Lower Skagit River Tributaries Riparian Vegetation Change Analysis Results

Abstract

This purpose of this study was to measure changes in riparian vegetation along six Lower Skagit River tributaries: Carpenter, Fisher, Hansen, Lake, Nookachamps, and East Fork Nookachamps Creeks. These creeks have temperature impairments, as determined in the *Lower Skagit River Tributaries Temperature Total Daily Maximum Load Study* (Zalewsky and Bilhimer, 2004).

The Washington State Department of Ecology analyzed riparian vegetation changes within 50-foot and 150-foot buffer zones along all six tributaries. Orthoimagery and Geographic Information System (GIS) devices were used to delineate and compare vegetation and land types between the years 1990 (or 1998 depending on available data) and 2006.

Overall, the changes in riparian vegetation were not substantial:

- Shade-producing vegetation increased slightly along Hansen and Nookachamps Creeks.
- Shade-producing vegetation declined slightly along Carpenter and Lake Creeks.
- There was little change in shade-producing vegetation along East Fork Nookachamps Creek, although some increases in dense shrubs and medium trees occurred in the 150-foot riparian zone.
- Two categories of shade-producing vegetation increased along Fisher Creek, while dense, medium trees decreased.

There was a general increase in barren and non-vegetated lands along the six tributaries. This increase in barren areas may be related to the trend of decreasing grass/pasture lands. When all six tributaries were combined, tall, dense trees increased in area, and medium, dense trees decreased in area.

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Table of Contents

Introduction

Excessively warm stream temperatures are harmful to fish and other aquatic organisms. Riparian vegetation can keep stream temperatures cooler by decreasing solar exposure to the water and providing cooler microclimates. An analysis of riparian vegetation change along temperature-impaired streams can show the extent of progress being made in restoring riparian vegetation, and by inference, progress toward cooler stream temperatures.

The Washington State Department of Ecology (Ecology) performed this analysis of vegetation change at the request of Ecology's Northwest Regional Office. The objective of the analysis was to review the effectiveness of voluntary efforts made by local landowners to increase vegetation within riparian zones along six tributaries of the Lower Skagit River. Riparian vegetation along these six tributaries was analyzed using Geographic Information System (GIS) devices and orthoimagery to compare changes between 1990 (or 1998 depending on available data) and 2006.

Background

A Total Maximum Daily Load (TMDL) report published in 2004 studied temperature impairments in six Lower Skagit tributaries: Carpenter, Fisher, Hansen, Lake, Nookachamps, and East Fork Nookachamps Creeks. The tributaries are located in largely agricultural lands, as well as in suburban, urban, and timber lands.

The TMDL report also included recommendations on improving stream riparian zones to allow full mature riparian vegetation to grow in order to improve stream shading and enhance the microclimate (Zalewsky and Bilhimer, 2004). Since then, some voluntary stream riparian zone restoration projects have been initiated by area landowners. This analysis examined the changes in riparian vegetation along these six streams as a result of these voluntary efforts and other land use activities.

Methods

Riparian vegetation types were mapped along the length of each tributary within two buffer widths, 50 feet and 150 feet. National Agricultural Imagery Program (NAIP) color orthophotos with an 18" resolution were used for 2006. The vegetation polygons were digitized using U.S. Geological Survey (USGS) black-and-white digital orthophoto quadrangles (1:24,000 resolution) for the years 1990 and 1998. All orthophoto images were taken during July of the respective year.

Carpenter Creek fell into two quadrangles within the black-and-white orthophoto layer. The majority of the creek was digitized using 1990 images, and the upper portion of the creek was digitized using a 1998 orthophoto. All other tributaries were located completely within either 1990 or 1998 orthophotos for the entire length of the creek.

Fifty-foot and 150-foot riparian zone widths were measured from the stream centerline for all six streams, with the exception of Nookachamps Creek. Due to the large width of Nookachamps Creek, the buffers were measured from the stream channel. Vegetation polygons were digitized at a scale of 1:2,500 (or higher). The upper boundaries of streams were delineated where appropriate to be consistent with stream temperature sensors and forest land boundaries.

Vegetation was classified into categories according to height, density, and type of vegetation. These classifications included:

- grasses/pasture (GP)
- shrubs: sparse (SS) or dense (SD)
- medium height trees: sparse (MS) or dense (MD)
- tall trees: dense (TD)
- no vegetation (NV)
- barren pasture (BP)

Sparse, tall trees were not observed, and therefore the category was not included in the analysis. Tall trees were differentiated from medium trees by the greater contrast and shadows that they cast relative to other vegetation types. Medium trees had an estimated height range from 10 feet to 80 feet. Trees over 80 feet, often coniferous, were classified as tall trees. Grasses/pasture included agriculture, low-lying forbs, wetlands, lawns, and fields. Non-vegetation polygons included concrete-covered areas, buildings, major roads, and other waterbodies. The "barren pasture" category included bare fields, brown patches of earth, exposed flood plains, and dirt roads.

