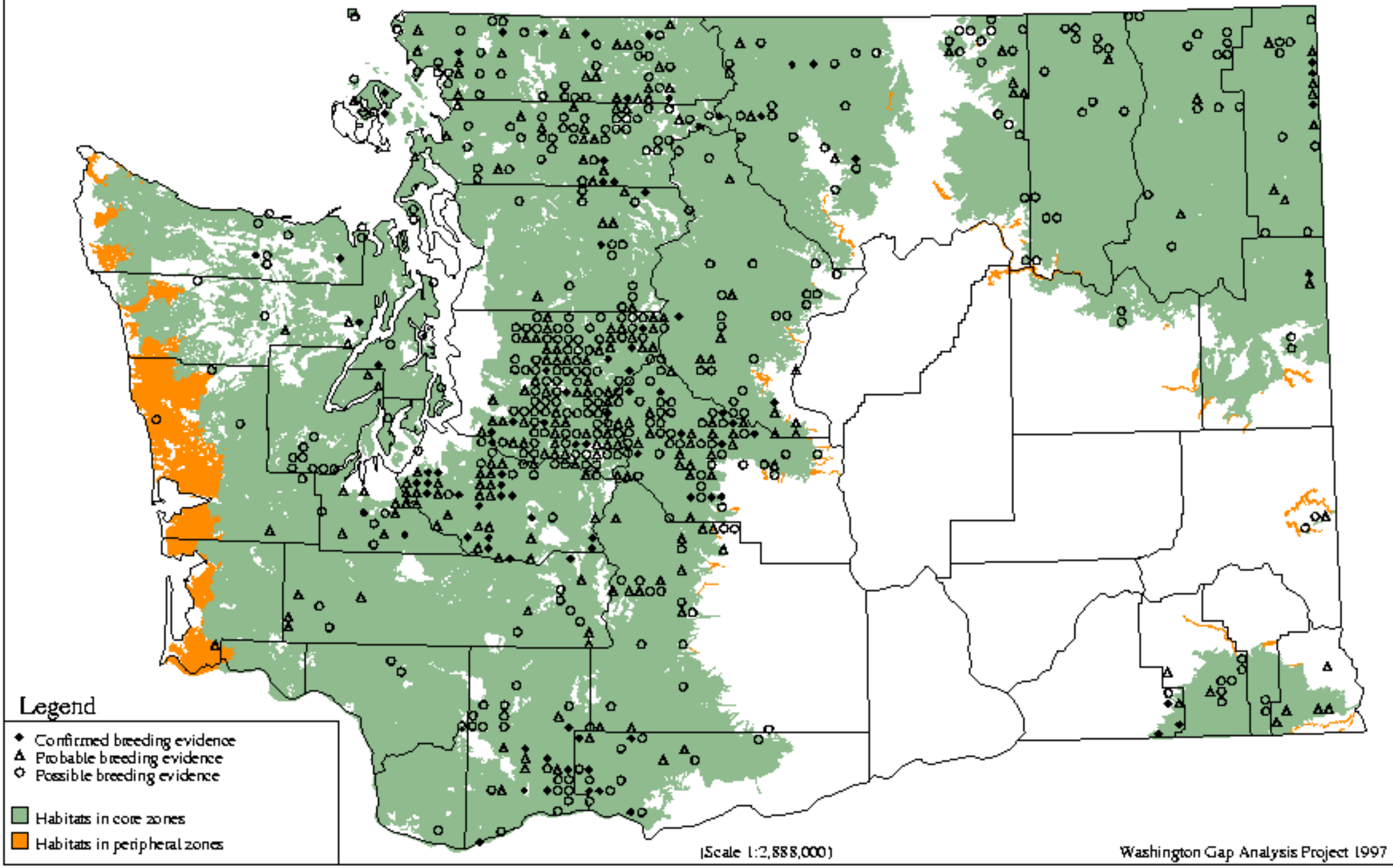
American Redstart - *Setophaga ruticilla*



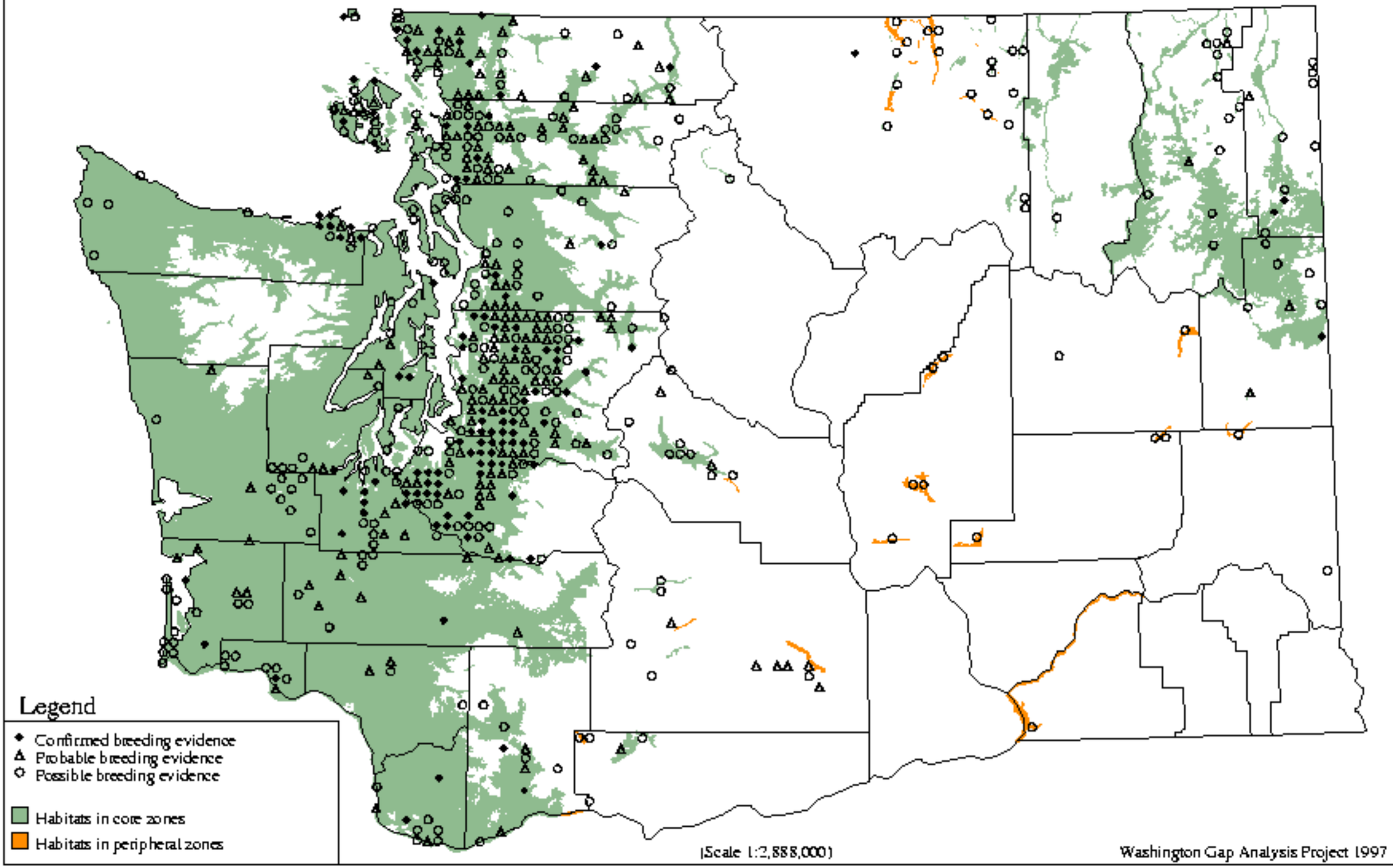
Northern Waterthrush - *Seiurus noveboracensis*



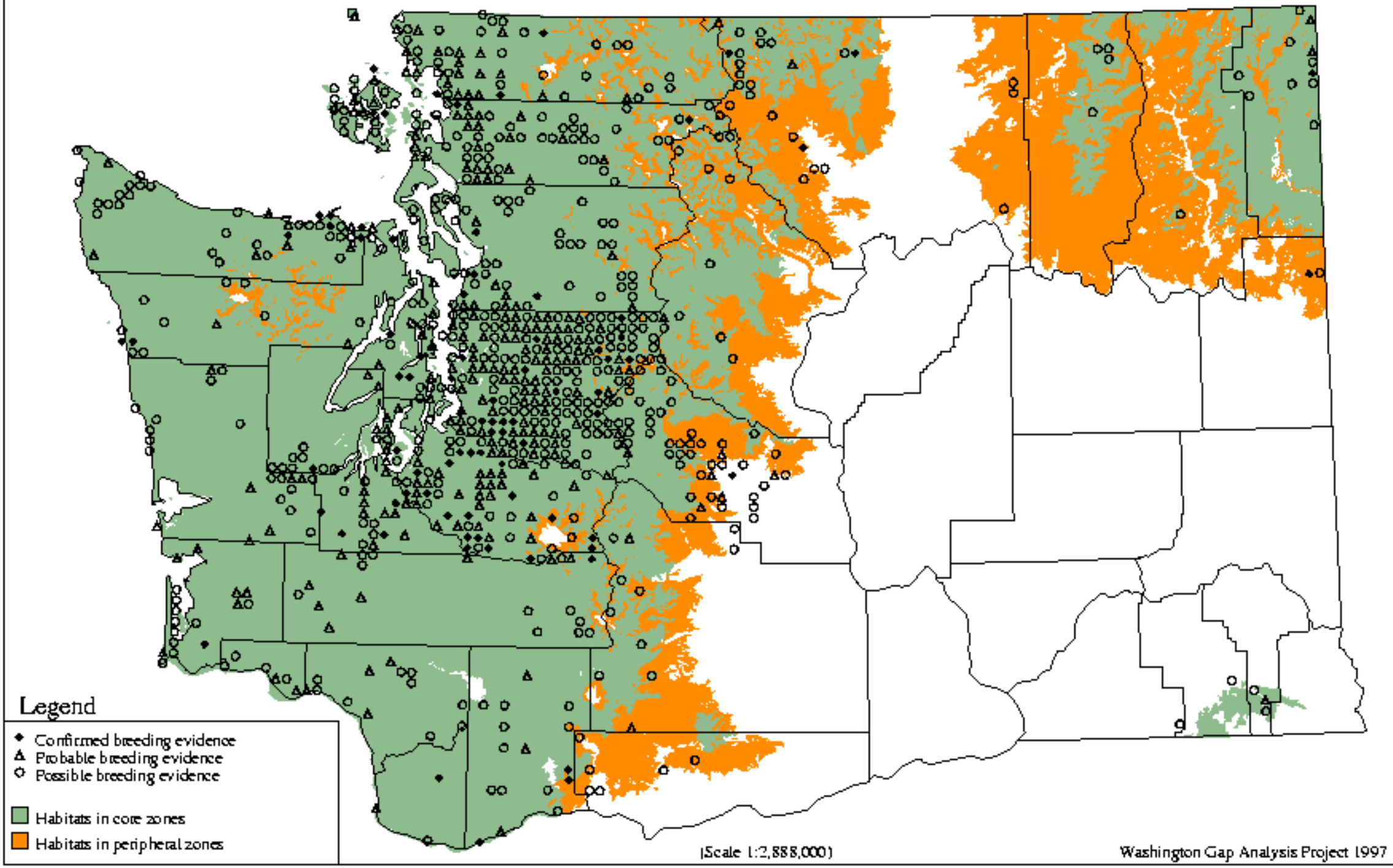
MacGillivray`s Warbler - *Oporornis tolmiei*



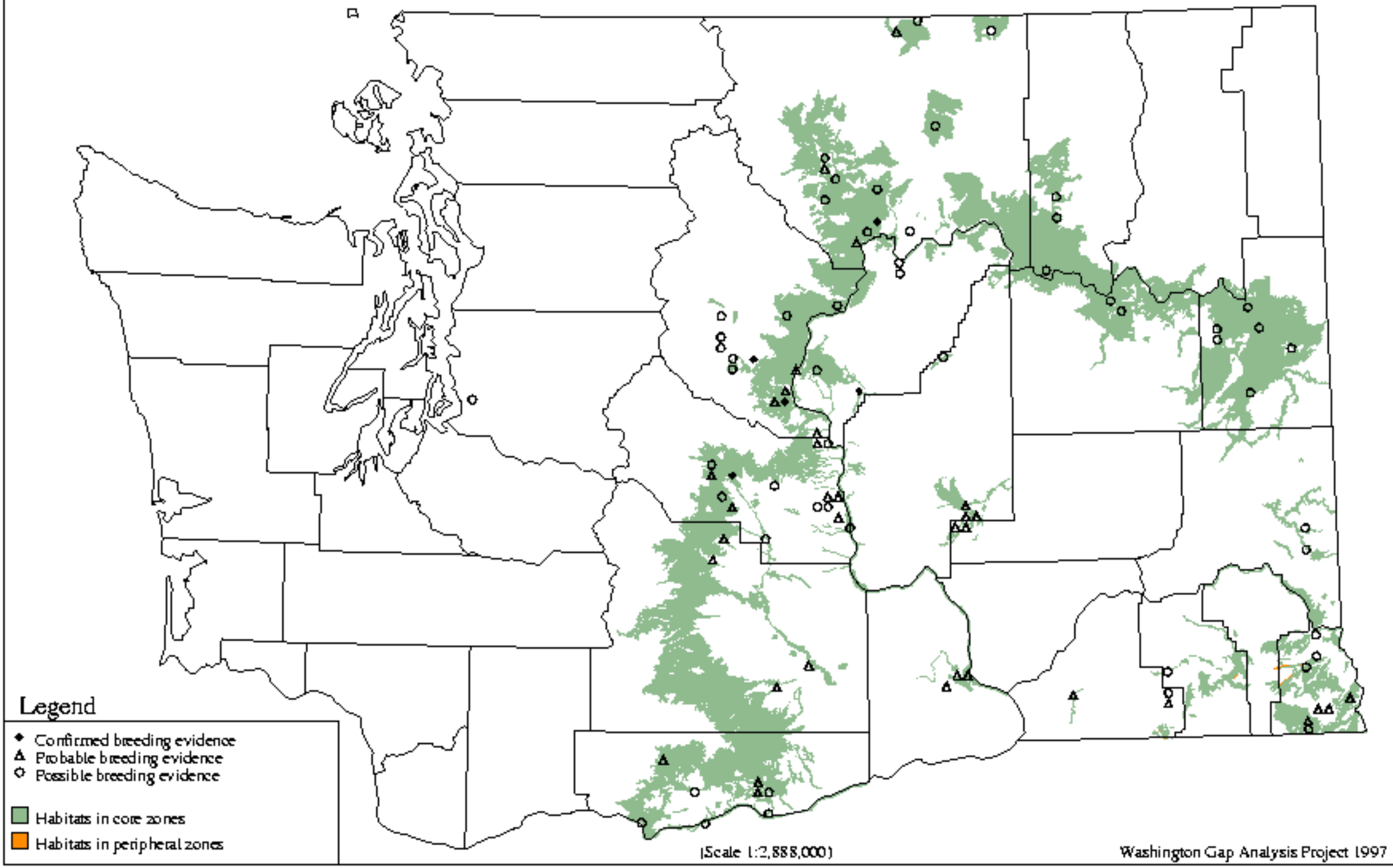
Common Yellowthroat - *Geothlypis trichas*



