



Cows and Fish Report

**Fisheries Biodiversity:  
Understanding the Link to Riparian Health**

**Cows and Fish**

Alberta Riparian Habitat Management Society Report No. 039

## **Acknowledgements**

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## **About Cows and Fish**

Riparian areas are those areas along rivers, streams, lakes, wetlands, springs, and ponds that are strongly influenced by water and are recognized by water-loving vegetation. Cows and Fish is striving to foster a better understanding of how riparian areas function and how improvements in management strategies in riparian areas can enhance landscape health and productivity for the benefit of livestock producers, their communities and others who value these landscapes.

Cows and Fish Supporters and Members: Producers and community groups, Alberta Beef Producers, Trout Unlimited Canada, Alberta Agriculture and Rural Development, Alberta Sustainable Resource Development, Alberta Environment, Department of Fisheries and Oceans, Agriculture and Agri-Food Canada, Alberta Conservation Association

Funding Associates: Alberta Environmentally Sustainable Agriculture

*Working with producers and communities on riparian awareness*

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**FISHERIES BIODIVERSITY:  
UNDERSTANDING THE LINK TO RIPARIAN HEALTH**

**Prepared for:**

**Alberta Riparian Habitat Management Society - Cows and Fish  
in partnership with  
Alberta Conservation Association**

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## **1.0 INTRODUCTION**

Maintaining fish and fish habitat is an integral part of maintaining healthy ecosystems and providing future opportunities for society. Similarly, biological diversity, including fish, wildlife and plants, is an indicator of a healthy ecosystem. The challenge of enhancing and maintaining these resources is considerable, but relies upon an understanding of the linkages between riparian health and aquatic ecosystem health. Once these linkages are understood, appropriate programs and messages can be delivered by organizations and agencies to an informed and interested public. Together, these organizations and the public can work together towards a common goal of the conservation and enhancement of riparian and aquatic ecosystems.

The Alberta Riparian Habitat Management Society working under the common name of ‘Cows and Fish’ has been undertaking riparian assessments throughout southwestern Alberta for more than 15 years. These riparian assessments have included Bob, Todd and Pekisko creeks. In 1999, the Alberta Conservation Association (ACA) conducted a survey of fish populations at Bob and Pekisko creeks, followed by further fish sampling at Bob Creek in 2000 and 2003, and at Todd Creek in 2000 and 2002. These studies provide an opportunity to understand linkages between riparian health and fish and their habitat.

### **Objective**

The objective of this study was to complete an exploratory analysis of existing riparian and fisheries data for Bob, Todd and Pekisko creeks to determine if the health scores of riparian areas assessed by Cows and Fish would correlate to measures of fish population structure and fish habitat variables (i.e., linkages).

## **2.0 METHODS**

### **2.1 Study Sites**

Three creeks having extensive riparian health assessment data were selected to determine the link between riparian health and fish populations/fish habitat. Todd Creek, Bob Creek and Pekisko Creek are located in southwest Alberta, in the Foothills Natural Region (Figure 1). Todd Creek is approximately 40 km long and flows in a southerly direction to the Crowsnest River. Bob Creek is about 15 km long and flows south into the Oldman River. Pekisko Creek flows in a northeasterly direction to the Highwood River and is approximately 55 km long.