The area, in acres, of each vegetation type was determined within the two buffer size classes (50-foot and 150-foot) for the years 1990/1998 and 2006. Percent change in vegetation was then calculated to express the difference between the two years for each individual creek and the combined difference for all creeks.

Results

The total area for each creek is presented in Table 1.

Table 1. Total area (in acres) of the riparian zones within 50-foot and 150-foot buffer widths.

Creek Name	50-foot	150-foot
Carpenter	84.1	253.3
Fisher	28.5	86.0
Hansen	75.0	224.4
Lake	46.4	138.4
Nookachamps	95.3	283.8
East Fork Nookachamps	53.6	160.9

Results of vegetation changes for the individual creeks are summarized in Tables 2-A and 2-B. Vegetation changes within a 50-foot buffer zone are shown for each creek in Table 2-A, and changes within a 150-foot buffer are presented in Table 2-B. A decrease in vegetation type is expressed by a negative sign preceding the percent change. Positive values indicate an increase in that vegetation type.

Table 2-A. Summary of area (acres) and percent change among vegetation types within 50-foot of each creek.

Vegetation Type*	1998 Area	2006 Area	Percent Change	Vegetation Type*	1990 Area	2006 Area	Percent Change
Hansen				**Carpenter**			
GP	10.10	11.55	14.4%	GP	48.23	47.61	-1.3%
SS	2.86	1.43	-50.0%	SS	2.82	2.77	-1.8%
SD	4.56	6.42	40.9%	SD	2.61	2.08	-20.3%
MS	2.45	1.57	-36.0%	MS	2.77	2.77	0.0%
MD	48.27	47.87	-0.8%	MD	22.26	21.08	-5.3%
TD	4.46	4.60	3.2%	TD	2.87	3.12	9.0%
NV	0.82	1.12	36.6%	NV	2.43	2.89	18.9%
BP	1.53	0.48	-68.5%	BP	0.10	1.79	1670.2%
Nookachamps				**Fisher**			
GP	49.94	46.81	-6.3%	GP	0.84	0.75	-10.1%
SS	5.69	7.38	29.8%	SS	0.53	0.49	-8.6%
SD	8.89	9.16	3.0%	SD	1.42	1.75	23.2%
MS	2.68	2.68	0.0%	MS	0.00	0.00	0.0%
MD	23.73	22.78	-4.0%	MD	16.32	15.61	-4.4%
TD	1.60	2.41	51.0%	TD	8.26	8.85	7.2%
NV	0.63	0.63	0.1%	NV	1.12	1.04	-7.4%
BP	2.16	3.62	67.5%	BP	0.00	0.00	**
East Fork Nookachamps				**Lake**			
GP	17.82	16.84	-5.5%	GP	9.96	11.78	18.3%
SS	0.07	0.65	826.1%	SS	1.57	1.85	18.2%
SD	5.13	4.91	-4.4%	SD	5.53	3.96	-28.5%
MS	0.87	0.9	3.0%	MS	1.71	0.59	-65.4%
MD	24.65	24.86	0.8%	MD	26.07	26.39	1.2%
TD	1.90	1.90	0.0%	TD	0.79	0.79	0.0%
NV	0.34	0.31	-10.4%	NV	0.62	0.69	11.5%
BP	2.86	3.26	14.1%	BP	0.13	0.32	155.4%

* Grass/pasture (GP); Sparse Shrubs (SS); Dense Shrubs (SD); Sparse, Medium trees (MS); Dense, Medium trees (MD); Dense, Tall trees (TD); No Vegetation (NV); and Barren Pasture (BP). Shade-producing vegetation types are highlighted.

** Percent change undefined.

Table 2-B. Summary of area (acres) and percent change among vegetation types within 150-foot of each creek.