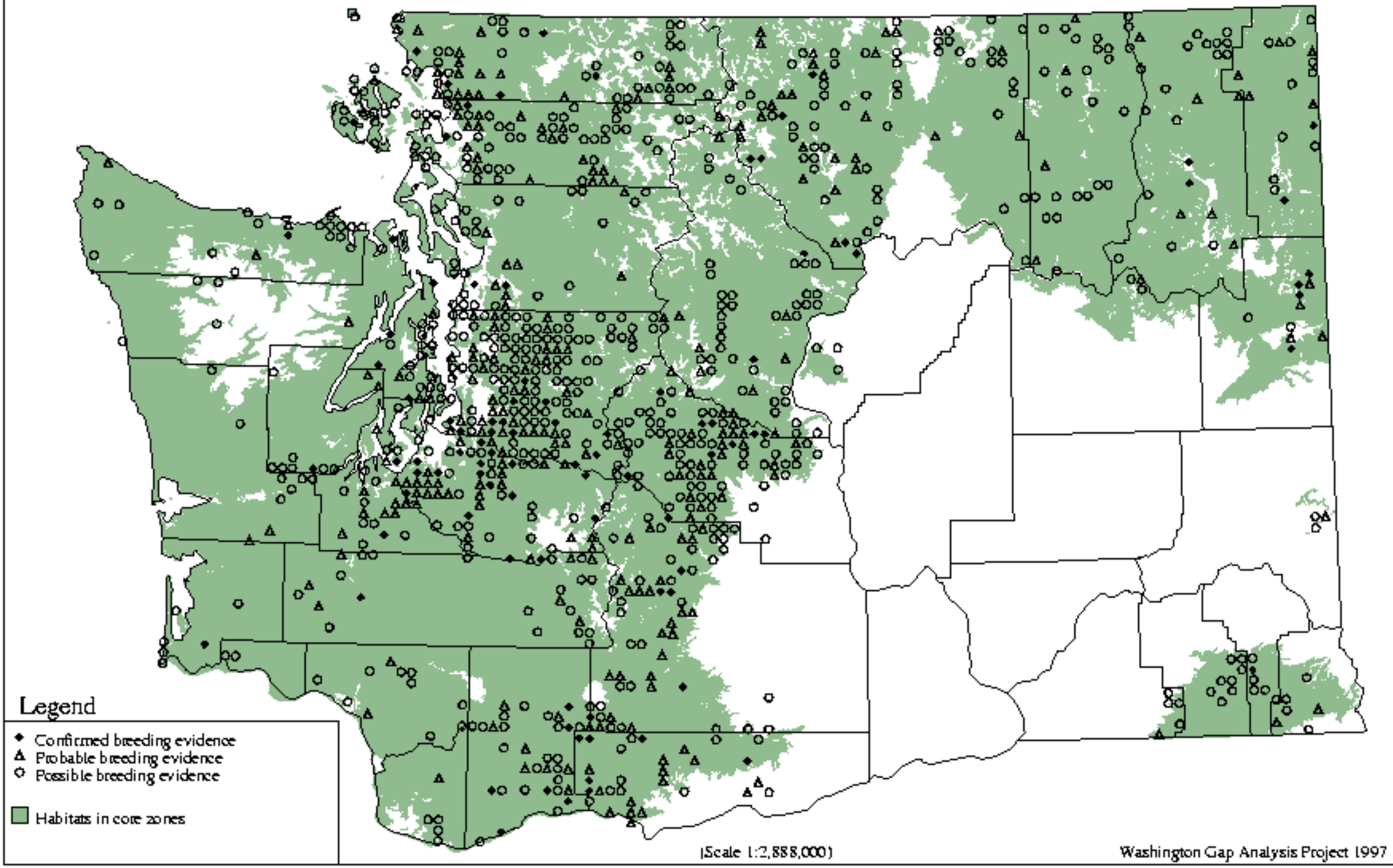
Wilson`s Warbler - *Wilsonia pusilla*



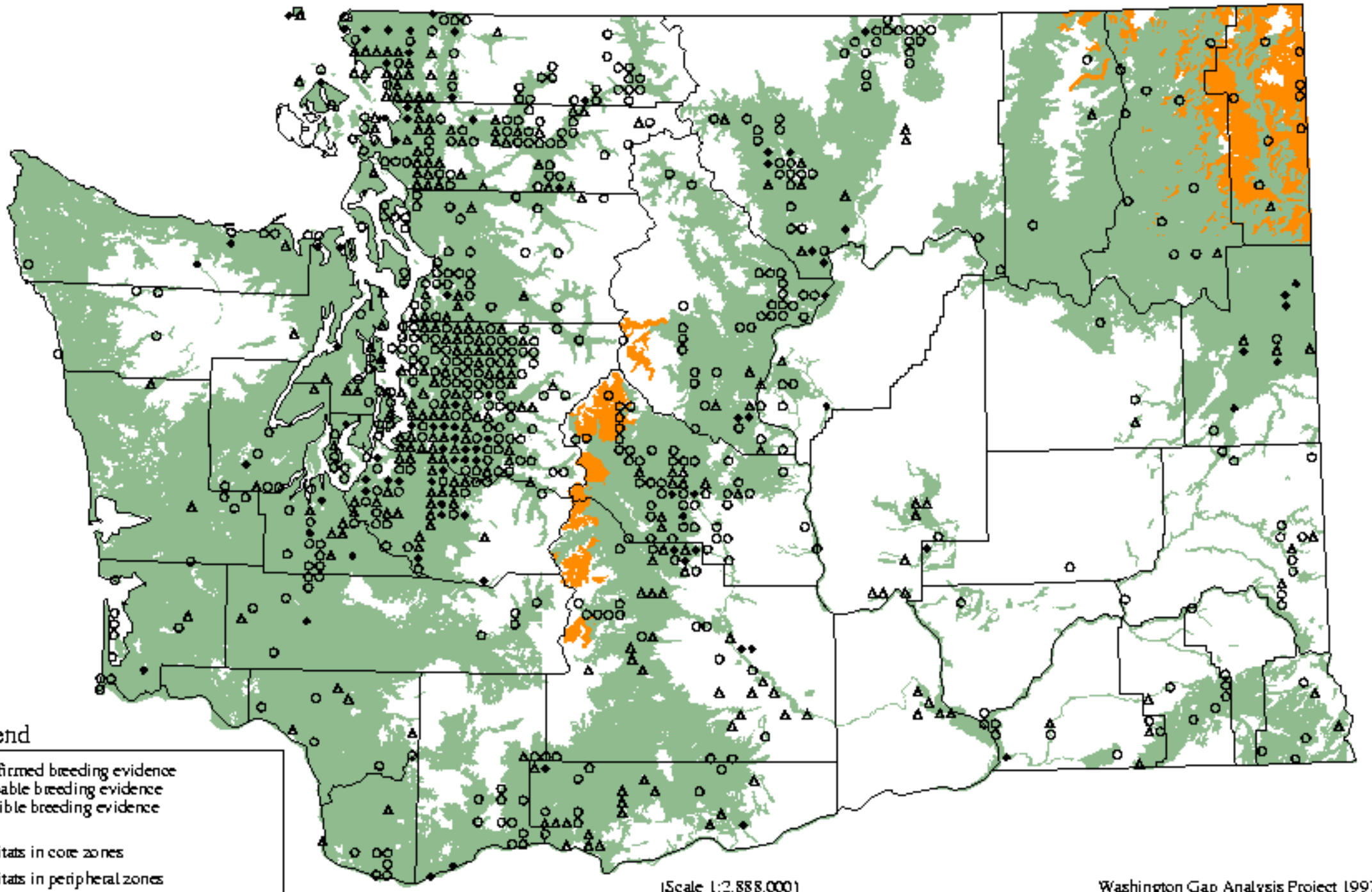
Yellow-breasted Chat - *Icteria virens*



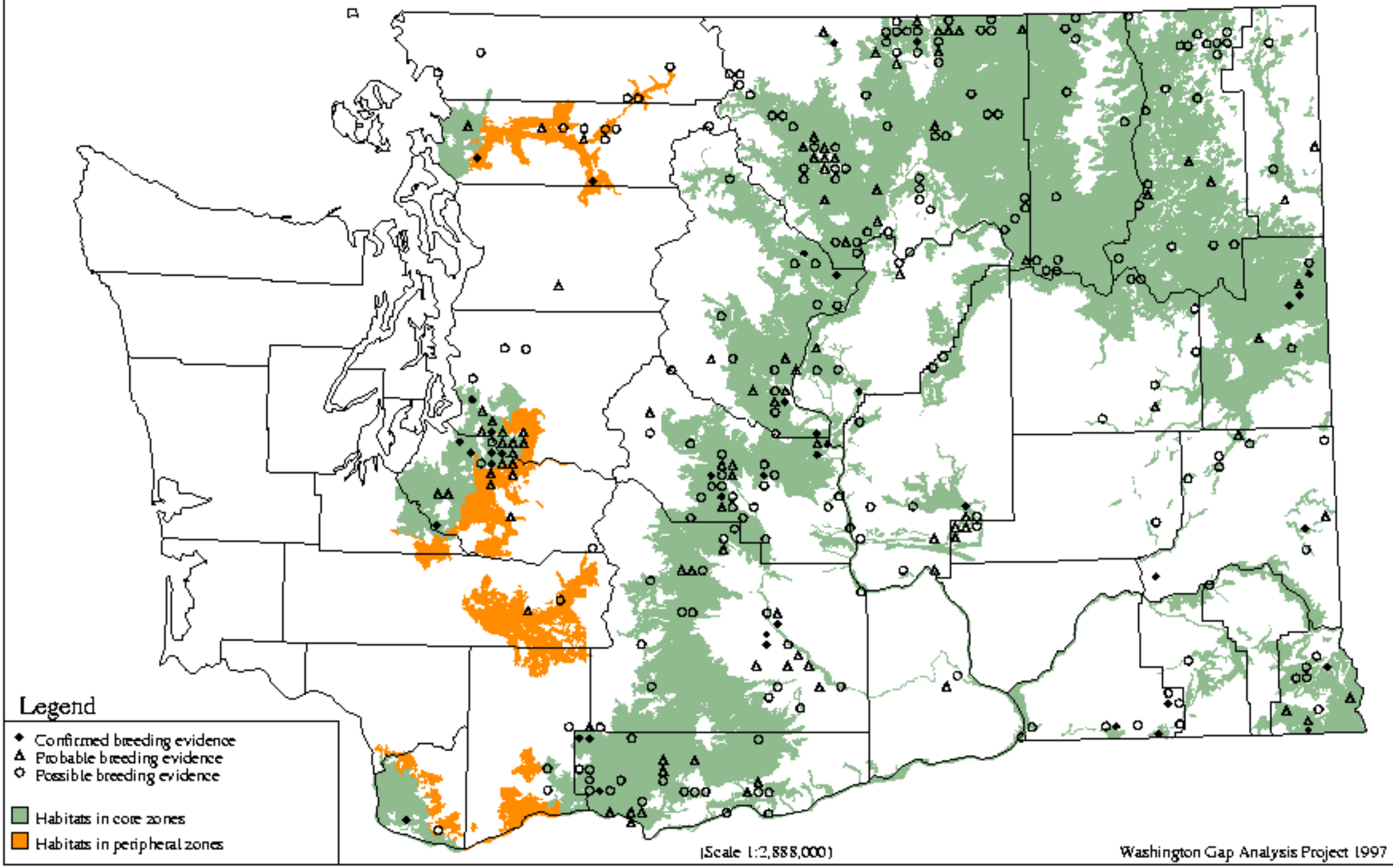
Western Tanager - *Piranga ludoviciana*



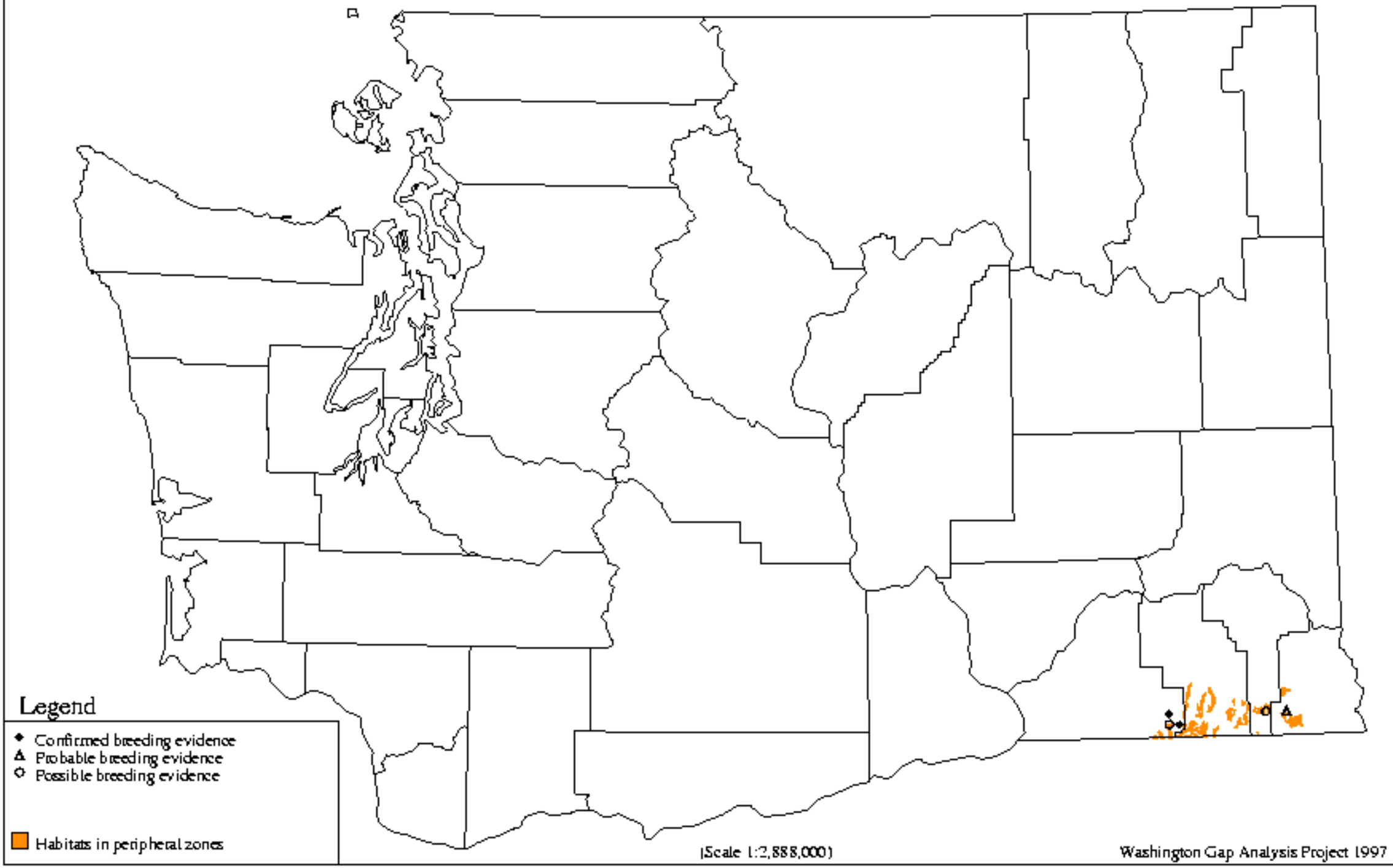
Black-headed Grosbeak - *Pheucticus melanocephalus*



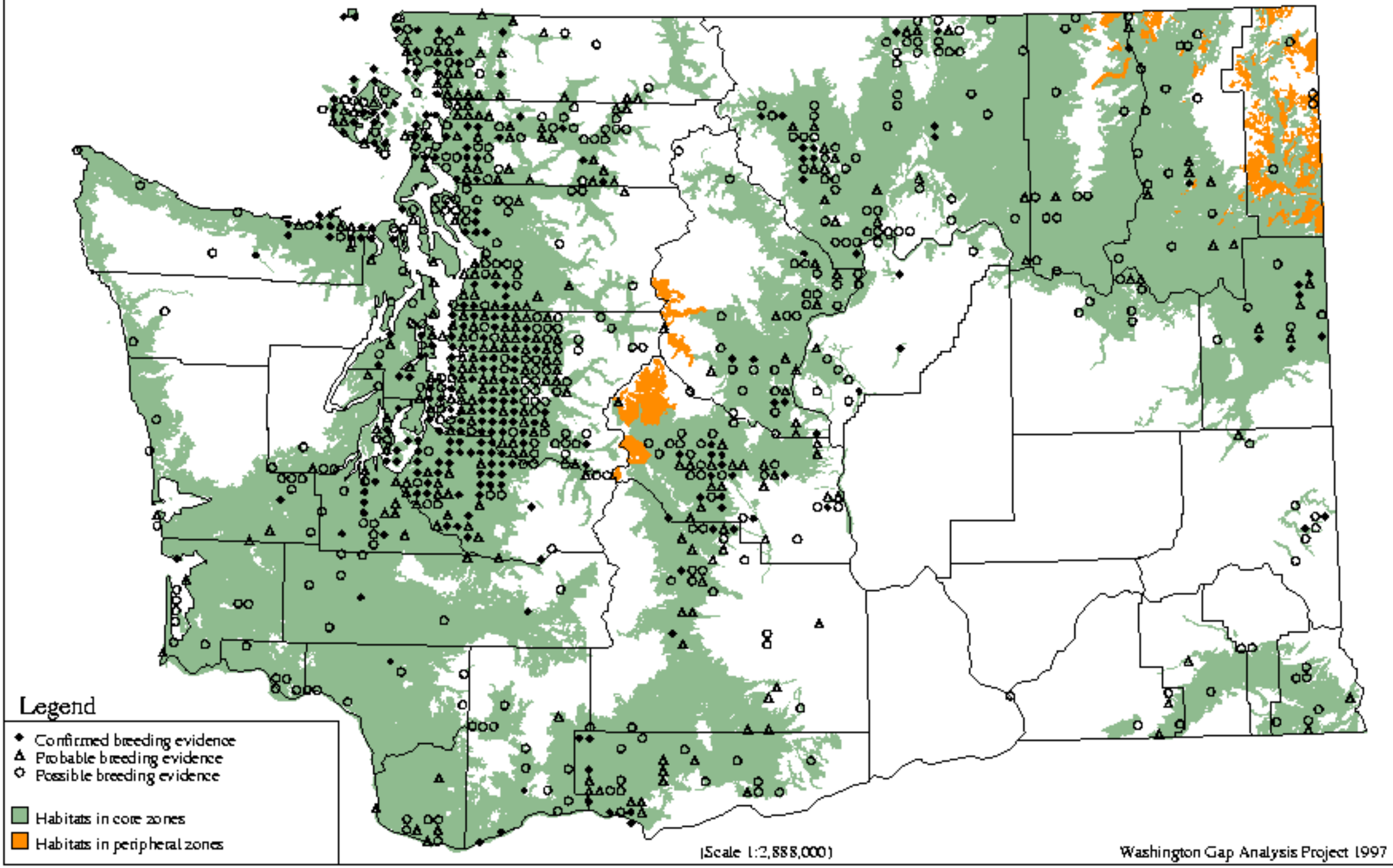
Lazuli Bunting - *Passerina amoena*



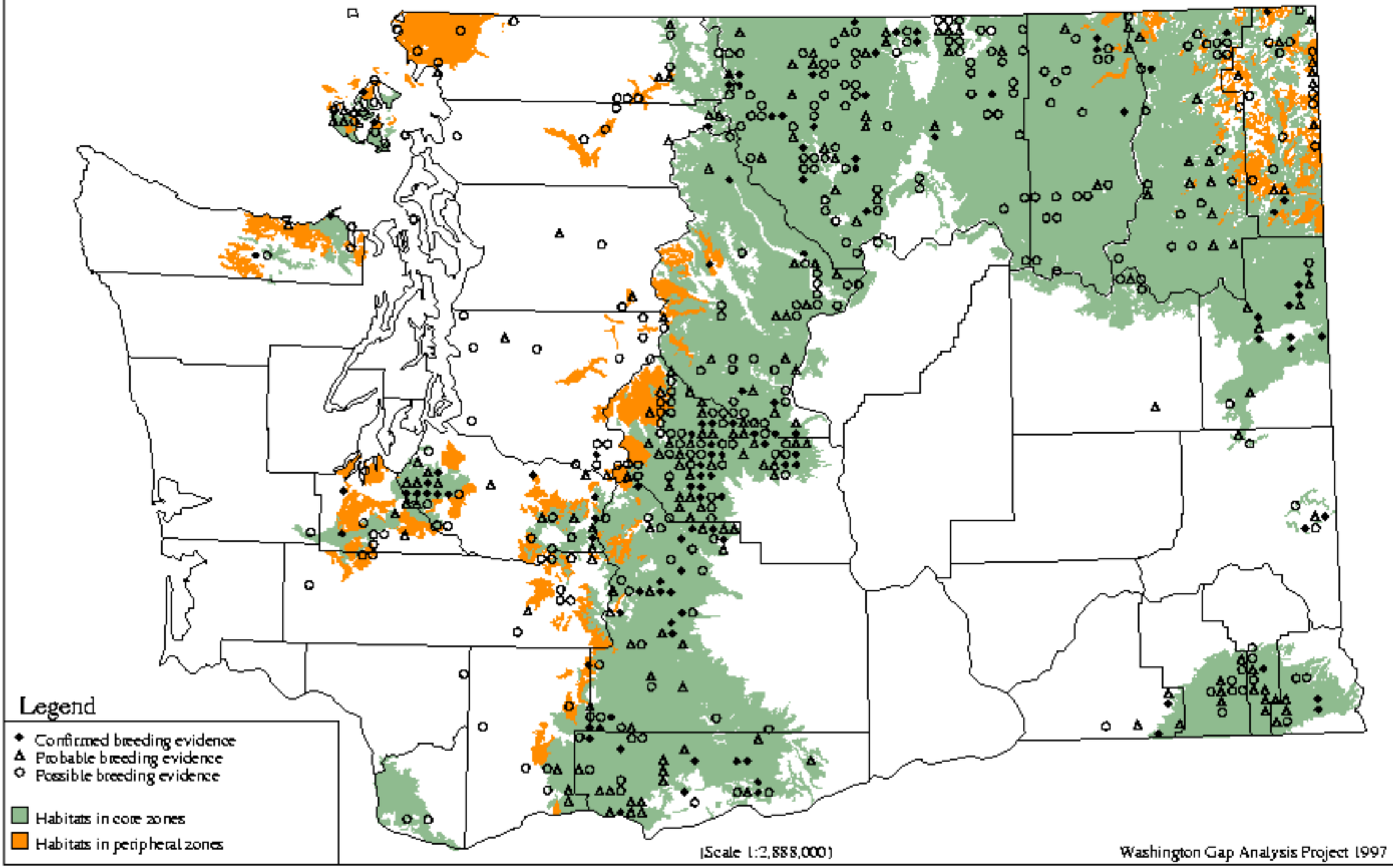
Green-tailed Towhee - *Pipilo chlorurus*