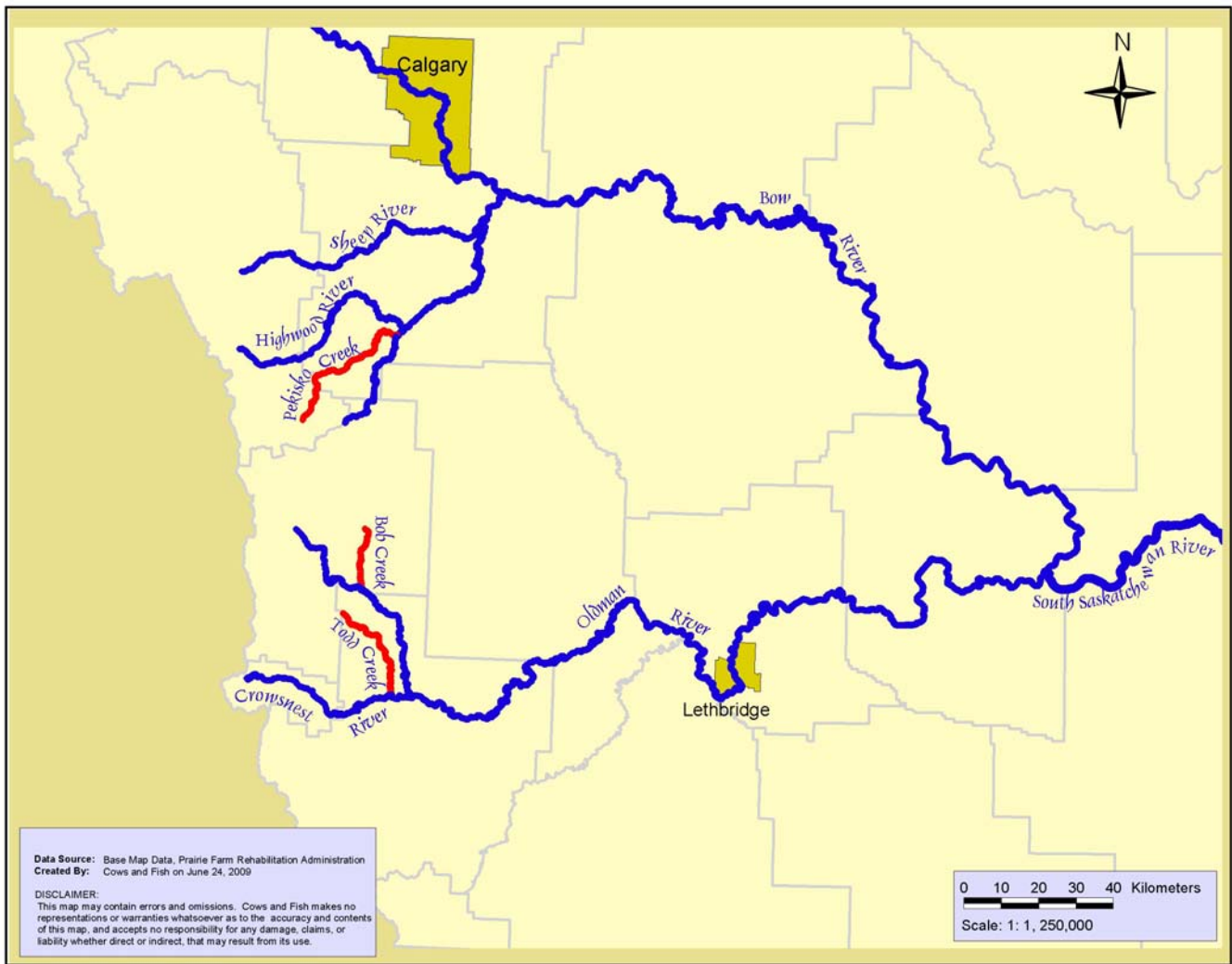
### **2.2 Riparian Health Assessments**

Riparian health assessment is used to evaluate riparian health using a variety of criteria related to ecological status, community structure and site stability. Metrics that are considered in an assessment include vegetative cover, disturbance-caused species, undesirable species, invasive plant species, trees and shrubs (establishment, regeneration and utilization), human disturbance, streambank rootmass protection and stream channel incisement, to name a few. Parameters are intended to indirectly evaluate the ability of a site to perform ecological functions. For example, the presence of bare soil and absence of vegetative cover reduces the ability of a site to trap sediment and filter water.

Riparian health inventory (RHI) is similar to riparian health assessment (RHA) but more thoroughly examines the vegetation, soil parameters, and hydrology of an area. Riparian health inventory is used by riparian resource management professionals to capture benchmark data, examine details of the plant community and structure, and for monitoring purposes. The riparian health score is calculated using the details of the inventory.

A score is allocated to each parameter and an overall riparian health score is generated for a particular site. A score of 80% or above denotes a *healthy* site where all key riparian functions are present. A score of 60 to 79% denotes a site that is *healthy with problems* since most but not all key riparian functions are present or some functions are impaired. This indicates that more attention should be given to management strategies on the site. A score of less than 60% denotes an *unhealthy* site and riparian functions are severely impaired.