Vegetation Type*	1998 Area	2006 Area	Percent Change	Vegetation Type*	1990 Area	2006 Area	Percent Change
Hansen				**Carpenter**			
GP	76.96	80.78	5.0%	GP	136.73	129.55	-5.2%
SS	7.01	4.32	-38.4%	SS	7.97	8.04	0.9%
SD	9.02	11.18	23.9%	SD	4.52	3.43	-24.1%
MS	5.26	4.48	-15.0%	MS	6.28	6.06	-3.5%
MD	99.90	100.86	1.0%	MD	68.29	62.05	-9.1%
TD	13.38	13.52	1.1%	TD	10.95	11.24	2.6%
NV	6.97	8.21	17.9%	NV	14.49	21.48	48.3%
BP	5.94	1.10	-81.5%	BP	4.06	11.50	183.2%
Nookachamps				**Fisher**			
GP	185.34	169.25	-8.7%	GP	9.06	7.10	-21.7%
SS	8.97	12.82	42.9%	SS	1.06	0.89	-16.1%
SD	12.80	13.76	7.5%	SD	9.52	11.39	19.6%
MS	4.67	5.24	12.1%	MS	0.53	0.53	0.0%
MD	56.91	55.75	-2.0%	MD	44.94	43.72	-2.7%
TD	5.02	6.22	24.0%	TD	16.89	17.27	2.3%
NV	3.52	3.68	4.7%	NV	4.00	4.65	16.2%
BP	6.54	17.09	161.1%	BP	0.00	0.46	**
East Fork Nookachamps				**Lake**			
GP	79.77	67.80	-15.0%	GP	40.31	43.24	7.3%
SS	0.77	2.29	196.1%	SS	5.79	7.55	30.4%
SD	7.96	8.54	7.3%	SD	15.79	13.27	-16.0%
MS	3.72	3.24	-12.8%	MS	4.21	2.13	-49.5%
MD	55.27	56.77	2.7%	MD	66.29	64.41	-2.8%
TD	3.88	3.88	0.0%	TD	1.57	1.57	0.0%
NV	2.23	2.47	10.6%	NV	4.30	4.34	0.9%
BP	7.30	15.91	118.0%	BP	0.13	1.89	1337.9%

* Grass/pasture (GP); Sparse Shrubs (SS); Dense Shrubs (SD); Sparse, Medium trees (MS); Dense, Medium trees (MD); Dense, Tall trees (TD); No Vegetation (NV); and Barren Pasture (BP). Shade-producing vegetation types are highlighted.

** Percent change undefined.

Results were also calculated to express change in vegetation cover for all six tributaries combined (Table 3).

Table 3. Area (acres) and percent change of all six tributaries combined.

Vegetation Type*	50-foot buffer			Vegetation Type*	150-foot buffer		
	1990/1998 Area	2006 Area	Percent Change		1990/1998 Area	2006 Area	Percent Change
GP	136.89	135.35	- 1.1%	GP	528.17	497.71	- 5.8%
SS	13.54	14.57	7.6%	SS	31.58	35.91	13.7%
SD	28.14	28.28	0.5%	SD	59.62	61.57	3.3%
MS	10.49	8.51	- 18.8%	MS	24.67	21.67	- 12.2%
MD	161.30	158.60	- 1.7%	MD	391.60	383.56	- 2.1%
TD	19.86	21.66	9.1%	TD	51.69	53.70	3.9%
NV	5.96	6.67	12.0%	NV	35.50	44.83	26.3%
BP	6.78	9.48	39.8%	BP	23.97	47.93	100.0%

* Grass/pasture (GP); Sparse Shrubs (SS); Dense Shrubs (SD); Sparse, Medium trees (MS); Dense, Medium trees (MD); Dense Tall trees (TD); No Vegetation (NV); and Barren Pasture (BP). Shade-producing vegetation types are highlighted.

Results for vegetation changes in all six tributaries combined are also shown in Figures 1 and 2.