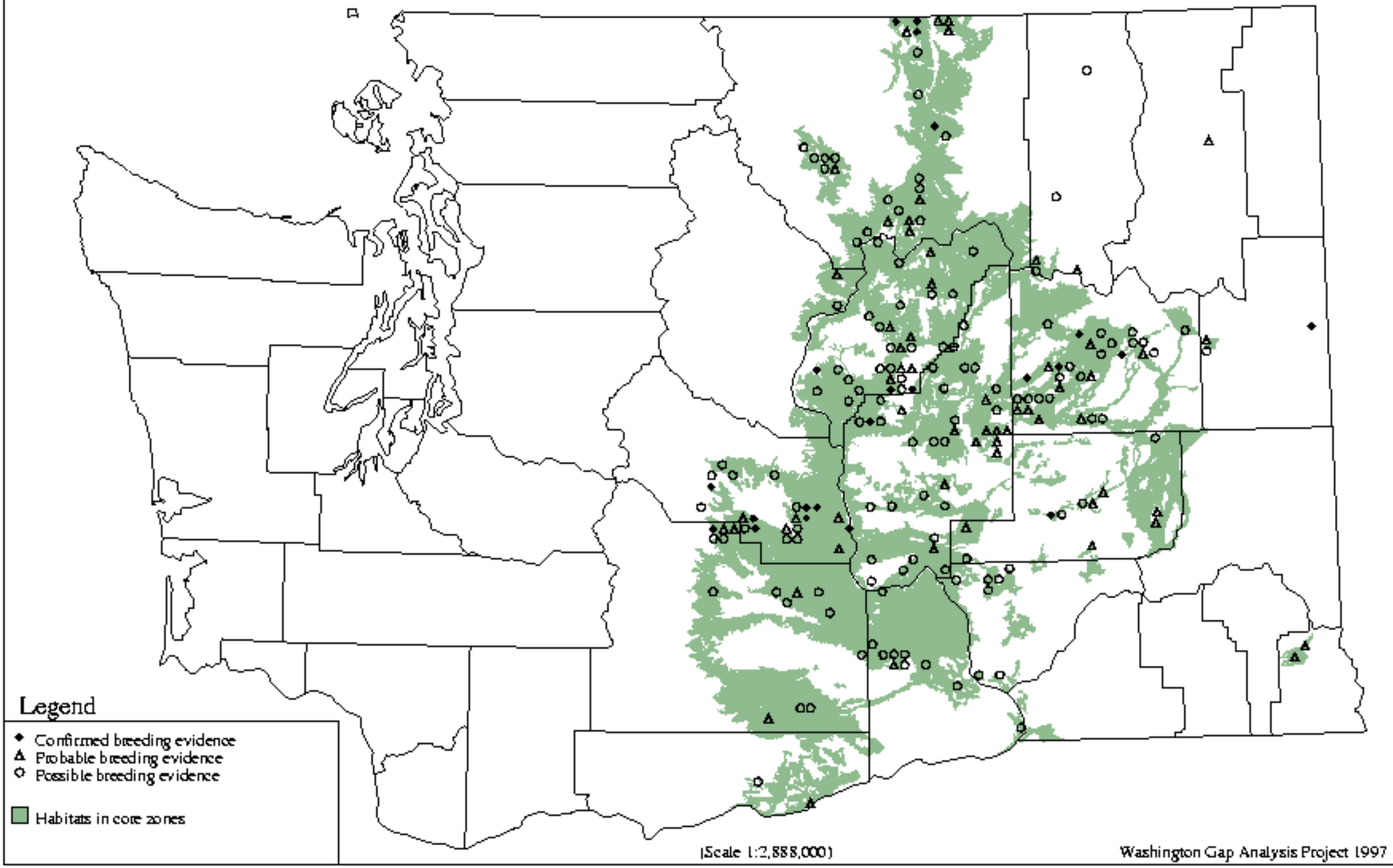
Spotted Towhee - *Pipilo maculatus*



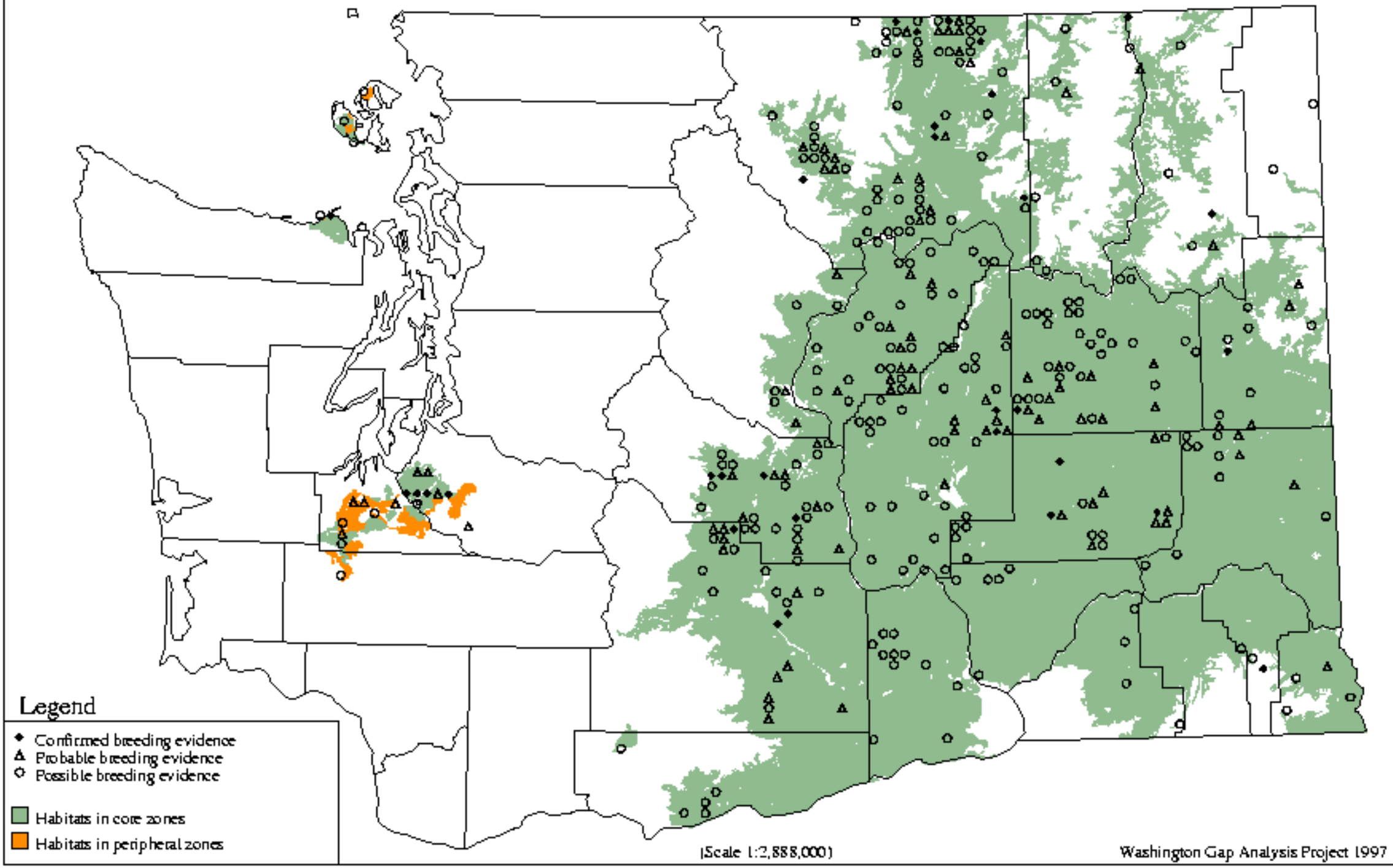
Chipping Sparrow - *Spizella passerina*



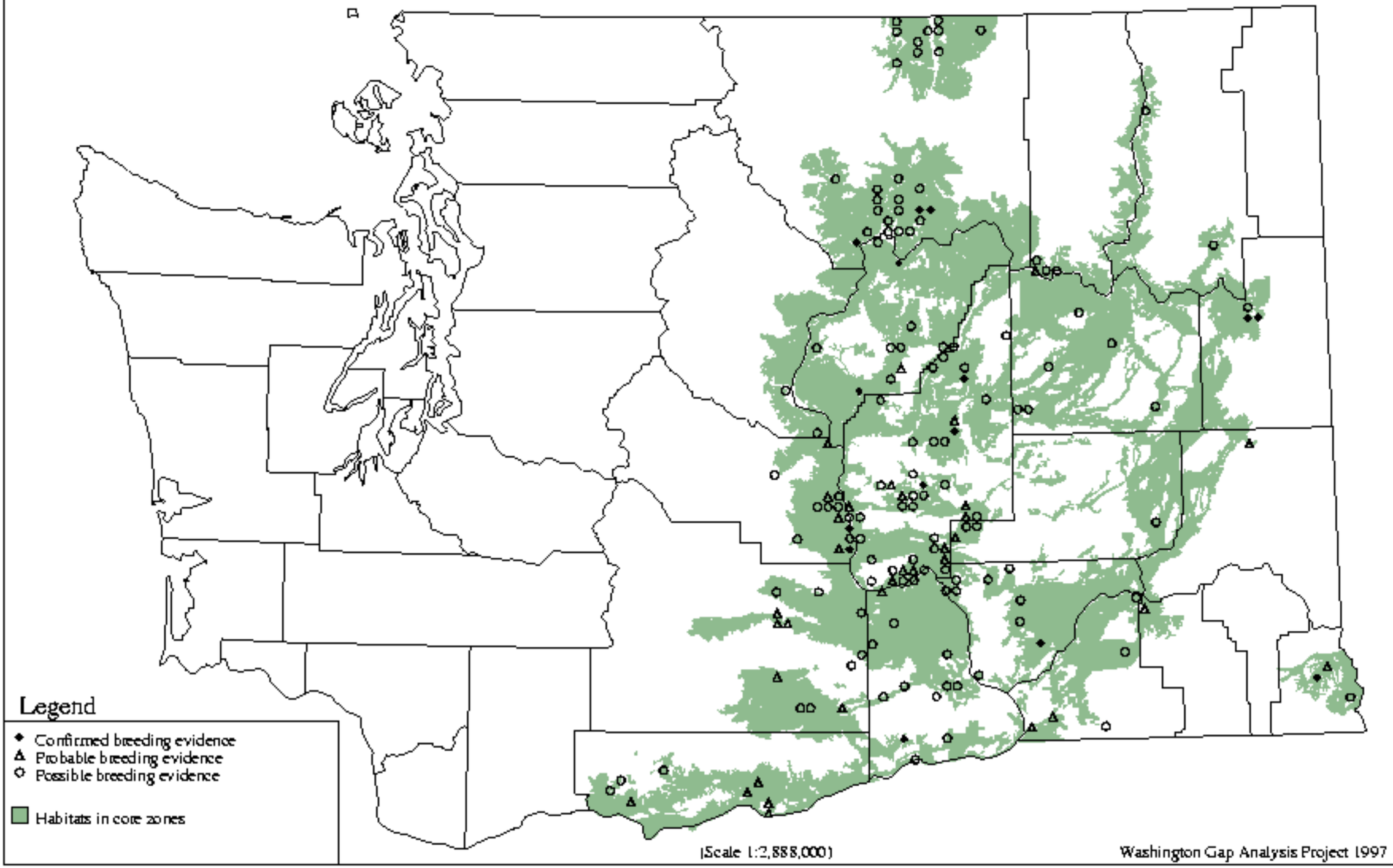
Brewer`s Sparrow - *Spizella breweri*



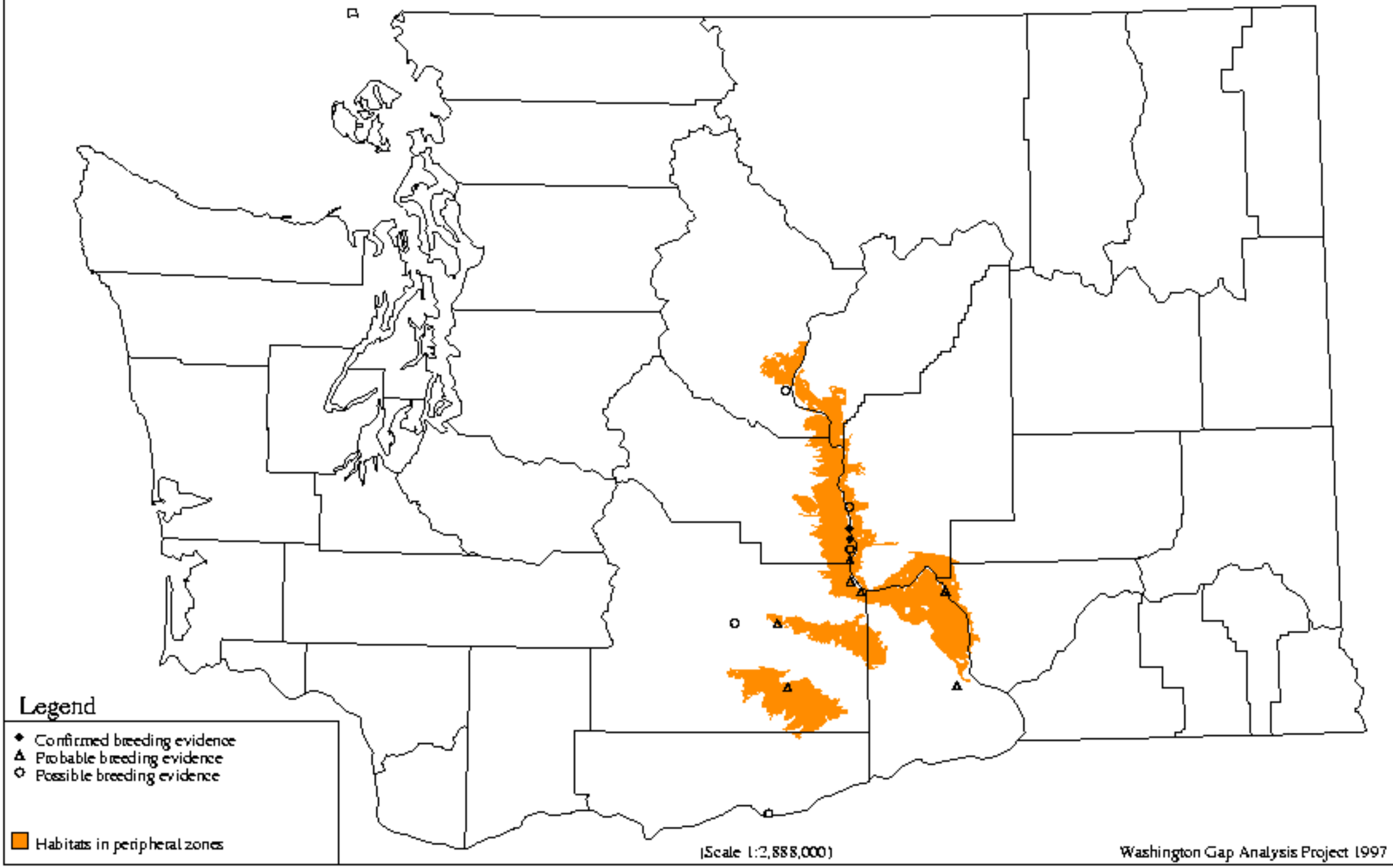
Vesper Sparrow - *Pooecetes gramineus*



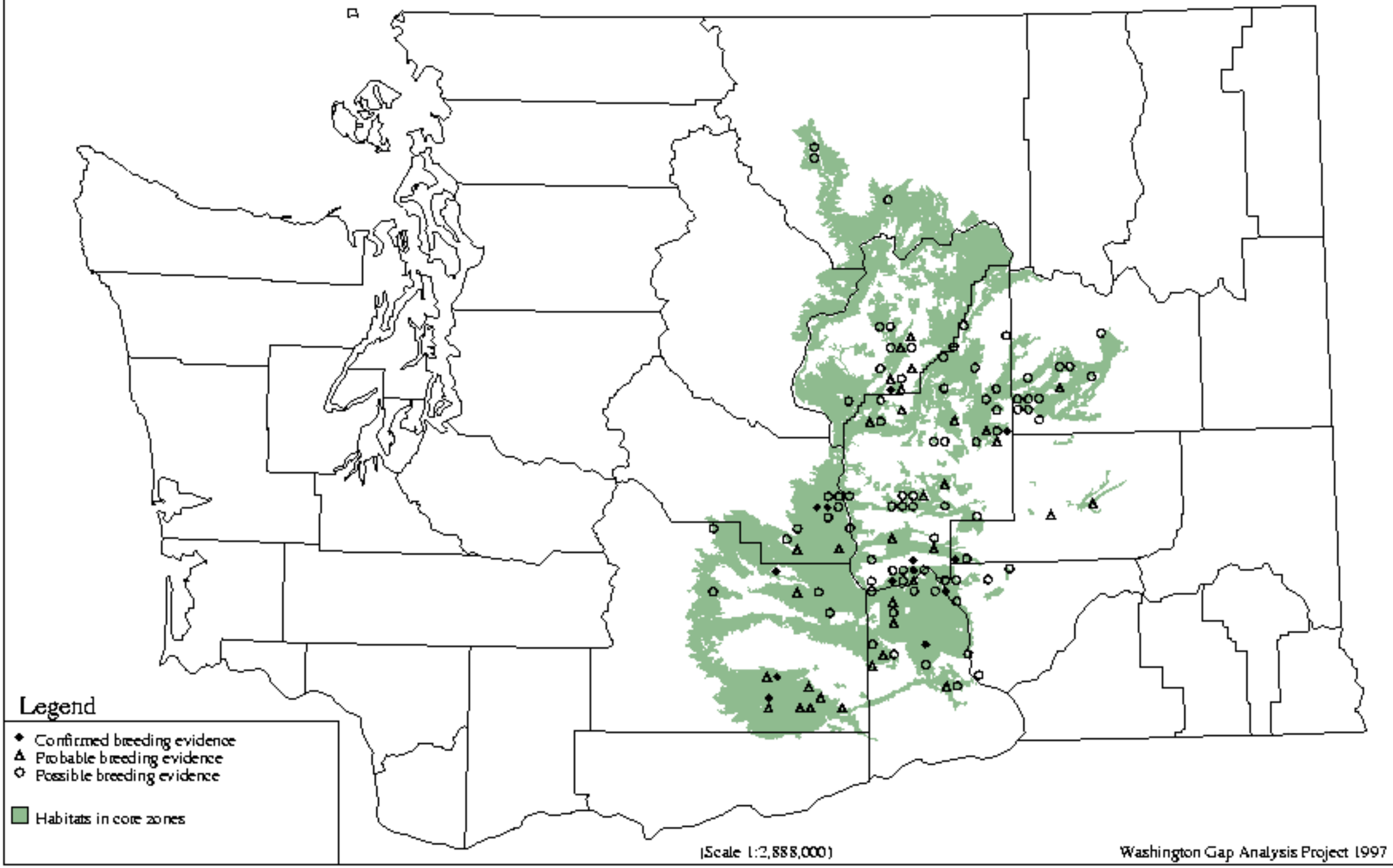
Lark Sparrow - *Chondestes grammacus*



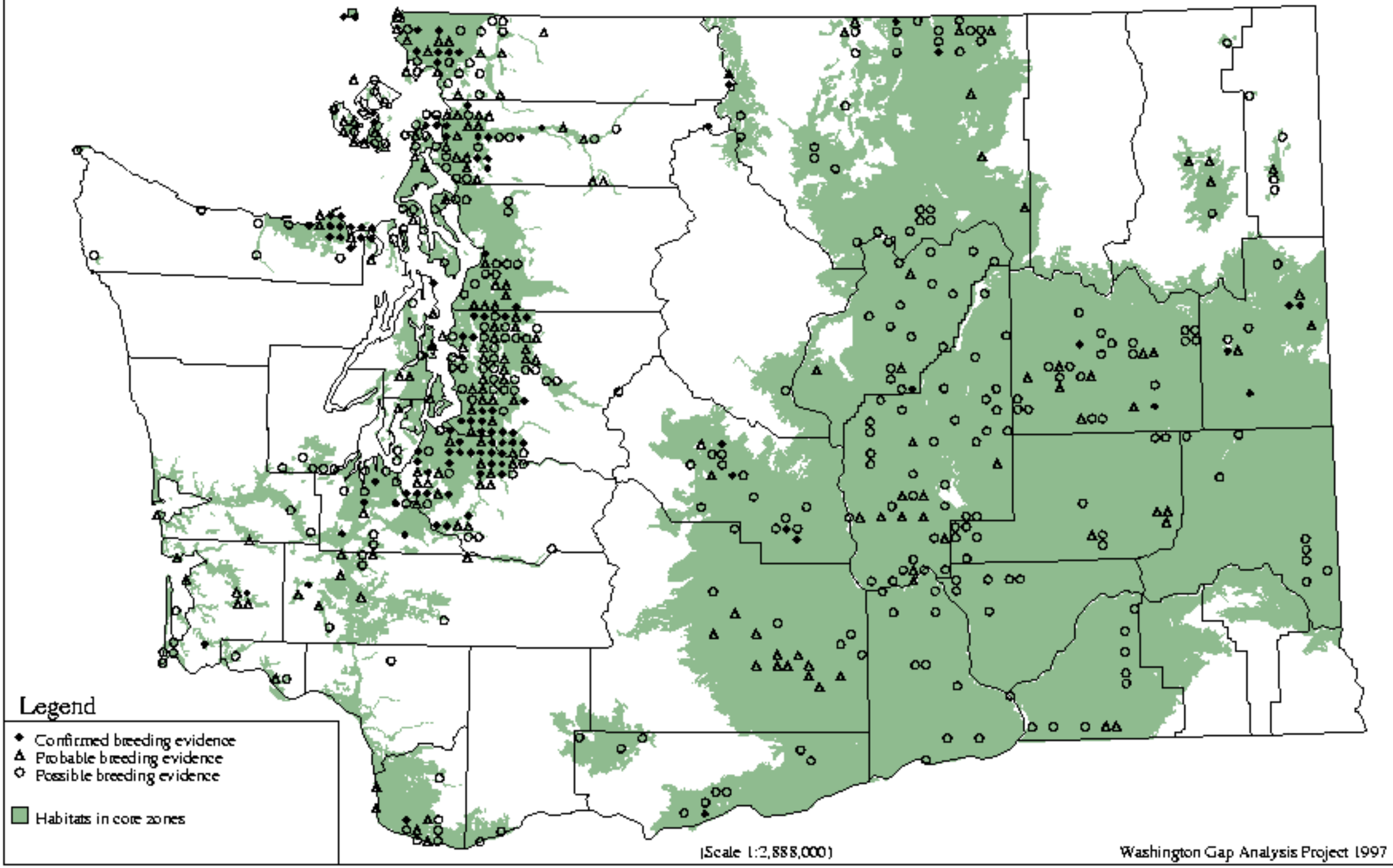
Black-throated Sparrow - *Amphispiza bilineata*