Riparian health inventories were conducted at various sites from 1998 to 2007 for Bob, Todd and Pekisko creeks using the methods described in the Alberta Lotic Wetland Health Inventory for Streams and Small Rivers (Survey) User Manual (Cows and Fish et al. 2006a and 2006b). Table 1 summarizes the number of sites and years in which Cows and Fish completed riparian assessments at the three creeks.



**Figure 1 – Location of Todd Creek, Bob Creek and Pekisko Creek in southern Alberta.**

**Table 1 – Summary of Riparian Assessments Completed at Bob, Todd and Pekisko creeks by Cows and Fish, 1998 to 2007.**

Creek	No. of Sites Surveyed	Site Numbers	Year Surveyed
Bob	8	1 to 8	1998
Bob	9	1 to 9	2005
Todd	1	1	2002
Todd	2	2,3	2003
Todd	5	4 to 8	2006
Todd	12	9 to 20	2007
Pekisko	14	1 to 14	1998
Pekisko	2	5,16	2000
Pekisko	2	5, 6	2002

On Bob Creek, eight riparian health assessments were completed in 1998, with all of the sites re-assessed in 2005, with the addition of one new site. On Todd Creek, 20 riparian health assessments were completed from 2002 to 2007 (Table 1). At Pekisko Creek, 14 riparian sites were assessed in 1998, with a further three re-assessments and one new site added in 2000 and 2002.

Table 2 summarizes the riparian health inventory and riparian health assessment parameters that were assessed. Some of the parameters in the riparian health inventory are used to derive the riparian health assessment score (i.e., preferred tree and shrub establishment and regeneration and utilization).

**Table 2 - Summary of Riparian Health Inventory (RHI) and Riparian Health Assessment (RHA) parameters.**

Riparian Health Inventory Parameters	Units
Size	Hectares
Trees	Presence/absence
Trees greater than 6 ft	% of project area
Trees greater than 1.5 ft	% of project area
Trees less than 1.5 ft	% of project area
Shrubs greater than 6 ft	% of project area
Shrubs greater than 1.5 ft	% of project area
Shrubs less than 1.5 ft	% of project area
Grass greater than 6 ft	% of project area
Grass greater than 1.5 ft	% of project area
Grass less than 1.5 ft	% of project area
Forbs greater than 6 ft	% of project area
Forbs greater than 1.5 ft	% of project area
Forbs less than 1.5 ft	% of project area
Canopy Cover - Trees	% as a decimal
Canopy Cover - Shrubs	% as a decimal
Canopy Cover - Grams	% as a decimal
Canopy Cover - Forbs	% as a decimal
Canopy Cover - Wood	% as a decimal
Canopy Cover - Weeds	% as a decimal
Canopy Cover - All	% as a decimal
Altered Banks	% of project area
Hoof Shear	% of altered bank
Trails	% of altered bank
Bareground	% of project area



<b>Riparian Health Assessment Parameters</b>	
Vegetative Cover of Floodplain and Streambanks	% Score
Invasive Plant Species	% Score
Disturbance-increaser Undesirable Herbaceous Species	% Score
Preferred Tree and Shrub Establishment and Regeneration	% Score
Utilisation of Preferred Trees and Shrubs	% Score
Standing Decadent and Dead Woody Material	% Score
Streambank Root Mass Protection	% Score
Human-caused Bareground	% Score
Pugging and/or Hummocking	% Score
Human-caused Alterations to the Polygon	% Score
Stream Channel Incisement (vertical stability)	% Score
Total Score - Vegetation	% Score
Total Score – Soil and Hydrology	% Score
Overall Score	% Score