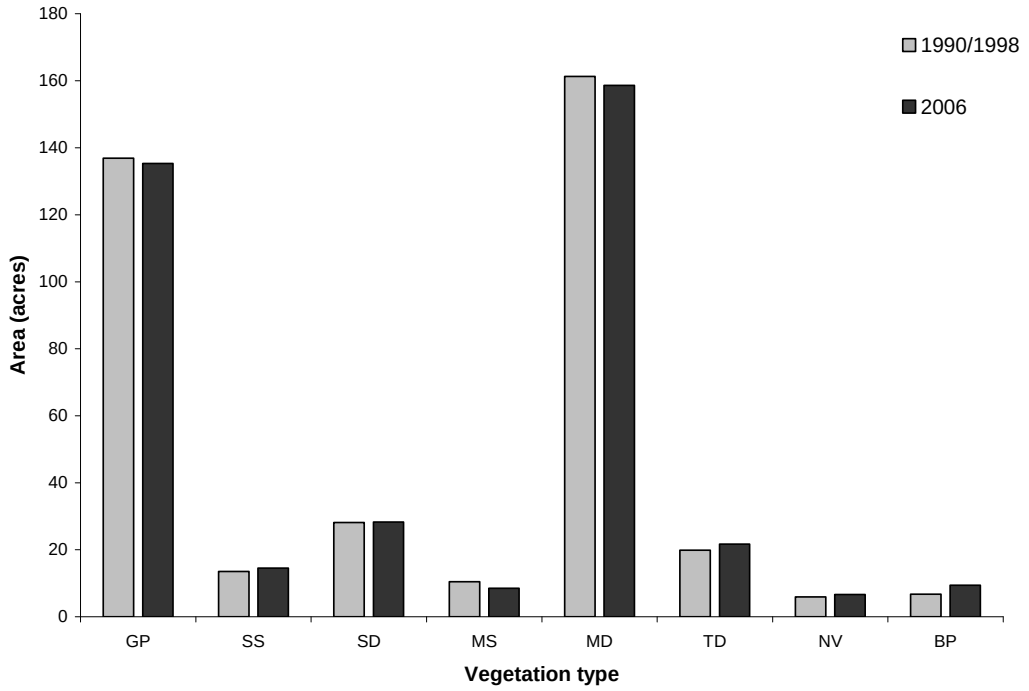


Figure 1. Comparison of area (acres) occupied by the eight vegetation types between 1990/1998 and 2006. Area includes the 50-foot buffer zones of all six tributaries combined.

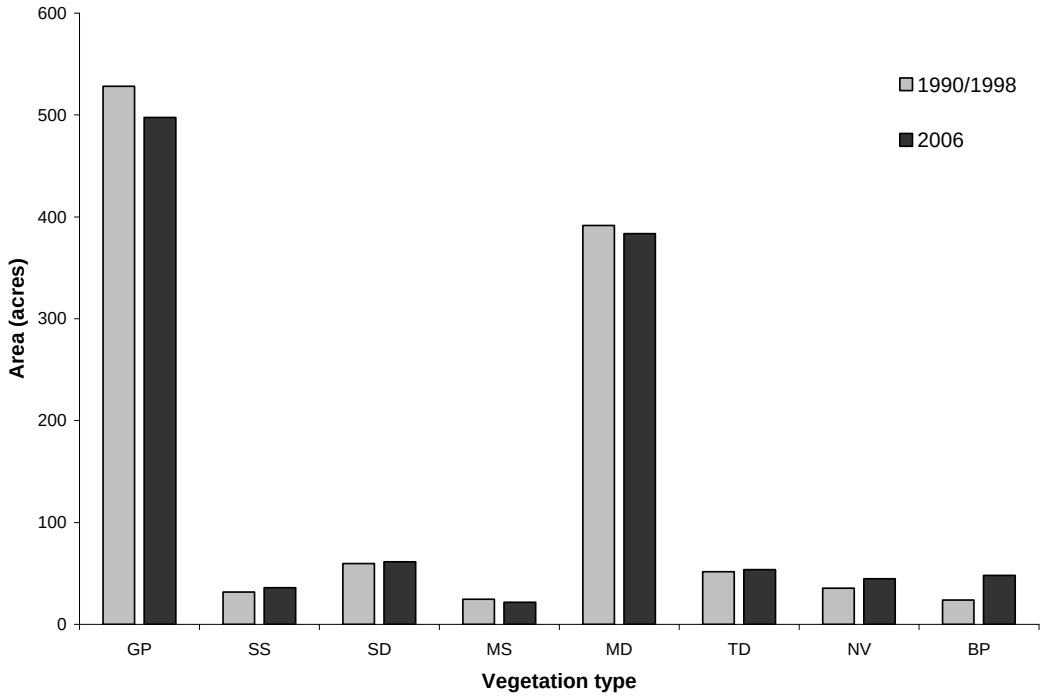


Figure 2. Comparison of area (acres) occupied by the eight vegetation types between 1990/1998 and 2006. Area includes the 150-foot buffer zones of all six tributaries combined.

Discussion of Results

The height and density of vegetation types can be indications of the amount of shade they produce. This analysis considered the following three categories to be shade-producing vegetation: dense shrubs; dense, medium trees; and dense, tall trees. The following five vegetation categories were considered non-shade-producing: grasses/pasture; sparse shrubs; sparse, medium trees; non-vegetation areas; and barren pastures.

Vegetation Changes along the Six Tributaries

Hansen Creek

There was a growth in dense shrubs and a decline of sparse shrubs within the riparian zones of Hansen Creek. Little change occurred in the area of dense, medium trees and dense, tall trees, although tall trees did increase slightly. Non-vegetated lands increased in both buffer zones (50-feet and 150-feet), but barren land decreased.