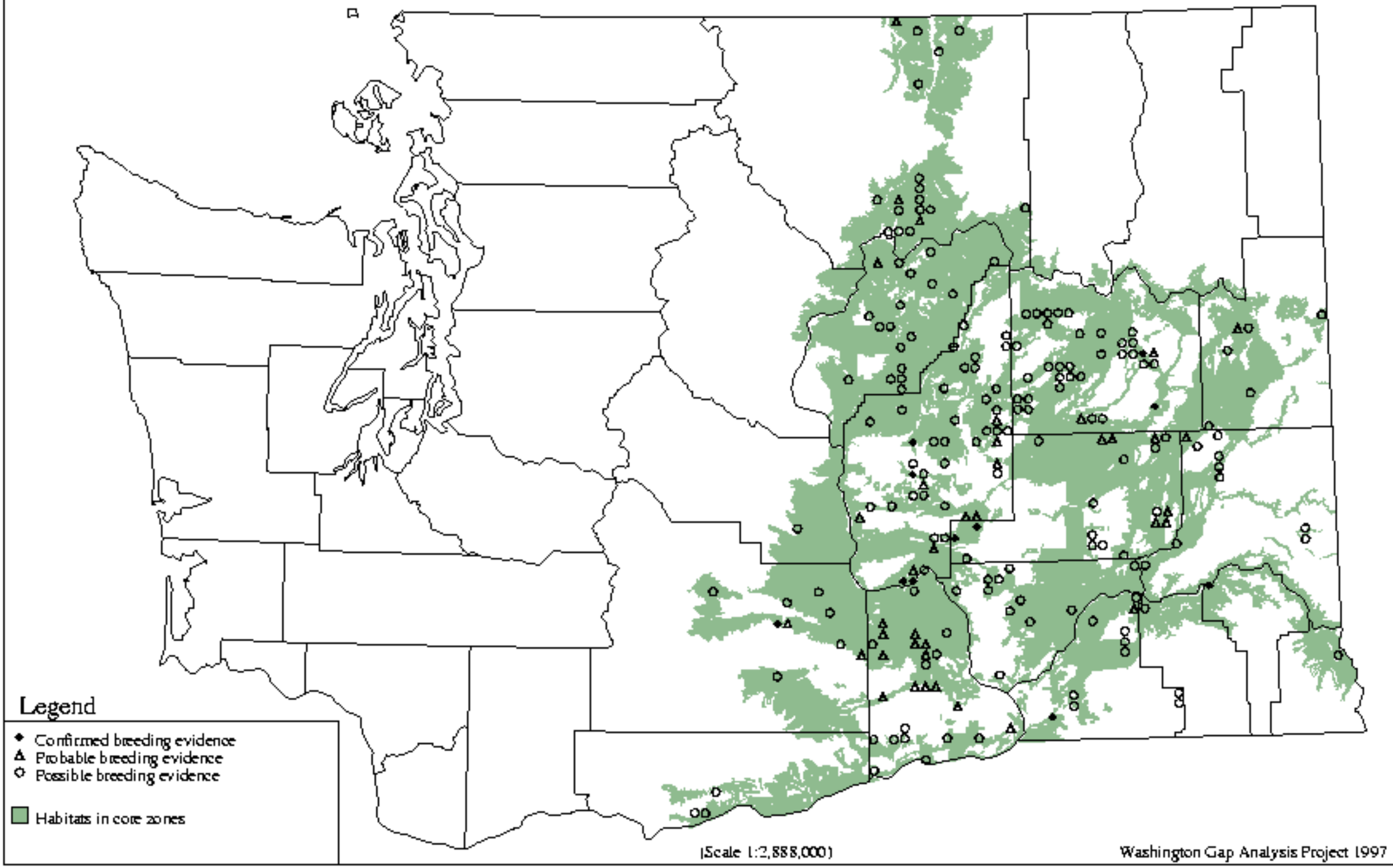
Sage Sparrow - *Amphispiza belli*



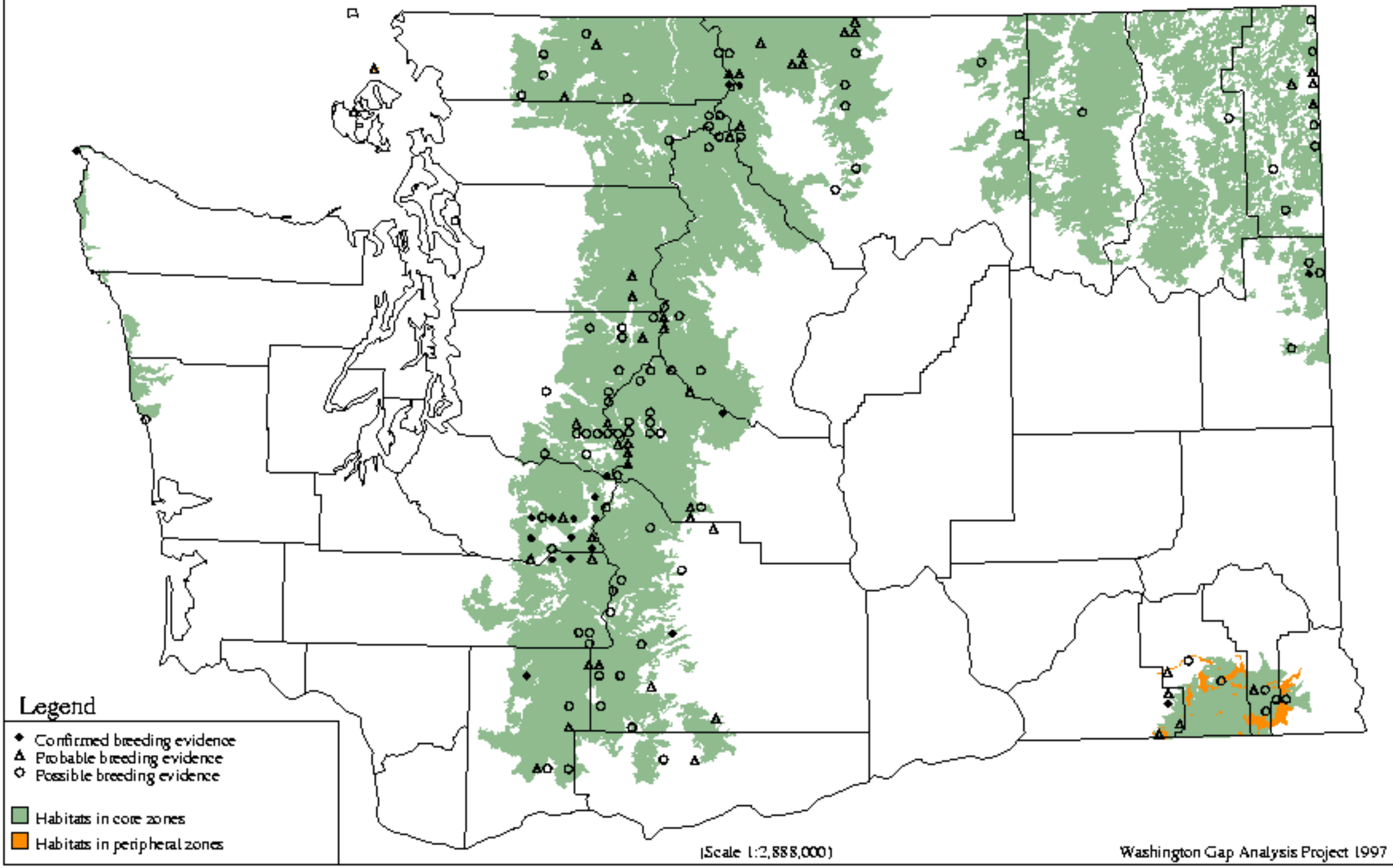
Savannah Sparrow - *Passerculus sandwichensis*



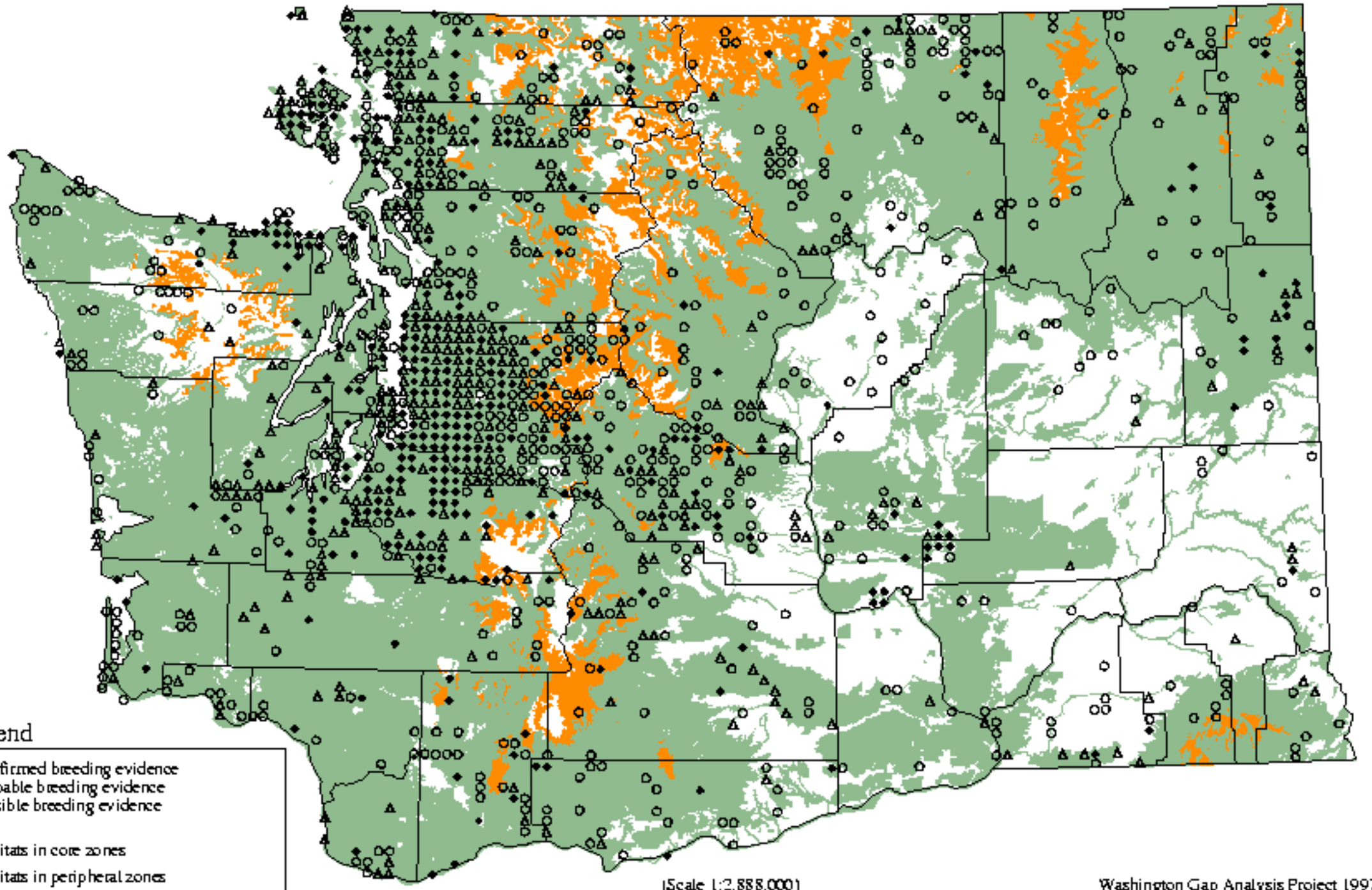
Grasshopper Sparrow - *Ammodramus savannarum*