### 2.3 Fisheries Surveys/Data

Fish population data (species and numbers captured) and fish habitat data (substrate, rooted channel width) were obtained from the FWMIS (Fisheries and Wildlife Management Information System) online database. For Bob Creek, fisheries data was found for August 1999, July 2000, July 2003 and May 2006. The majority of fisheries sampling at Bob Creek was completed by the ACA with additional sampling completed by the University of Lethbridge and Concordia University College of Alberta. For Todd Creek, fisheries data was found for August and September 2000, August 2002, April 2003, July 2006, August 2007 and June 2008. The majority of fisheries sampling at Todd Creek was completed by the ACA with additional sampling completed by the University of Lethbridge, Royal Alberta Museum, Pisces Environmental Consulting Services Ltd. and Matrix Solutions Inc. For Pekisko Creek, fisheries data was found for May, September and October 1994, September 1995, October 1996, September 1997 and 1998, August 1999 and July 2000. The majority of fisheries sampling at Pekisko Creek was completed by Alberta Fish and Wildlife, with additional sampling completed by the ACA and Concordia University College of Alberta.

In addition to data provided by the FWMIS database, a fisheries literature and data survey was conducted to increase the amount of data available for analysis. This search was largely completed using an Internet search and the Palliser Environmental Services Ltd. (PESL) library. Based on this literature review, little additional information was found that was usable for this project. ACA completed a fisheries inventory of small creeks in southwestern Alberta in 2003 (Faulter 2003). As part of this inventory, Bob Creek was sampled at three sites and habitat data (substrate, stream widths) were recorded. The data from Faulter (2003) was also obtained from the FWMIS data. ACA also completed fish population estimates at Bob Creek (three sites) and Pekisko Creek (two sites) in 1999 (Wieliczko 2001). The data from Wieliczko (2001) was also obtained from the FWMIS data. EMA (1986) completed fish sampling throughout Pekisko Creek in 1986 as part of an instream flow needs study; however, the fisheries data was collected at a reach scale (five reaches) and it was not possible to match the fish sampling areas with Cows and Fish riparian assessment sites.

### 2.4 Data Synthesis and Statistical Analyses

All statistical analyses were performed using NCSS Statistical System 2006 (Hintze 2006).

#### **Riparian Health and Fisheries Data Synthesis**

A comparison of watershed scores was made to identify the overall riparian health score for each of Bob, Todd and Pekisko creeks. A watershed score was determined by averaging the individual riparian health assessment scores for each creek. A subset of the riparian health assessment data was developed by comparing riparian sites

with corresponding fisheries data sets. The riparian sites that had accompanying fisheries data were kept in the data set for further analysis (Table 3). The riparian sites and the fisheries data not having an association were omitted from the evaluation. Note that the sample size (n) was not equal among the health categories. In addition, not all riparian health metrics were collected for all sites which were considered gaps in the data set.

**Table 3 - Summary of fish sampling dates and riparian health assessment data.**

Site	Fisheries Sample Date	Riparian Assessment Date	Riparian Health Category	Riparian Health Score <sup>a</sup>
BOB1	20-Aug-99	1998, 2005	HWP, HWP	70
BOB1	17-Jul-03	1998, 2005	HWP, HWP	70
BOB5	20-Aug-99	1998, 2005	U, U	46
BOB6	19-Aug-99	1998, 2005	HWP, HWP	70
BOB6	18-Jul-03	1998, 2005	HWP, HWP	70
BOB6	17-Jul-03	1998, 2005	HWP, HWP	70
BOB7	12-Jul-00	1998, 2005	HWP, HWP	65
TOD1	28-Aug-00	2002	H	84
TOD7	12-Sep-00	2006	HWP	74
TOD11	25-Jul-06	2007	H	82
TOD11	28-Sep-00	2007	H	82
TOD11	07-Aug-02	2007	H	82
TOD12	30-Aug-07	2007	HWP	77
TOD13	28-Aug-00	2007	H	82
TOD14	28-Aug-00	2007	HWP	72
TOD16	28-Aug-00	2007	H	82
PEK1	19-Jul-00	1998	H	90
PEK5	23-Aug-99	1998, 2002	HWP, HWP	80
PEK5	23-Sep-97	1998, 2002	HWP, HWP	80
PEK5	03-Oct-96	1998, 2002	HWP, HWP	80
PEK6	31-Aug-99	1998, 2002	U, HWP	56

<sup>a</sup> Note that the 1998 data was used in the analysis for Bob and Pekisko creeks.