Nookachamps Creek

Tall, dense trees increased within the riparian zone of Nookachamps Creek. There was also a decrease in non-shade-bearing grass and an increase in shade-producing shrubs. However, barren lands increased in area within both buffer zones.

East Fork Nookachamps Creek

In general, there was little change in vegetation types along the East Fork Nookachamps Creek. There was some increase of shade-producing vegetation within the 150-foot riparian zone. Within the 50-foot zone, the increase in medium, dense trees was slight, and dense shrubs decreased. No change occurred in the total area of tall, dense trees in either zone. The amount of barren land increased in both buffer widths, while grasses decreased in area. There was a decrease in the amount of non-vegetated surfaces within the 50-foot zone and an increase in the same type within the 150-foot zone.

Carpenter Creek

Two categories of shade-producing vegetation along Carpenter Creek decreased in area, while non-vegetation and barren land surfaces increased. However, there was a slight increase in the total area of tall, dense trees. This pattern was true for both the 50-foot and 150-foot buffer zones. A 3.9-acre area occupied by dense, medium trees in 1990 appears to have turned into wetland in 2006. Wetlands in this analysis are classified as grass/pasture.

Fisher Creek

Along Fisher Creek, the shade-producing categories of shrubs and tall trees increased in area between 1990 and 2006 within the two buffer zones, while the grass/pasture and sparse shrub polygons decreased in area. However, shade-producing medium, dense trees decreased in area. Within the 50-foot zone, non-vegetated surfaces decreased, but the same category increased in the 150-foot zone.

Lake Creek

There was an increase in non-shade land types along the length of Lake Creek. Barren lands greatly increased, with most of the increase occurring in the broader 150-foot buffer. Other land types that do not contribute shade increased as well, although not as dramatically. While little change occurred with dense, medium trees and dense, tall trees, dense shrubs and sparse, medium trees decreased throughout the riparian zone.

Vegetation Changes along All Six Tributaries Combined

When riparian zones from all tributaries were combined, there were a few slight trends in vegetation changes. There was an increase in barren lands and a decrease in grass/pasture. This appeared to happen most often by farmland that was vegetated in the 1990s and left barren in 2006. The barren category also includes dirt roads, which may have accounted for some of the change. Non-vegetated surfaces increased throughout the tributary riparian zones, especially in the 150-foot zones. There was also a decrease in medium, dense trees and an increase in tall, dense trees.

In general, the changes in riparian vegetation followed the same pattern within the 50-foot and 150-foot buffer zones. The increases in sparse shrubs, barren pastures, and non-vegetation areas were greater in the 150-foot buffer zone, while increases in dense, tall trees were greater in the 50-foot buffer zone. This could reflect an effort by landowners to enhance shade production and lessen the increase of non-shade-producing land types in the narrower 50-foot zone. Grasses and pastures, however, had sharper decreases in the 150-foot zone, although this decrease was likely due to the increase in barren pasture.

Overall, the changes in area of vegetation types for the six individual creeks and those six creeks combined were not substantial. While the percent change values are high for some vegetation types, the amount of area may not have changed greatly. A polygon with a small area, for instance, may have an especially high percent change value when the increase in area is actually very small.

There is a potential source of error in digitizing vegetation, due to the low resolution of the black-and-white (1990/1998 years) imagery and the possibility of human error. Although the range of error is not calculated, the range of error should be noted when examining the results, particularly results with very slight changes.

Conclusions

Riparian vegetation growth varied among the six creeks, although most changes were not substantial:

- The majority of shade-producing vegetation increased slightly along Hansen and Nookachamps Creeks.
- Two categories of shade-producing vegetation increased along Fisher Creek, while dense, medium trees decreased.
- Shade-producing vegetation declined slightly along Carpenter and Lake Creeks.
- There was little change in the riparian vegetation of East Fork Nookachamps Creek, although a slight increase in shade-producing vegetation occurred in the 150-foot zone.

Non-vegetated surfaces increased in the majority of the six creek riparian areas. There was a decrease in grass/pasture lands along all creeks except Hansen and Lake, although this decrease seemed to be replaced with barren areas in most riparian zones. When all six tributaries were combined, tall, dense trees appeared to have increased in area, while medium, dense trees had decreased.

There was no clear difference in vegetation changes between the 50-foot and 150-foot buffer zones. In general, both buffer widths showed the same patterns. Increases in areas of barren pastures and non-vegetation were greater within the 150-foot riparian zones, and tall, dense trees had greater increases in the 50-foot zones.