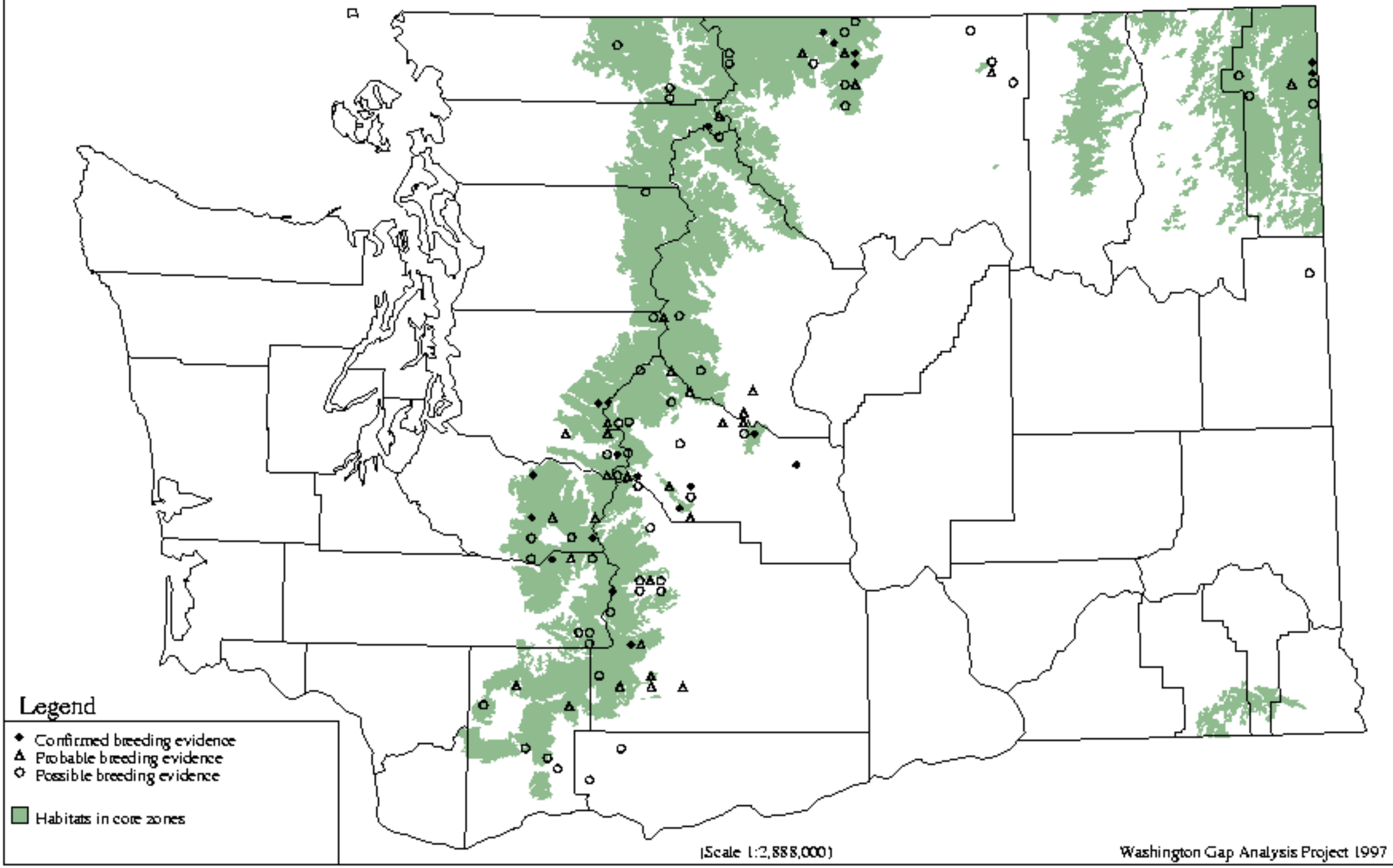
Fox Sparrow - *Passerella iliaca*



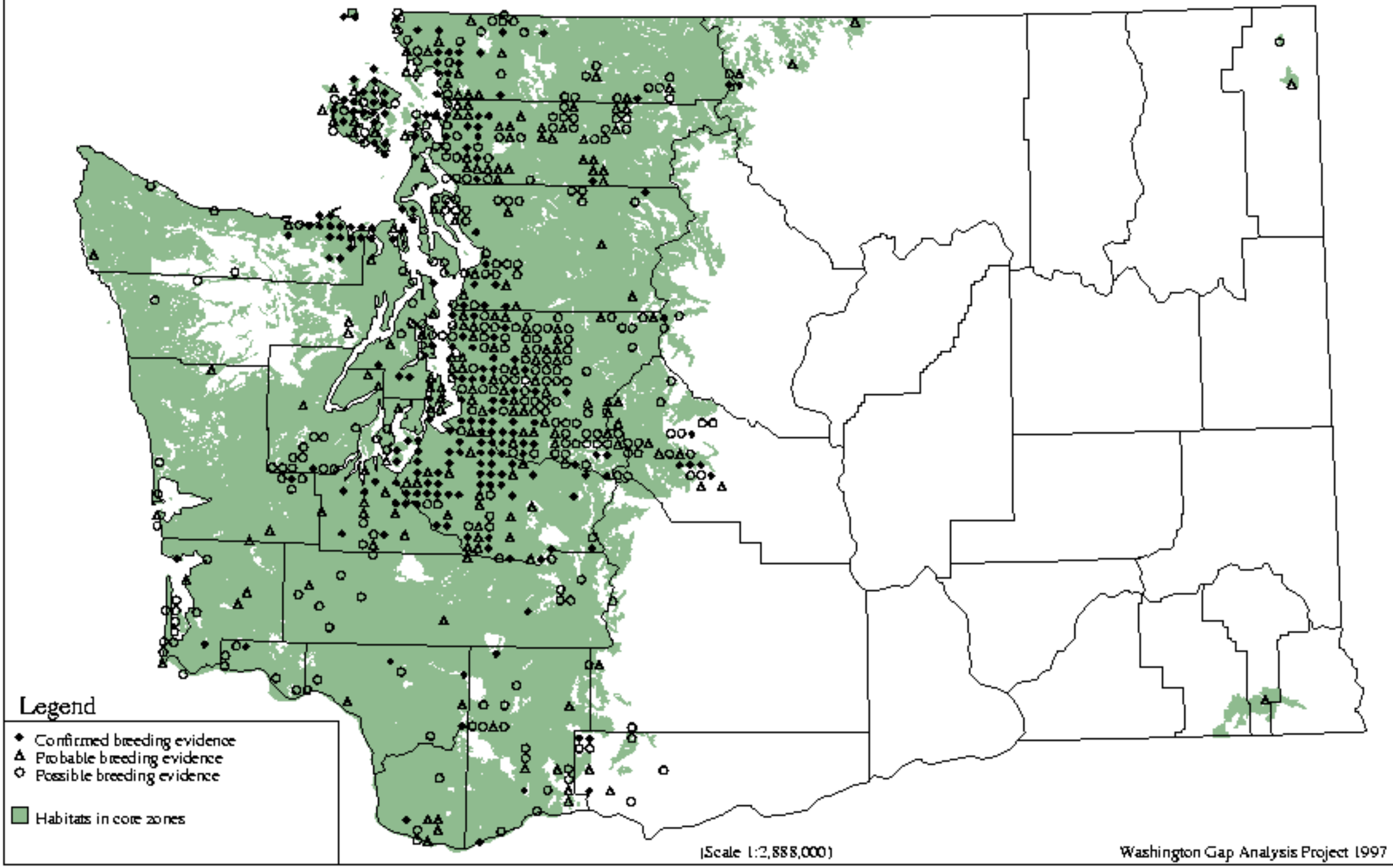
Song Sparrow - *Melospiza melodia*



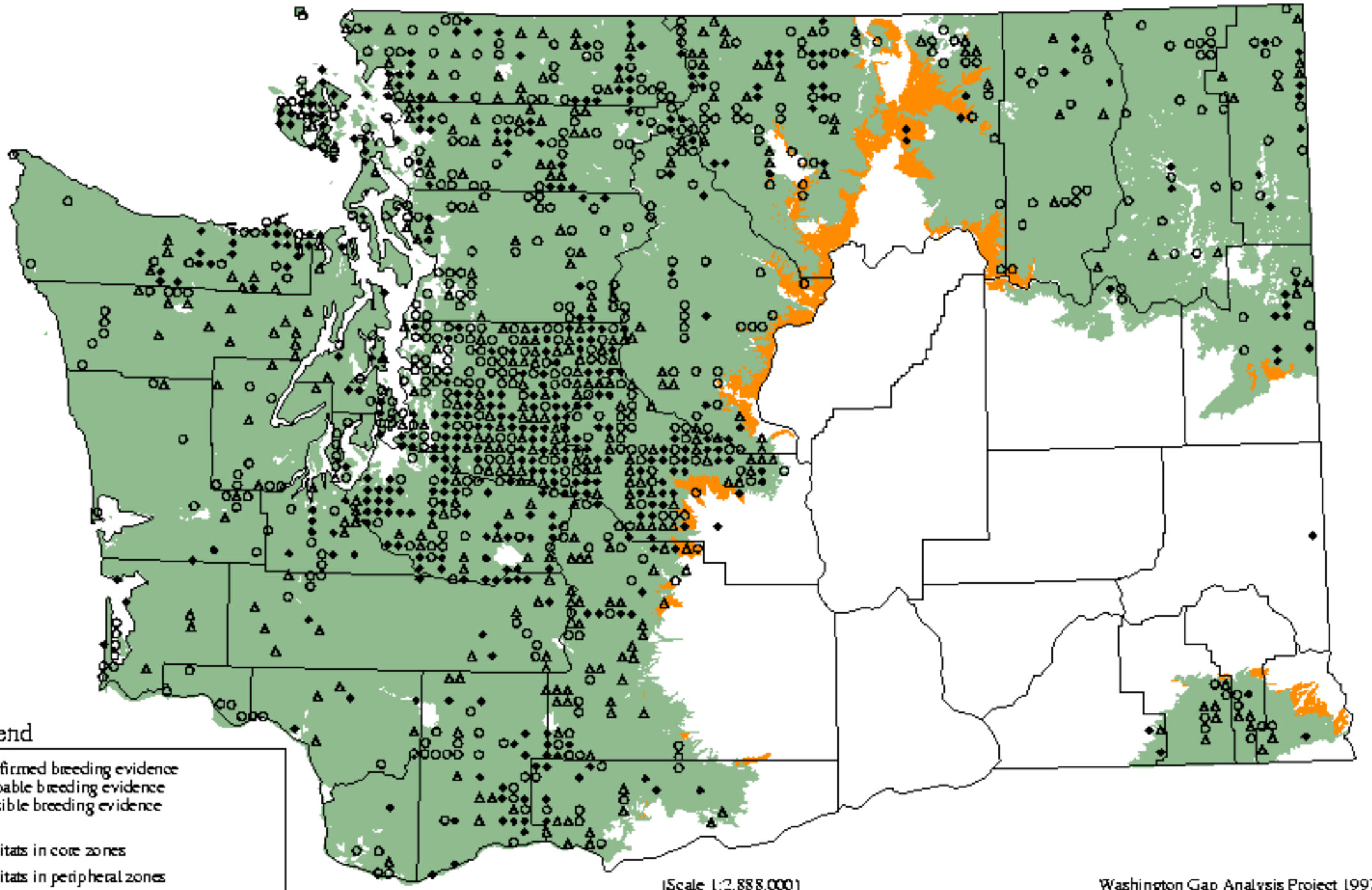
Lincoln`s Sparrow - *Melospiza lincolnii*



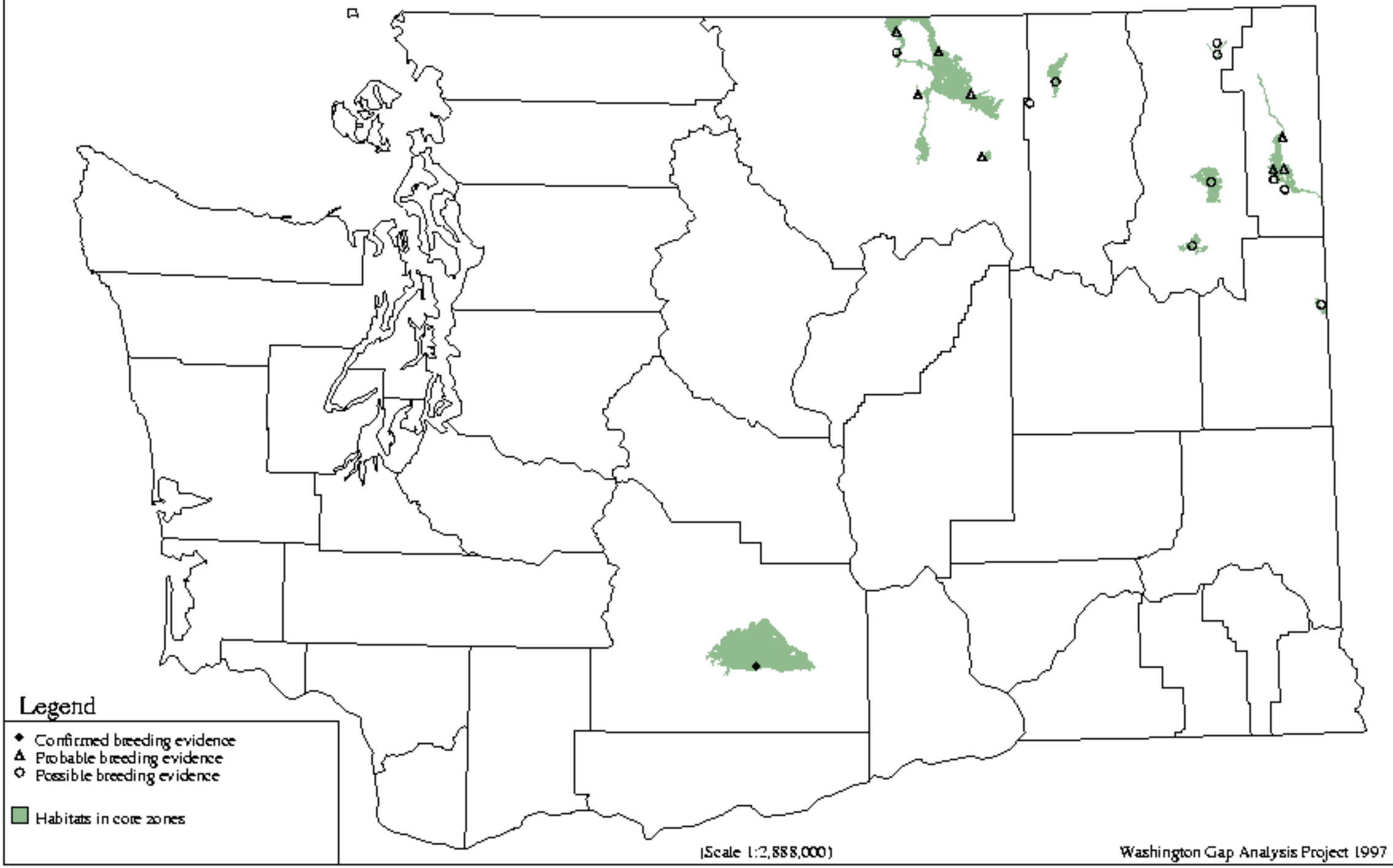
White-crowned Sparrow - *Zonotrichia leucophrys*



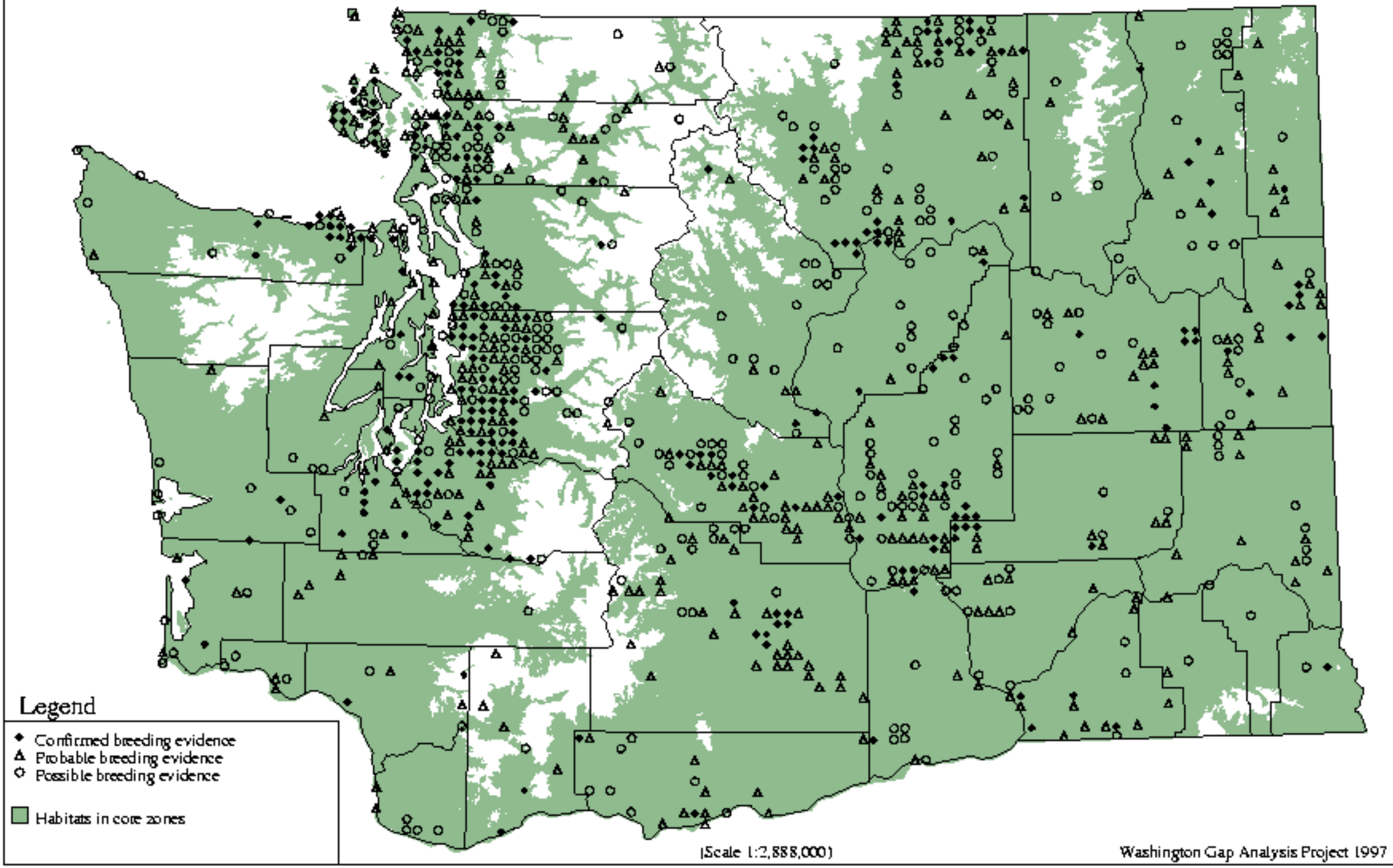
Dark-eyed Junco - *Junco hyemalis*



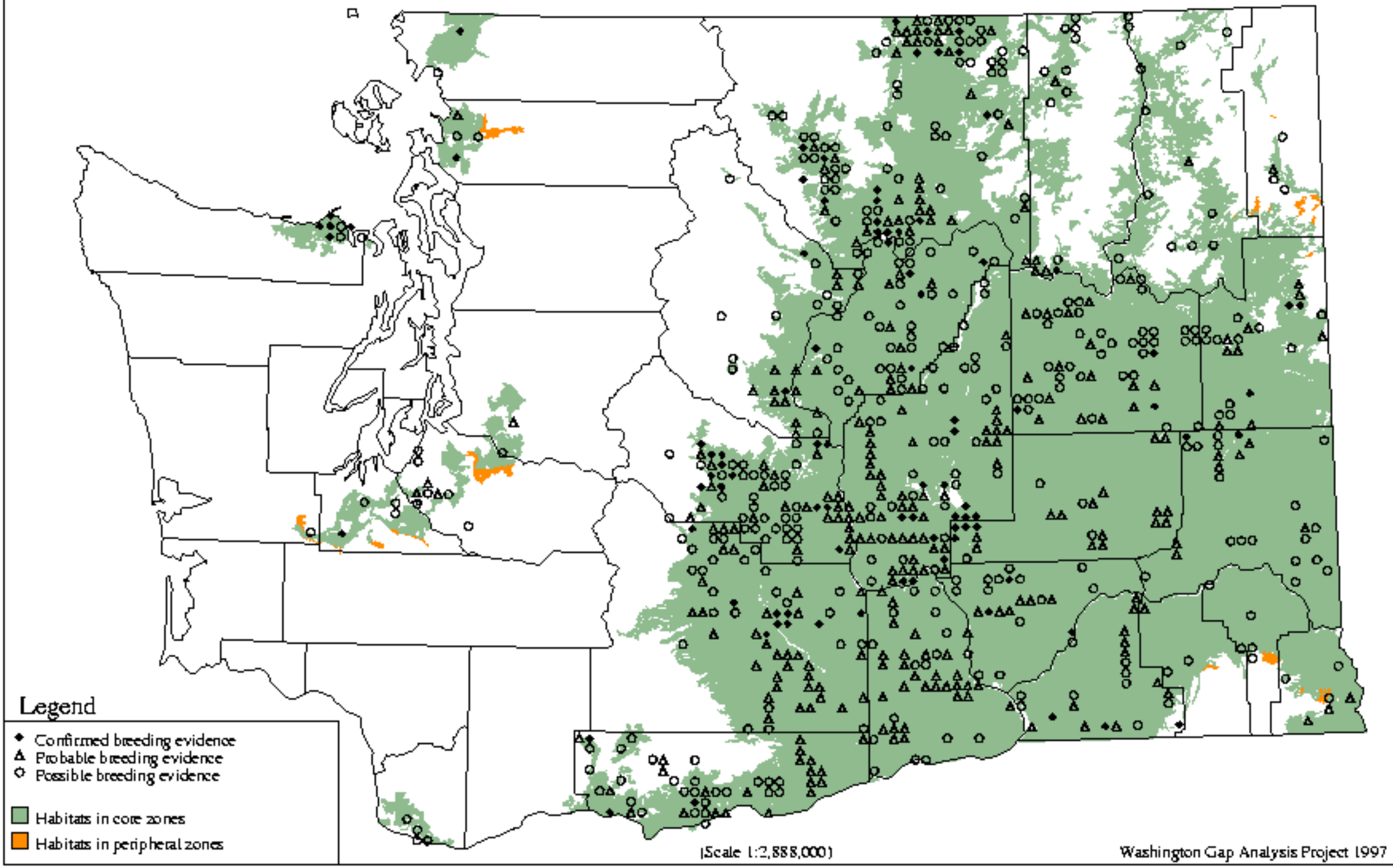
Bobolink - *Dolichonyx oryzivorus*



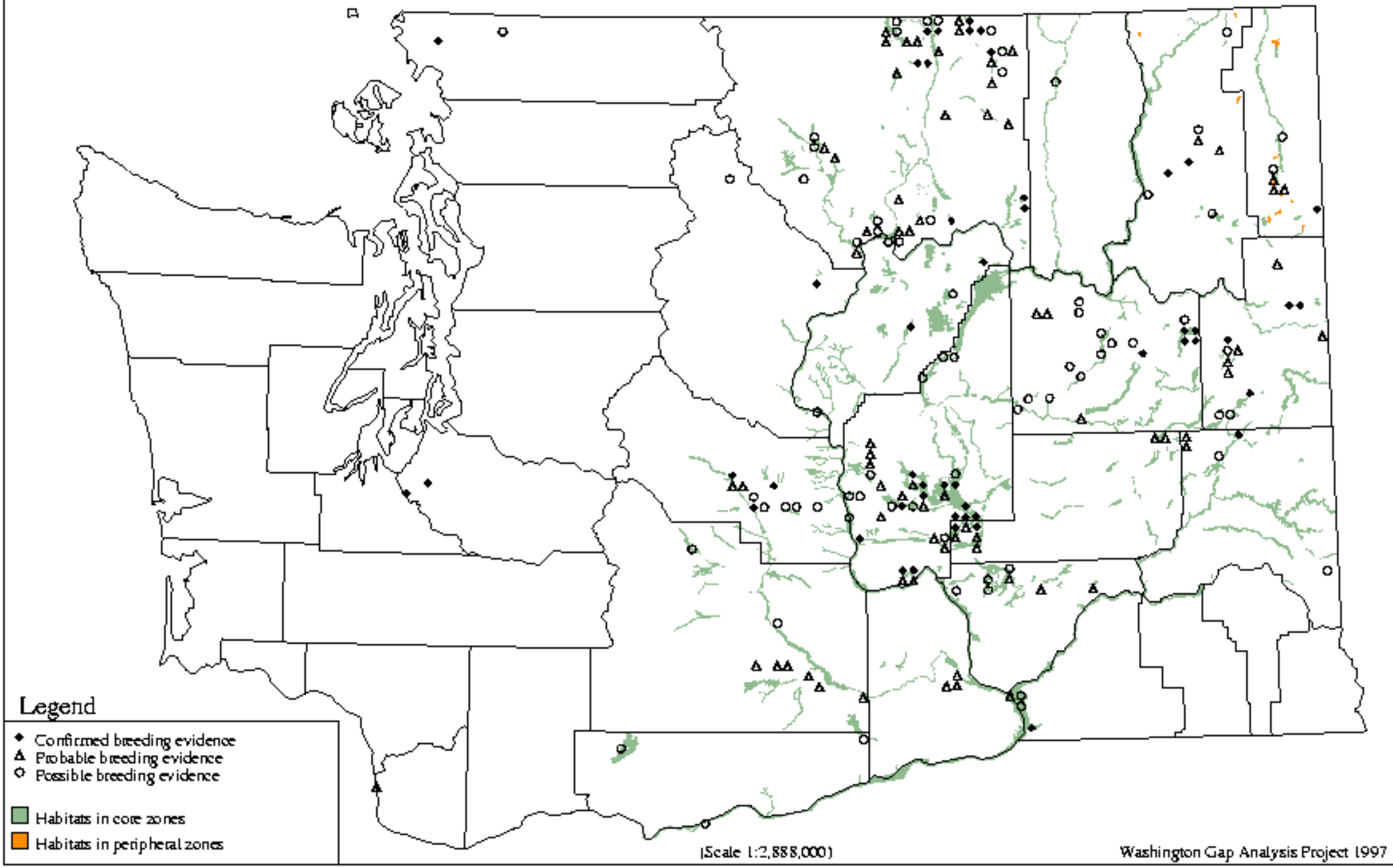
Red-winged Blackbird - *Agelaius phoeniceus*