Shade-producing vegetation contributes to greater shade coverage and cooler microclimates, and increases in these vegetation types may reflect improvements in riparian quality. For instance, an increase in tall, dense trees could indicate that landowners are allowing forest lands to mature, which is beneficial to streams with temperature impairments. Increases in non-shade-producing vegetation types likely indicate a negative change in riparian quality by contributing to higher stream temperatures.

Recommendations

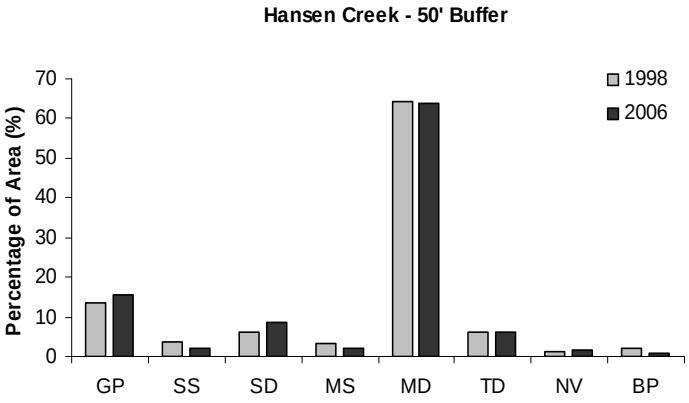
While these positive and negative effects can be implied by a vegetation change analysis, a more detailed analysis is needed to determine those changes in riparian quality.

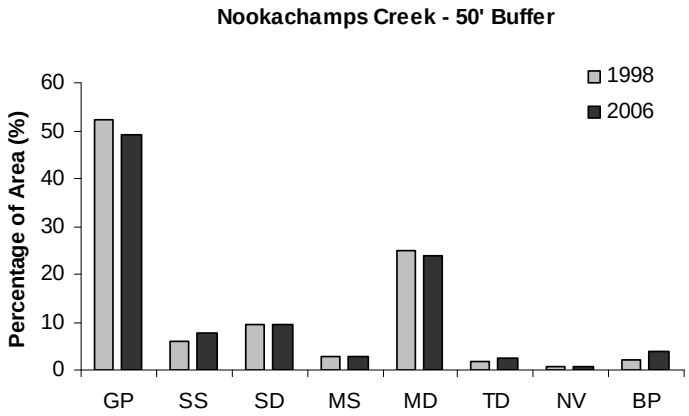
References

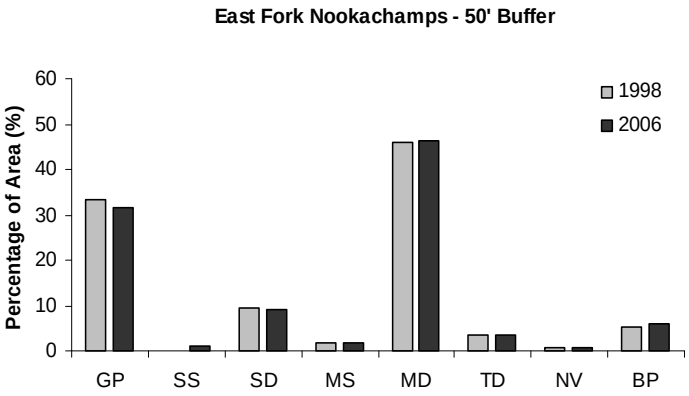
Zalewsky, B. and D. Bilhimer, 2004. Lower Skagit River Tributaries Temperature Total Maximum Daily Load Study. Washington State Department of Ecology, Olympia, WA. Publication No. 04-03-001. www.ecy.wa.gov/biblio/0403001.html