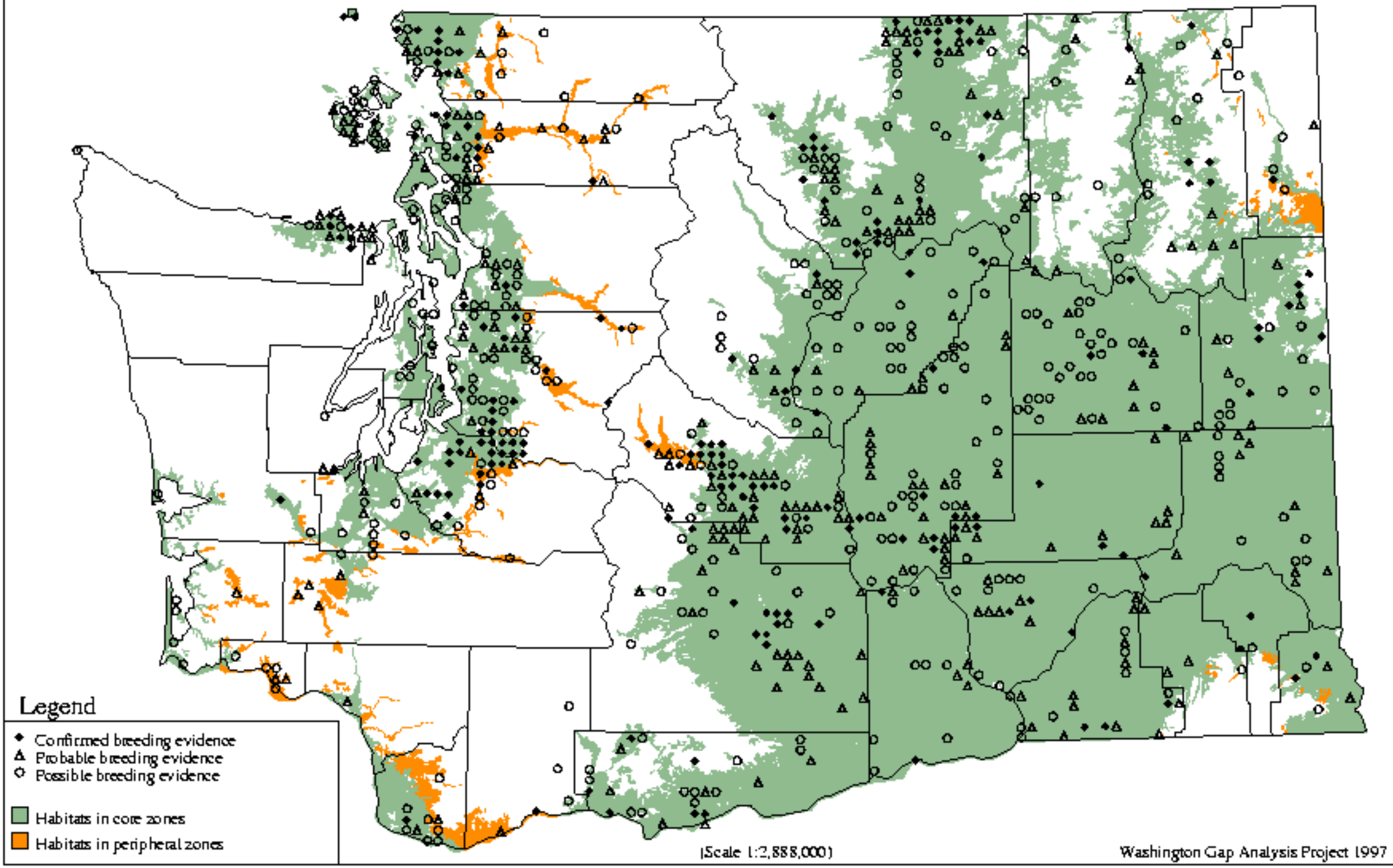
Western Meadowlark - *Sturnella neglecta*



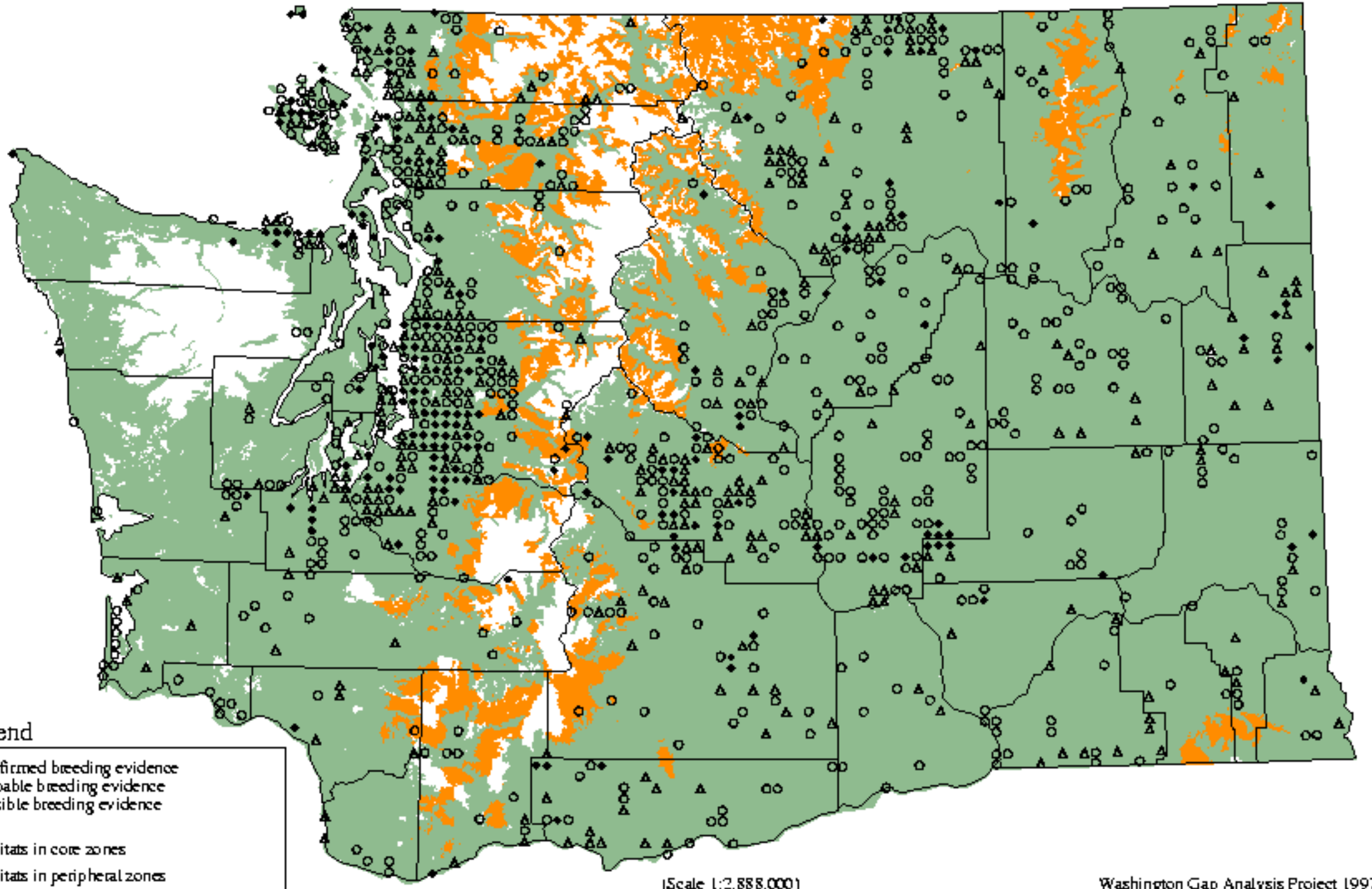
Yellow-headed Blackbird - *Xanthocephalus xanthocephalus*



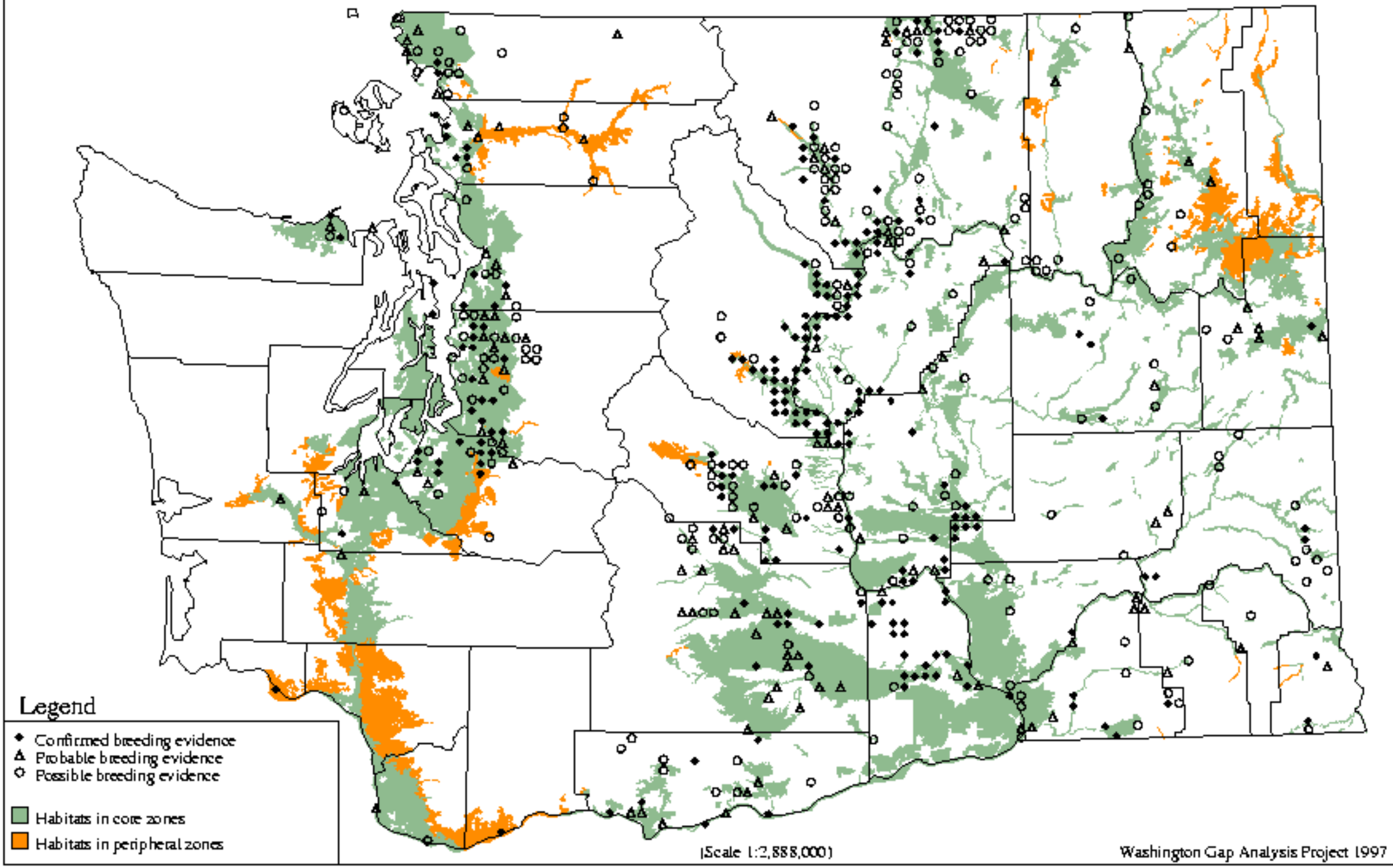
Brewer`s Blackbird - *Euphagus cyanocephalus*



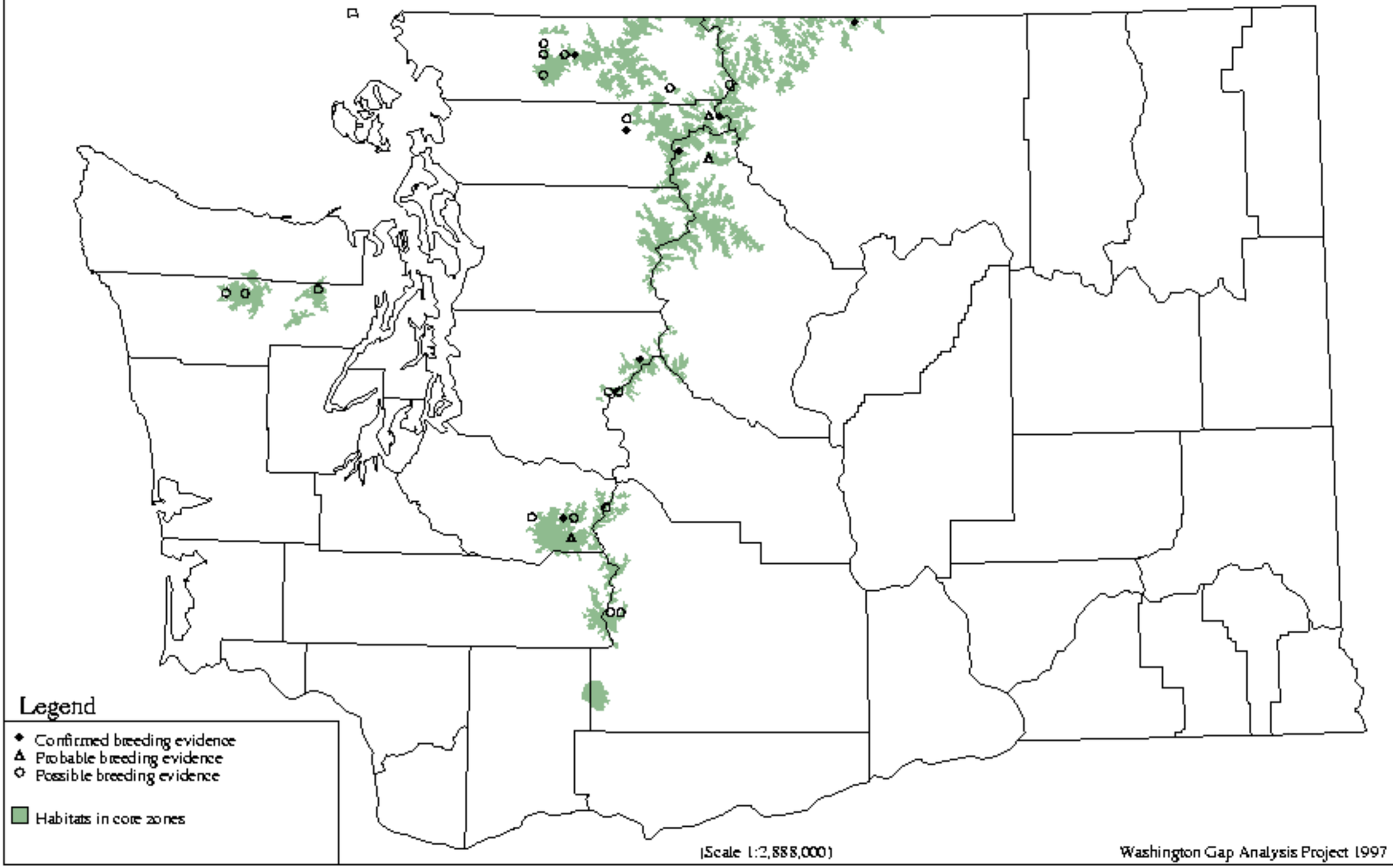
Brown-headed Cowbird - *Molothrus ater*



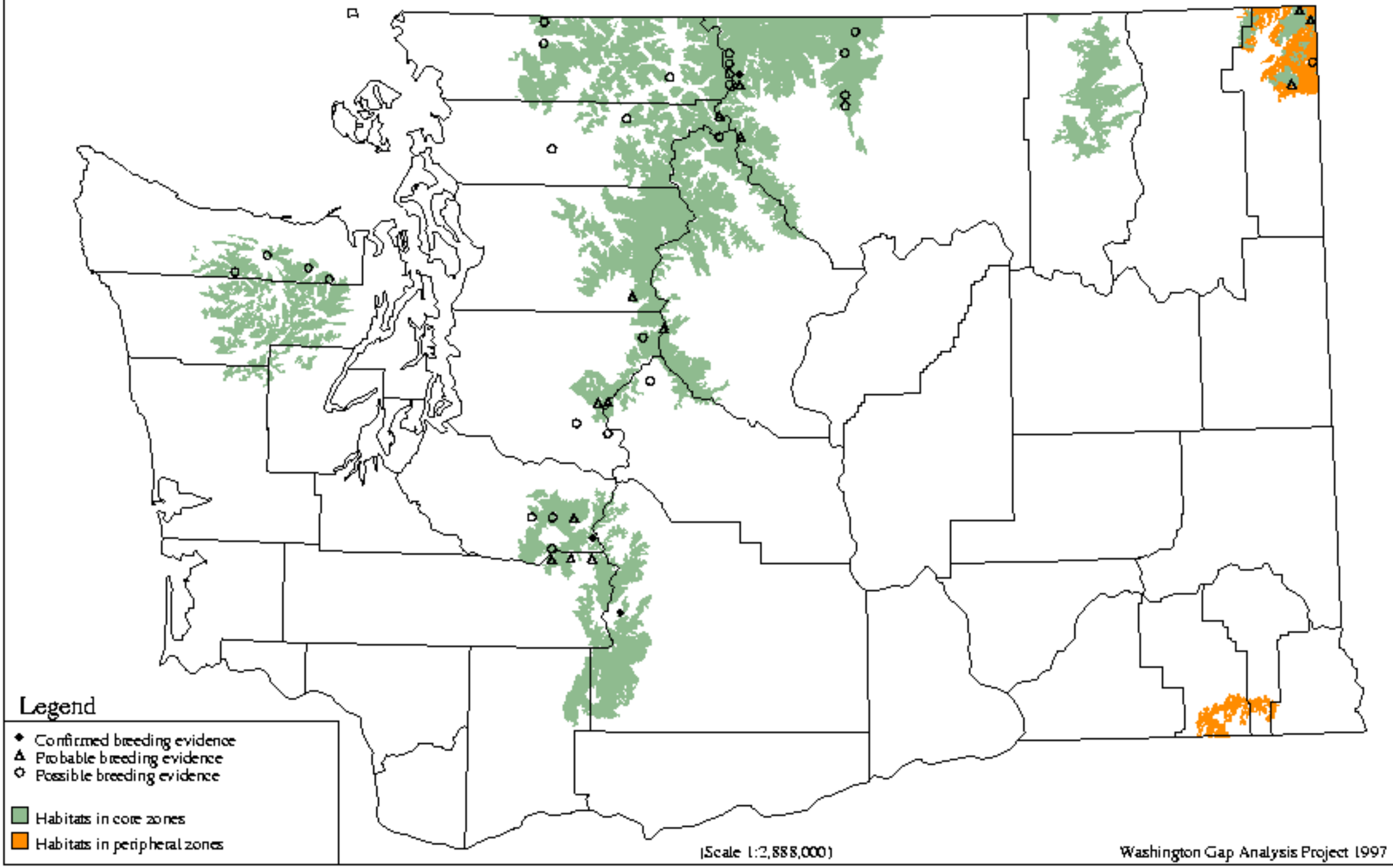
Bullock`s Oriole - *Icterus bullockii*



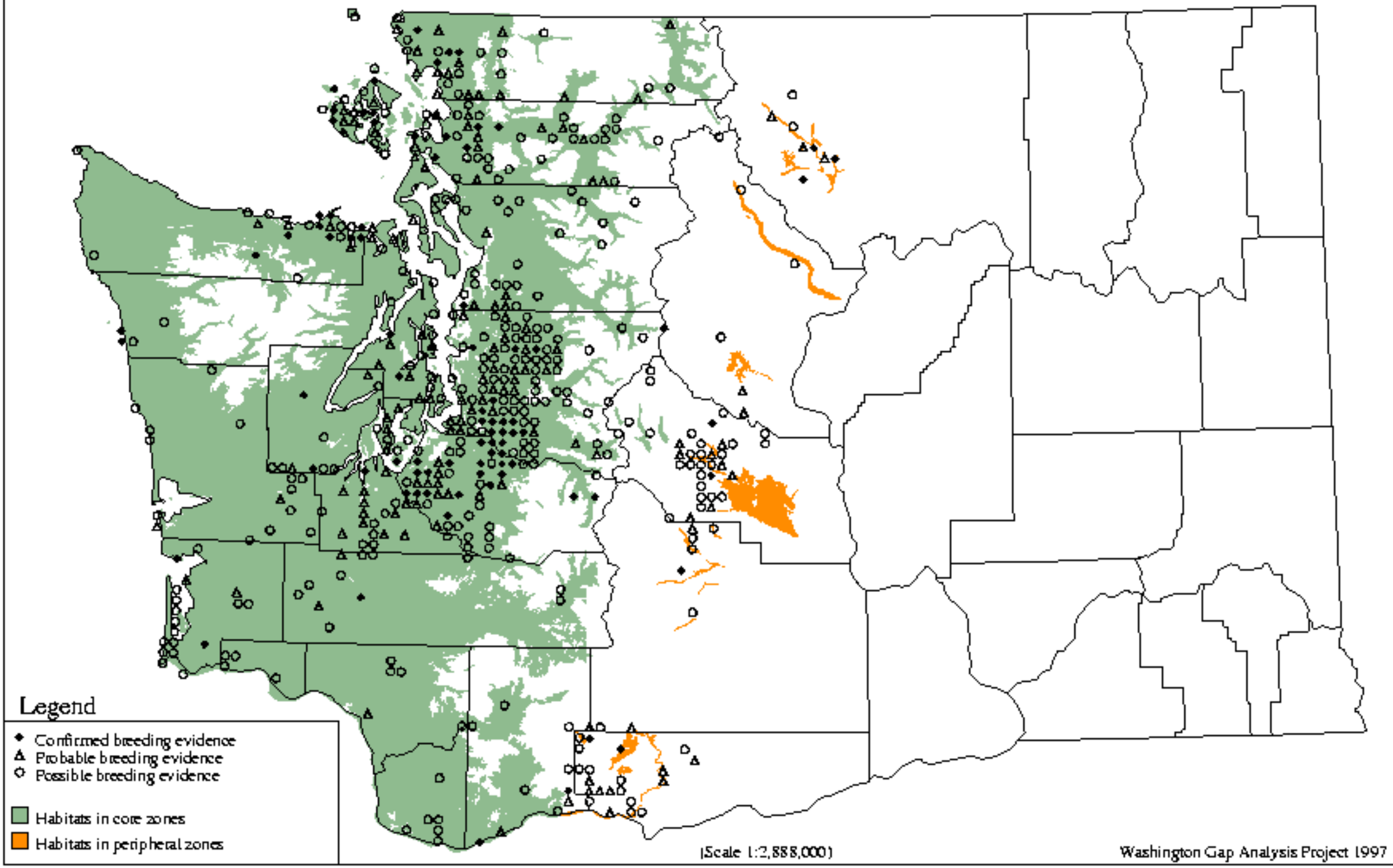
Gray-crowned Rosy-Finch - *Leucosticte tephrocotis*