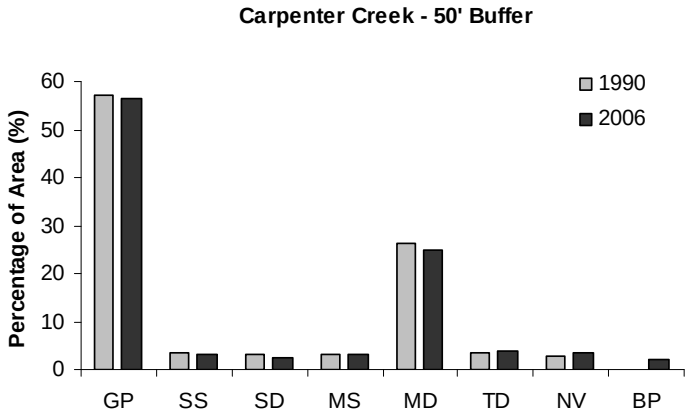
Appendices

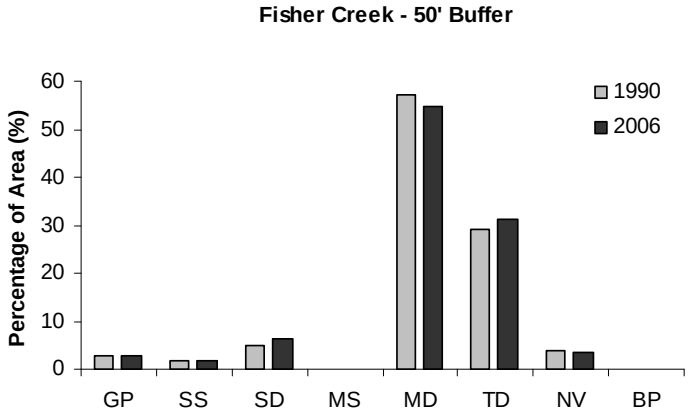
Appendix A. Comparison of Percent of Riparian Zone Occupied by Vegetation Type within 50-foot Buffer Widths