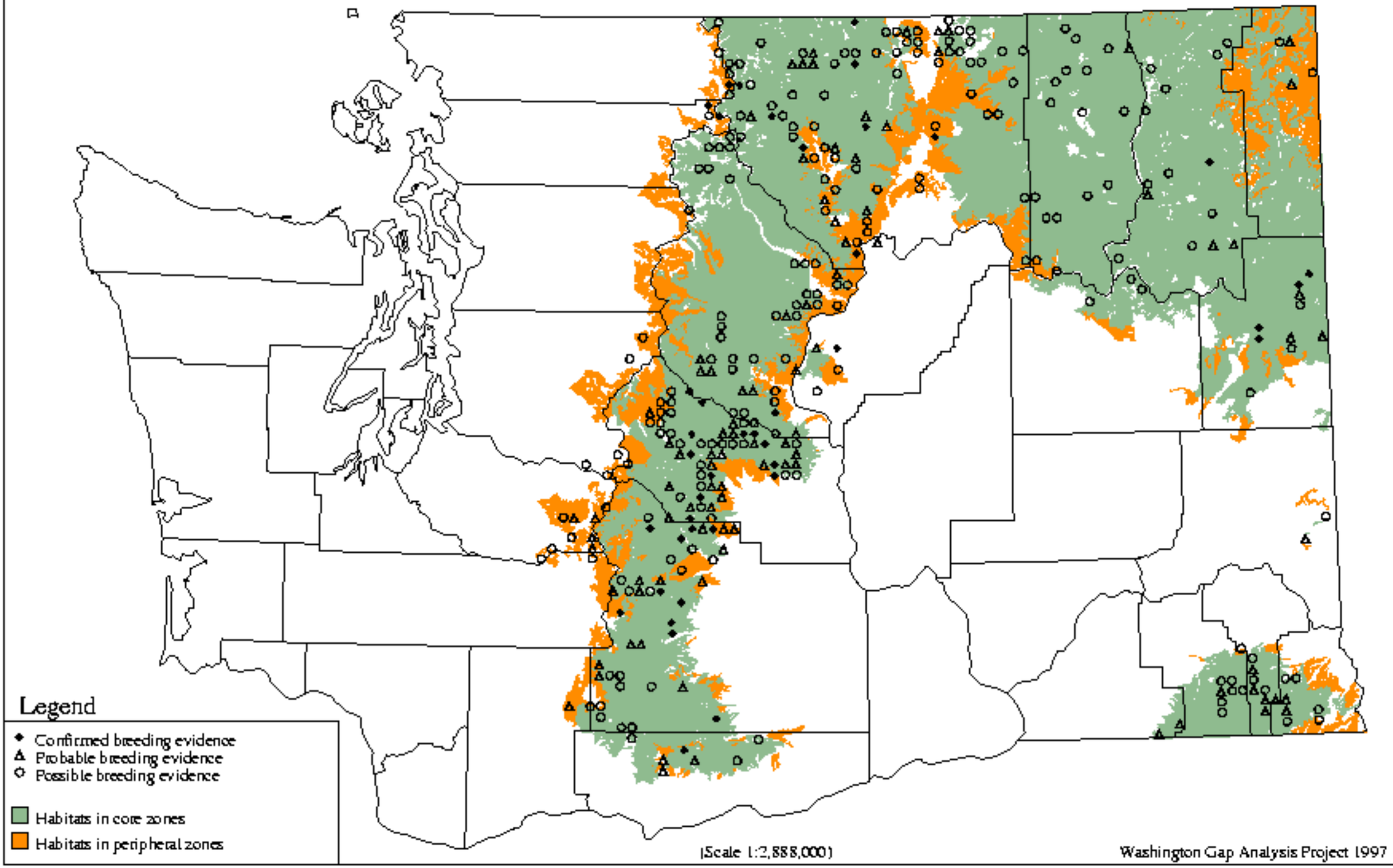
Pine Grosbeak - *Pinicola enucleator*



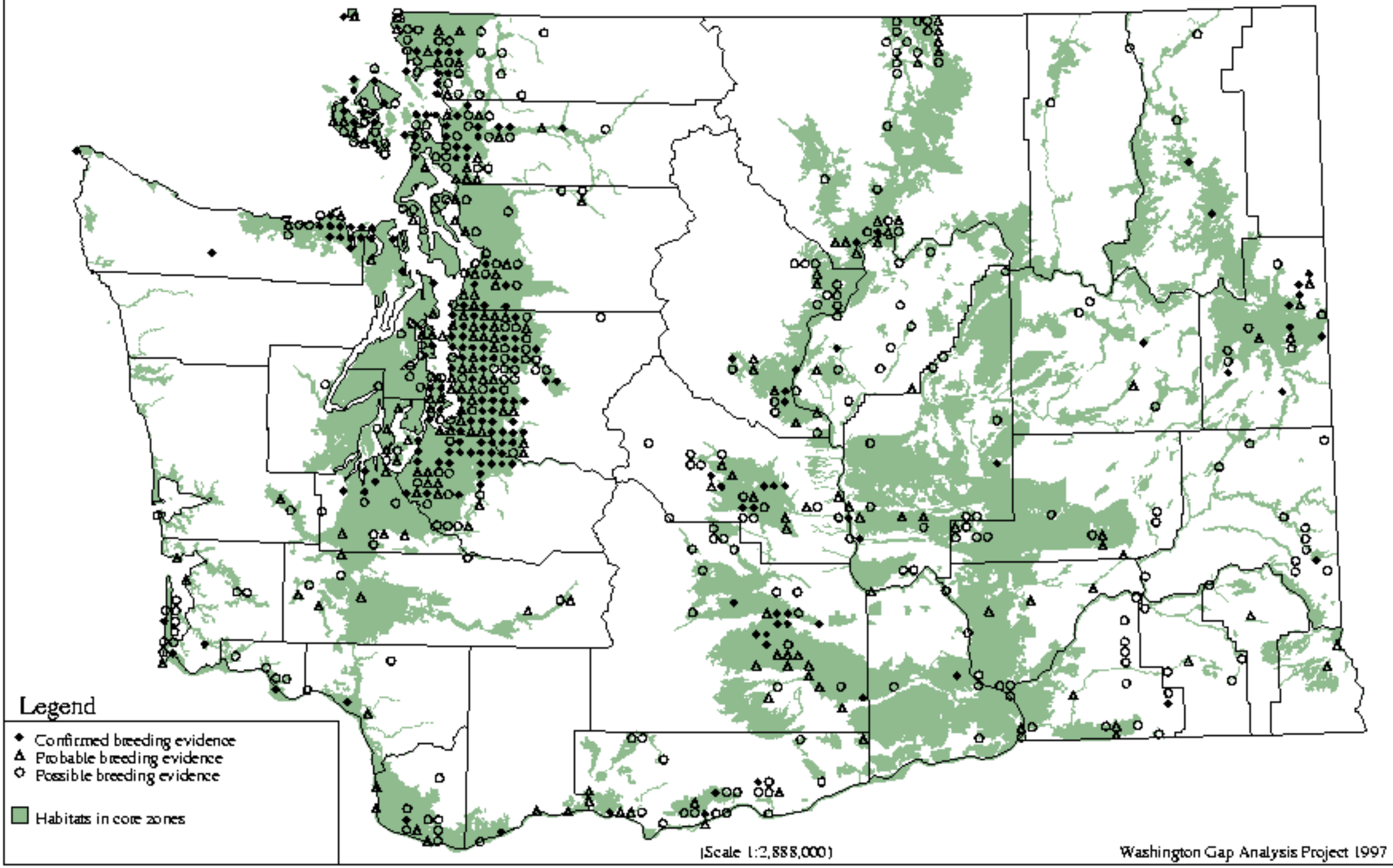
Purple Finch - *Carpodacus purpureus*



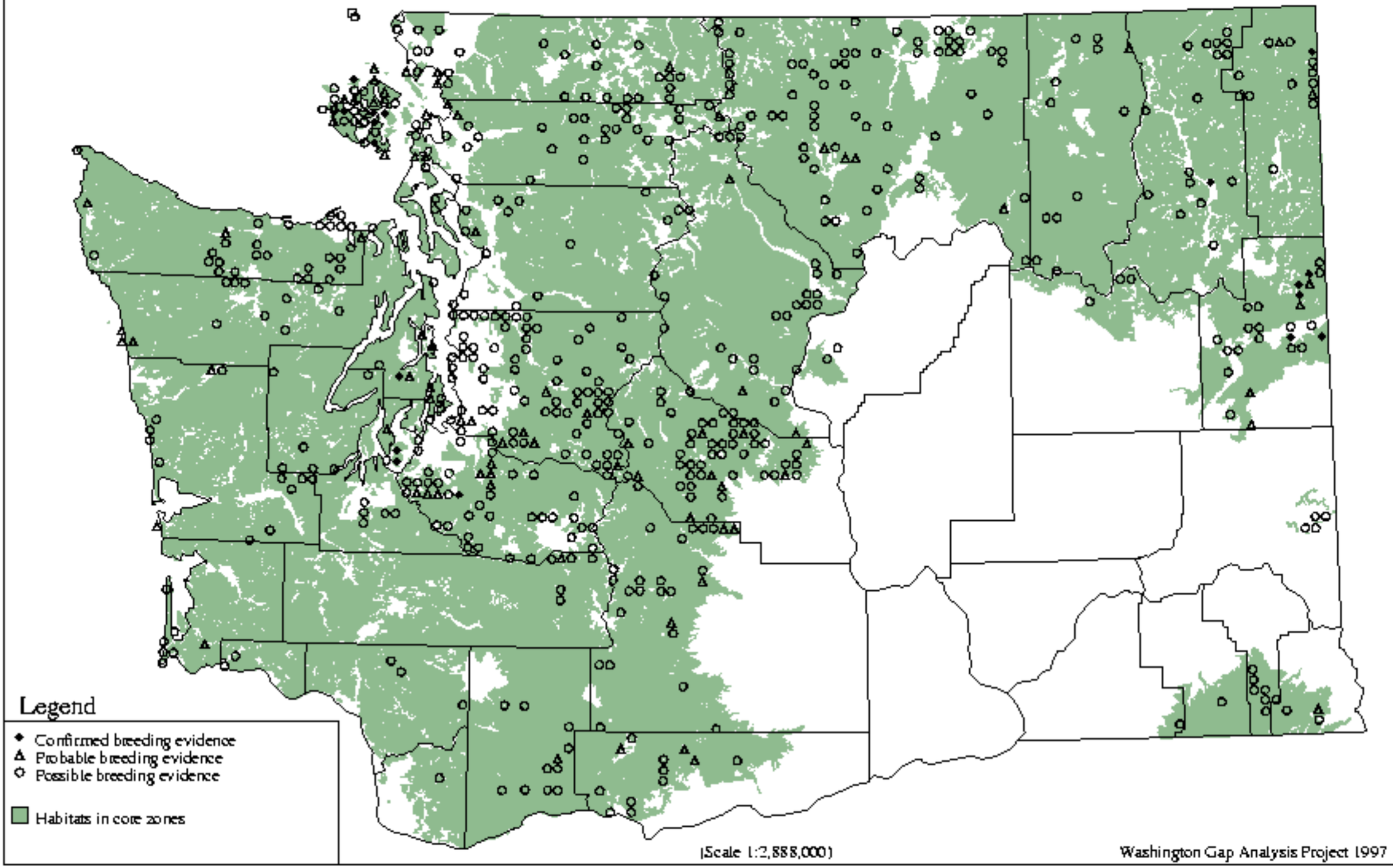
Cassin`s Finch - *Carpodacus cassinii*



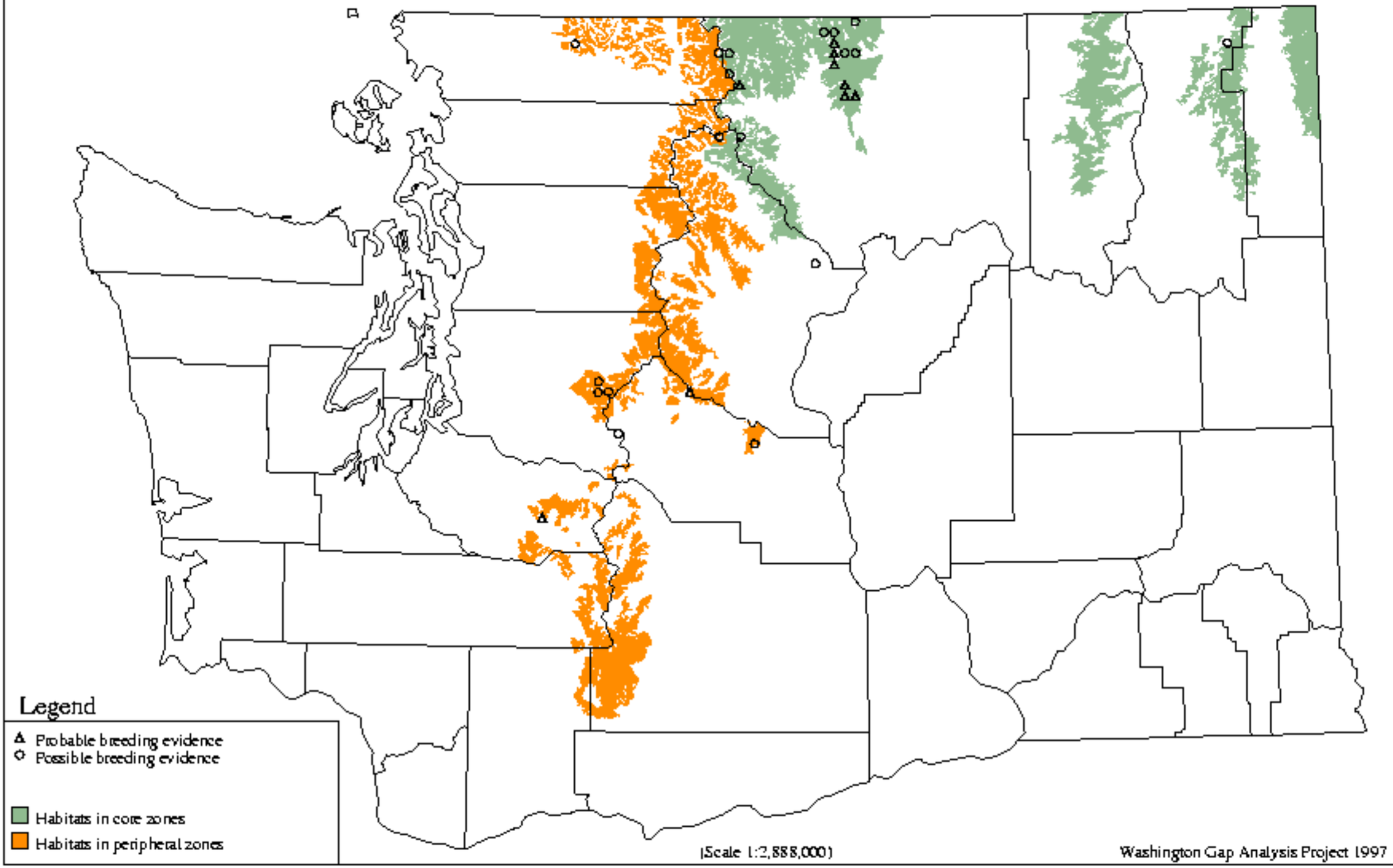
House Finch - *Carpodacus mexicanus*



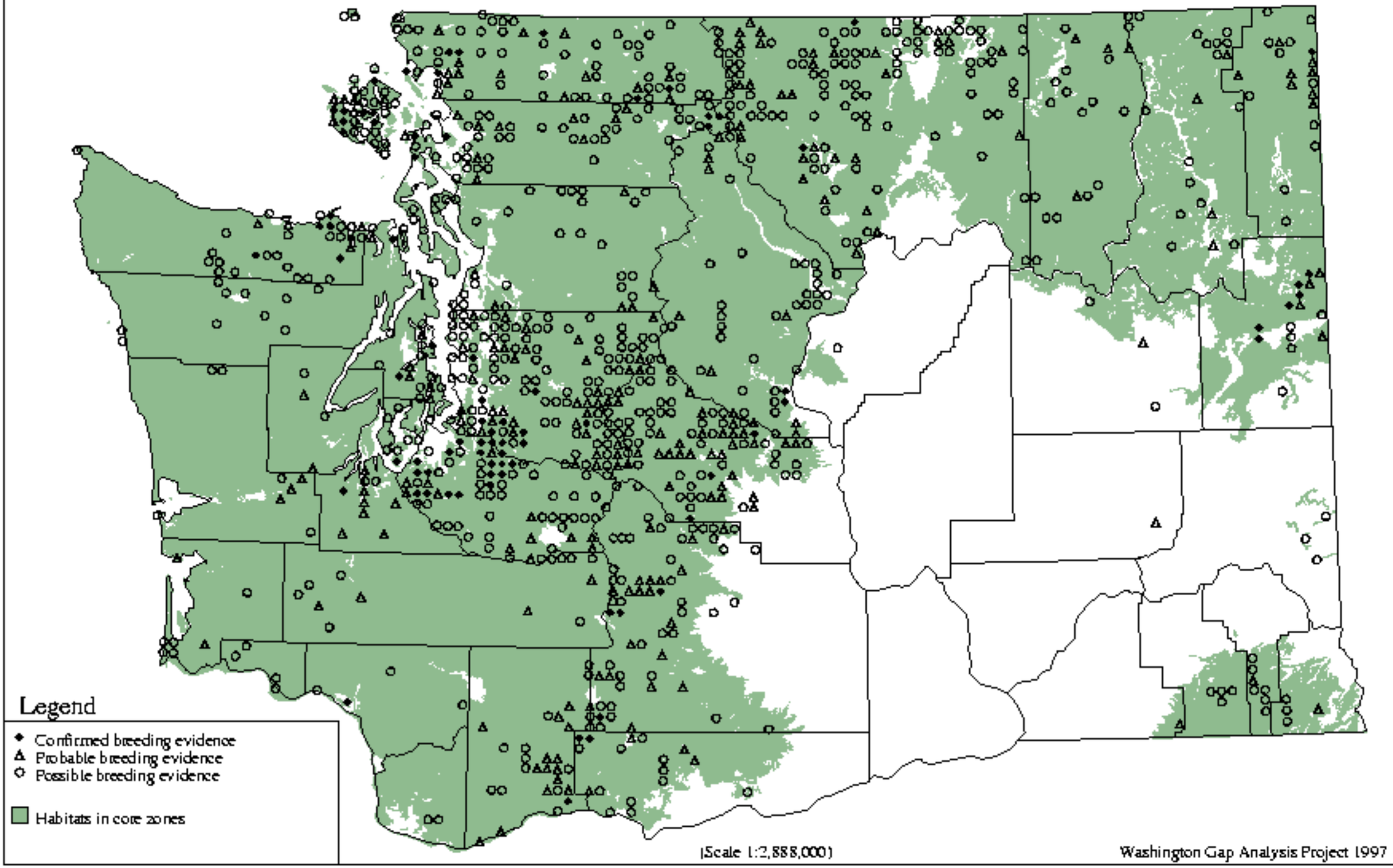
Red Crossbill - *Loxia curvirostra*



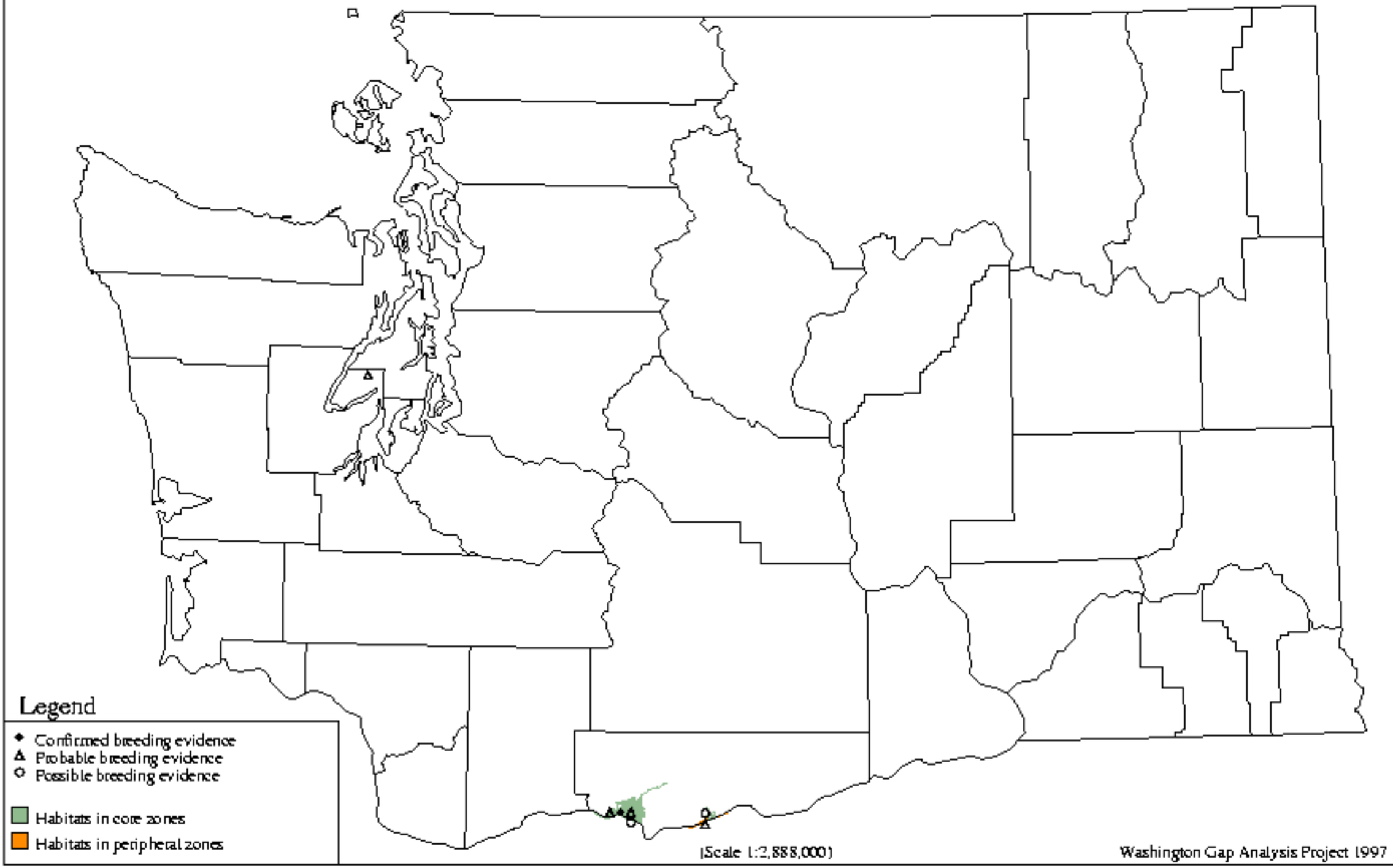