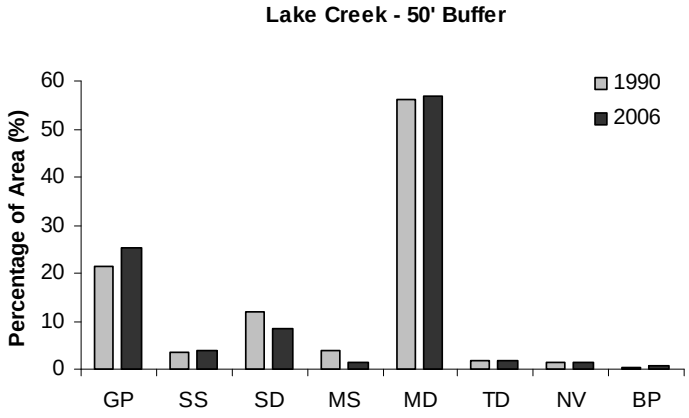






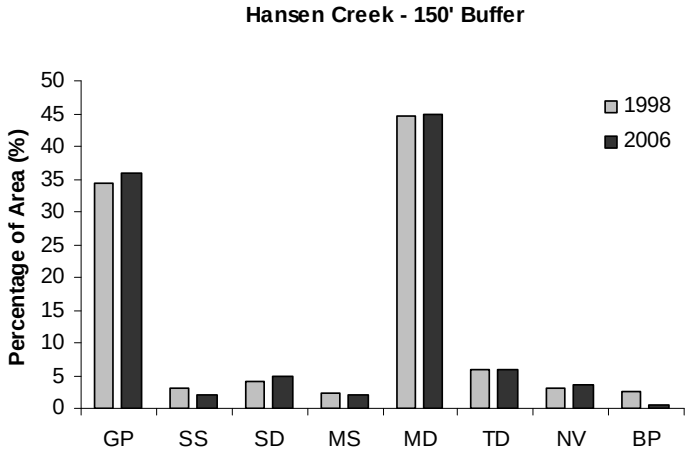


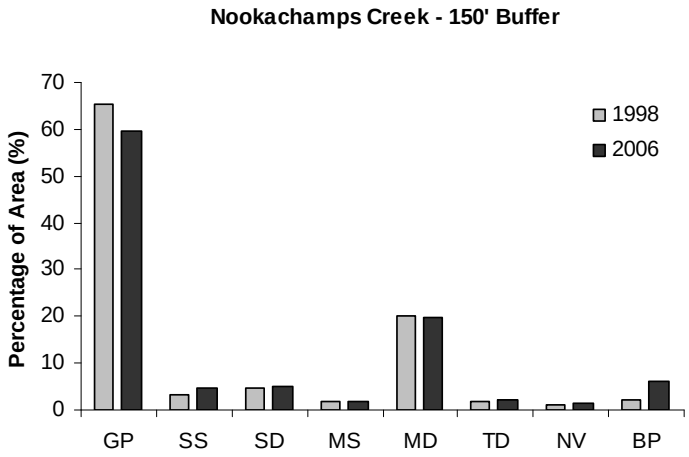


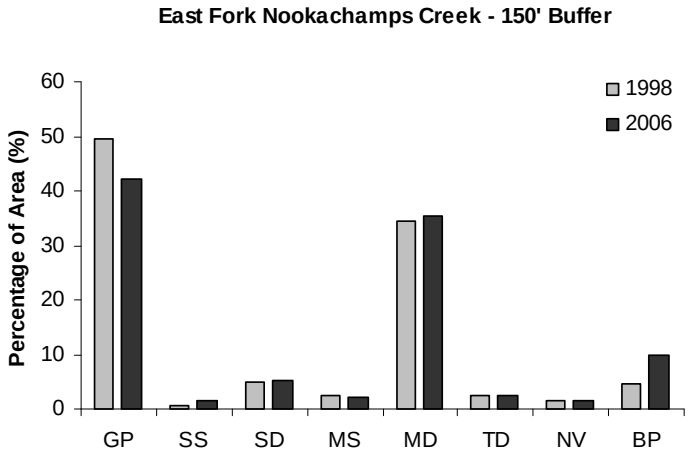


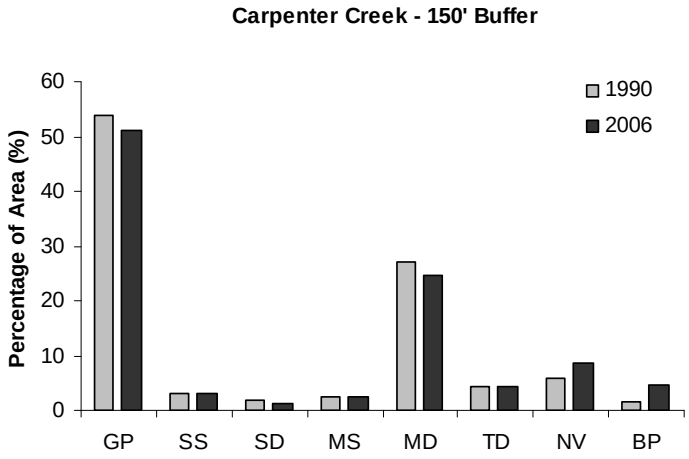
Vegetation types, along the x-axis: Grass/pasture (GP); Sparse Shrubs (SS); Dense Shrubs (SD); Sparse, Medium trees (MS); Dense, Medium trees (MD); Dense, Tall trees (TD); No Vegetation (NV); and Barren Pasture (BP).

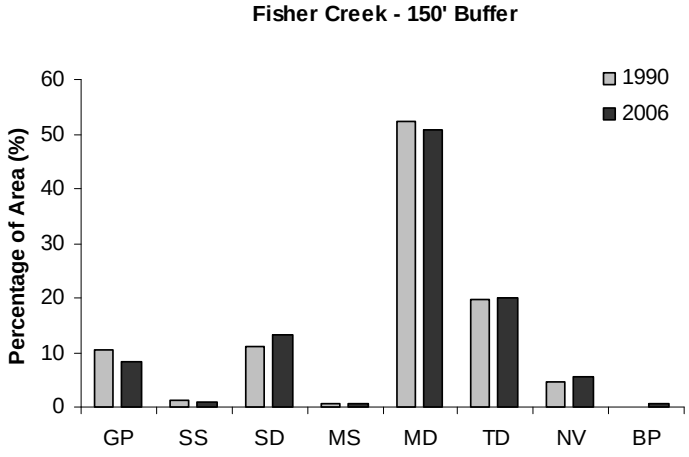
Appendix B. Comparison of Percent of Riparian Zone Occupied by Vegetation Type within 150-foot Buffer Widths

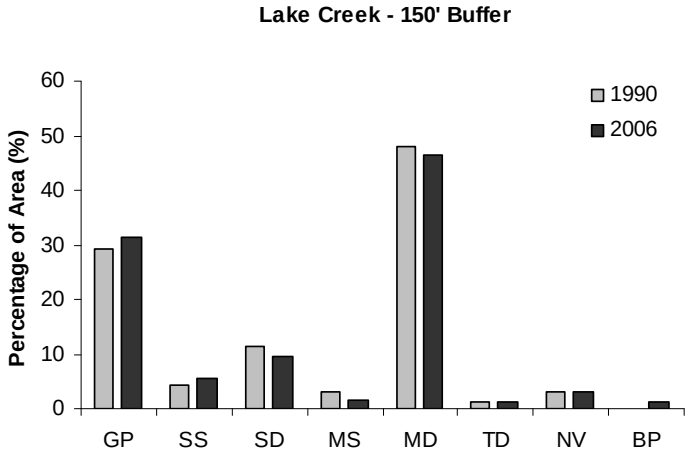












Vegetation types, along the x-axis: Grass/pasture (GP); Sparse Shrubs (SS); Dense Shrubs (SD); Sparse, Medium trees (MS); Dense, Medium trees (MD); Dense Tall trees (TD); No Vegetation (NV); and Barren Pasture (BP).