White-winged Crossbill - *Loxia leucoptera*



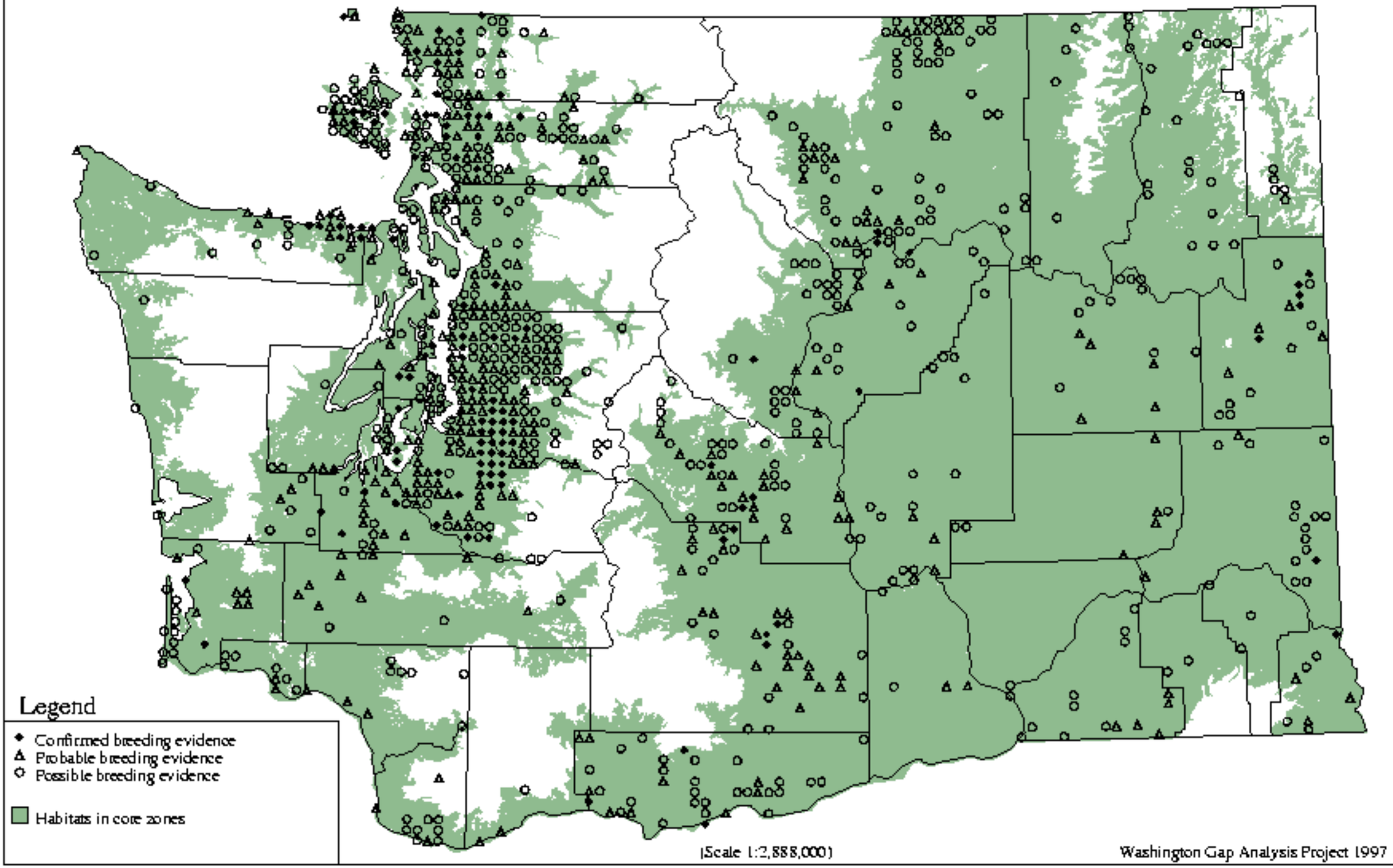
Pine Siskin - *Carduelis pinus*



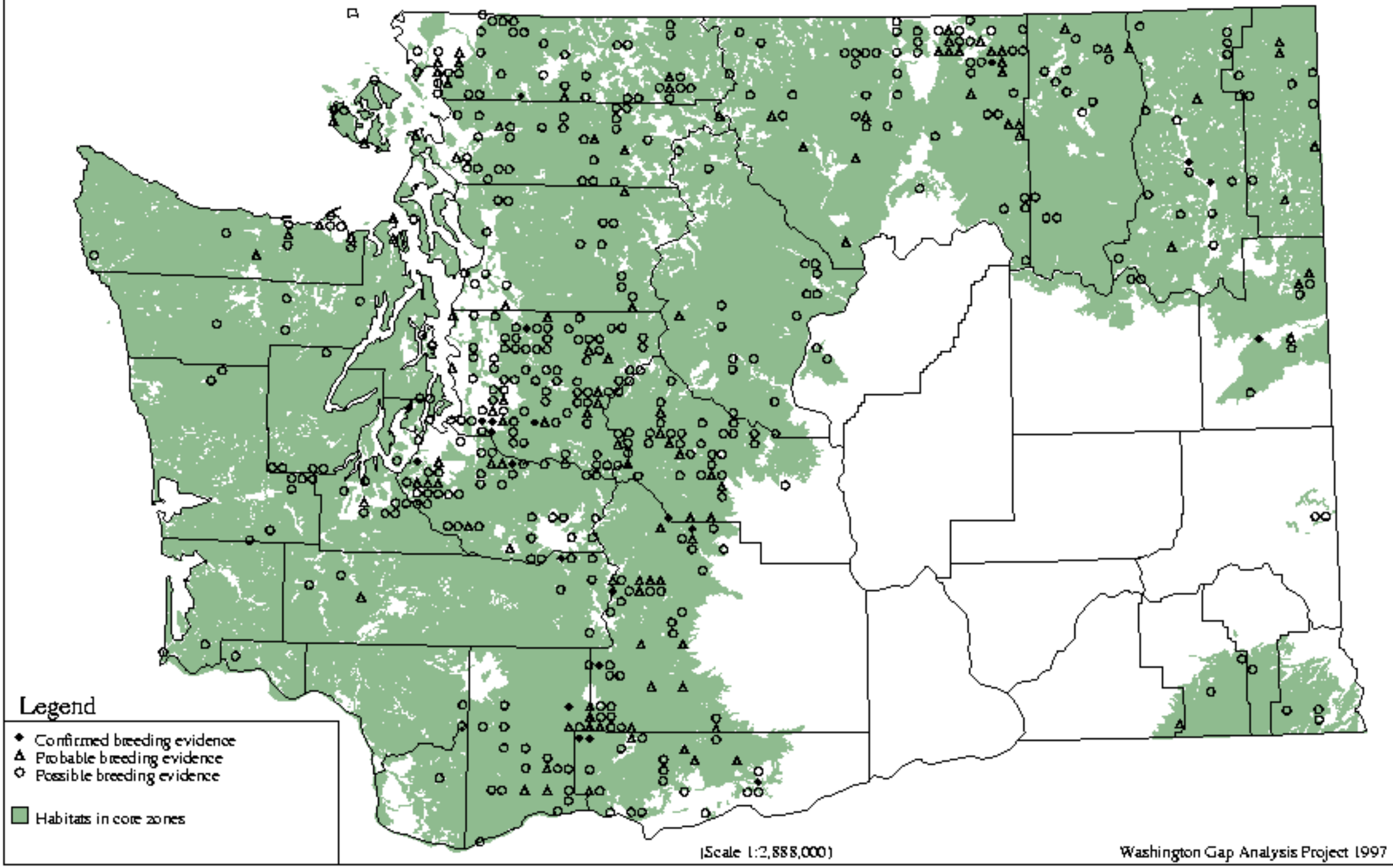
Lesser Goldfinch - *Carduelis psaltria*



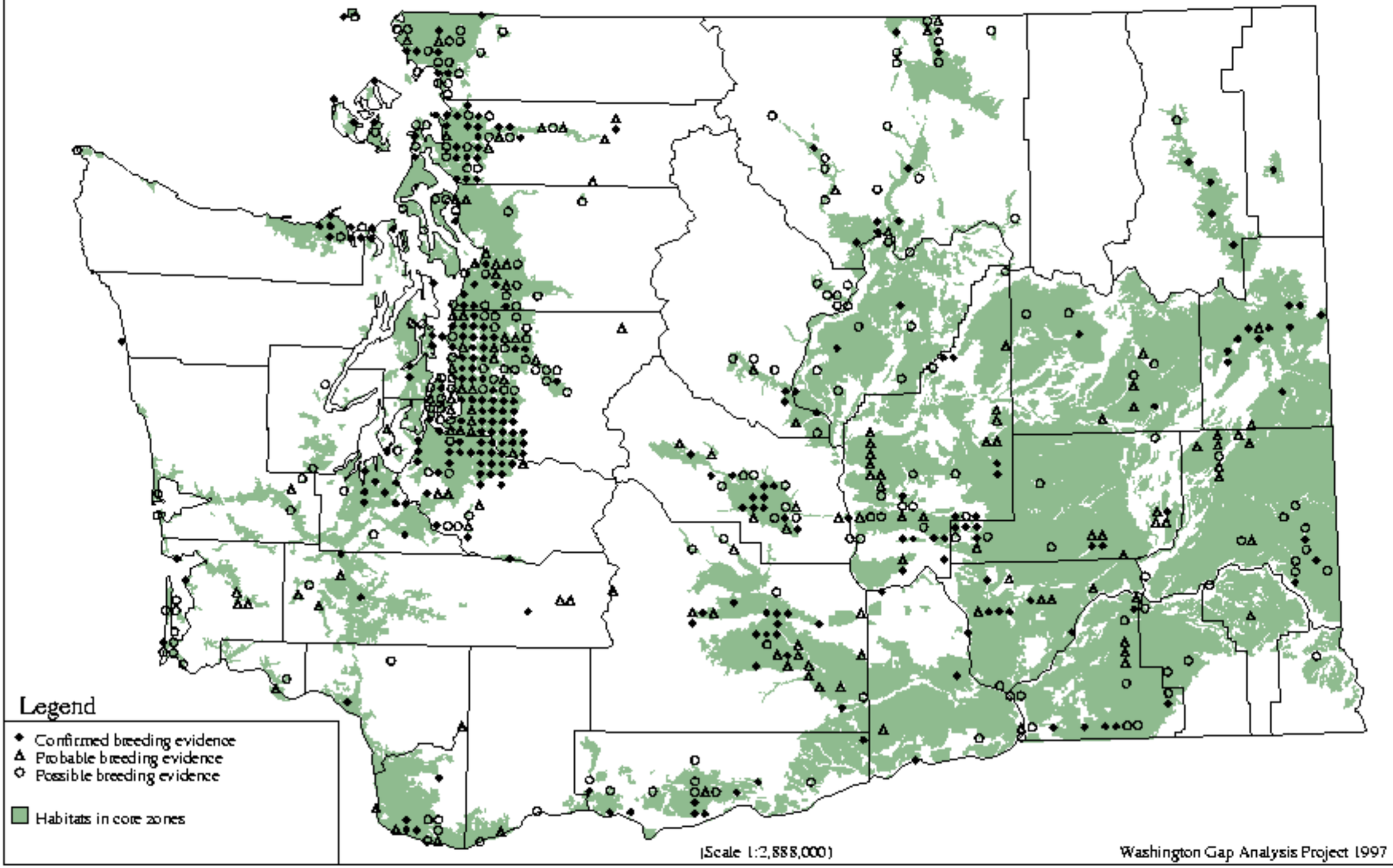
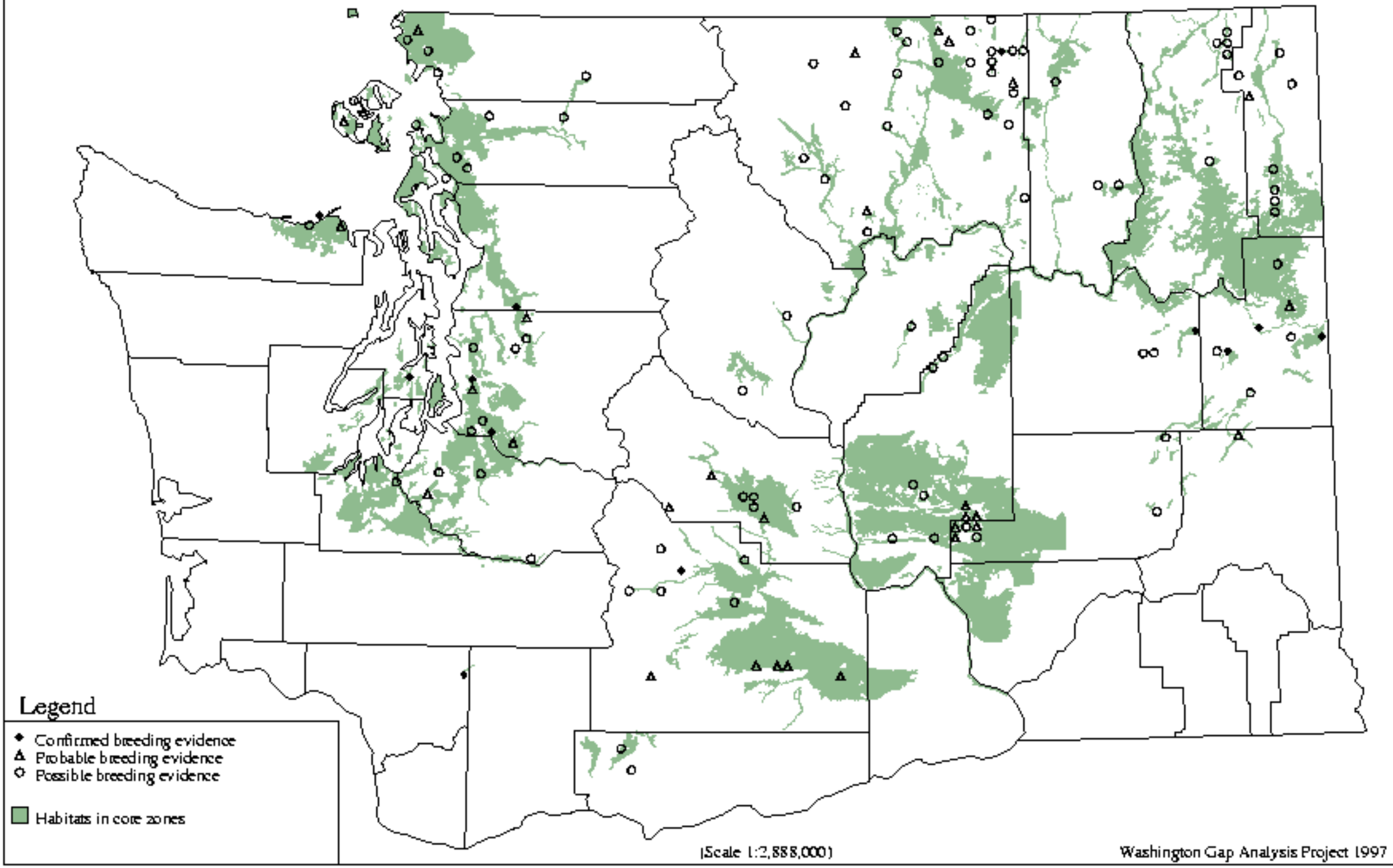
American Goldfinch - *Carduelis tristis*



Evening Grosbeak - *Coccothraustes vespertinus*



House Sparrow - *Passer domesticus*



Sora - *Porzana carolina*