### Qualitative Observations

Presence/absence and yes/no qualitative observations provided from the riparian health assessments were assigned a 1 for yes/present and 0 for no/not present. Box plots were created to compare riparian health assessment categories (i.e., *healthy*, *healthy with problems* and *unhealthy*) with riparian health metrics (e.g., canopy cover, rootmass protection and bank material).

### Normality

Normality tests were conducted to test the hypothesis that the data were normally distributed. The normality test was limited by a small sample size ( $n < 100$ ), thus it was analysed for normality using the Martinez-Iglewicz distribution, known for robustness. This test is powerful for heavy-tailed symmetric distributions as well as a variety of other situations. A value of the test statistic that is close to 1 indicates that the distribution is normal.

### ANOVA

Data was grouped according to treatments of *healthy* (n=7), *healthy with problems* (n=7) and *unhealthy* (n=4). ANOVA was used to determine if there was a significant difference among the health categories and the riparian health assessment criteria and fisheries data for normally distributed data. For those parameters where the health categories were significantly different, the Tukey Kramer Multiple Comparison Test was used to determine which

categories were different. If data were not normally distributed, the Kruskal-Wallis Multiple-Comparison Z-Value Test (Dunn's Test) was used to determine the differences among categories.

### **Spearman Correlation Matrix**

A correlation matrix was created using the Spearman Rank Correlation (Pair-wise deletion) (Hintze 2006). Pair-wise deletion was selected for removal of missing values. Each correlation is based on all pairs of data values in which no missing values occur. Missing values occurring in other variables do not influence the calculations. In general, correlation cannot be inferred from populations having correlation coefficients between -0.5 and 0.5 unless the sample size is large (e.g.,  $n = 500$ ) (Sokal and Rohlf 1995). Metrics were considered moderately correlated when  $-0.6 > r > 0.6$ .

### **Cluster Analysis**

Cluster analysis is used to group data. Fish species presence/absence data was clustered by riparian health category using dendograms.

## **2.5 Assumptions and Limitations**

Some assumptions have been made with regards to the riparian and fisheries data.

- 1) **The riparian health ratings and fish population data were stable through time.** The riparian health assessments and fisheries sampling were almost entirely completed in different years. For example, if riparian health had improved or declined at a site prior to fish sampling, the fisheries results would be reflective of the current, unknown riparian health rating and not the assessed riparian health rating. The effects of changing riparian health are probably minor to moderate. Cows and Fish re-surveyed eight sites at Bob Creek in 2005 that had been surveyed in 1998 and found the health rating had changed (healthier) at two (25%) sites. Similarly, three re-assessments at Pekisko Creek over a four year period confirmed the riparian health ratings were unchanged.
- 2) **During fish sampling, all captured fish were recorded and entered into databases.** Some of the studies were focused on trout species and may have not entered forage fish data into electronic databases. The influence of this assumption on data is difficult to assess but there is some evidence in the FWMIS data and reports that suggest accurate records of forage fish (particularly small-bodied) presence/absence and numbers were not kept.

## **3.0 RESULTS**

### **3.1 Riparian Health**

Table 4 summarizes the riparian health scores for the three creeks using all assessed sites and using fisheries sites only (i.e., assessed riparian sites for which there was corresponding fisheries data). Although *healthy with problems* is the most common riparian rating for the three creeks (Table 4), each creek did show an overall trend. Bob Creek has had nine riparian assessments of which 22% rated *healthy* but 34% rated *unhealthy*. On an overall watershed riparian health score (i.e., average of all sites assessed), Bob Creek scored 64.9 (the lowest of the three creeks) and for fisheries sites scored 61.7 (also the lowest). Overall, the Bob Creek watershed trended toward *unhealthy* based on riparian health.

Todd Creek has had 21 riparian assessments of which 33% rated *healthy* and only 10% rated *unhealthy*. On an overall watershed score, Todd Creek scored 72.7 (the highest of the three creeks) and for fisheries sites scored 77.9 (also the highest). Overall, the Todd Creek watershed trended toward *healthy* based on riparian health.

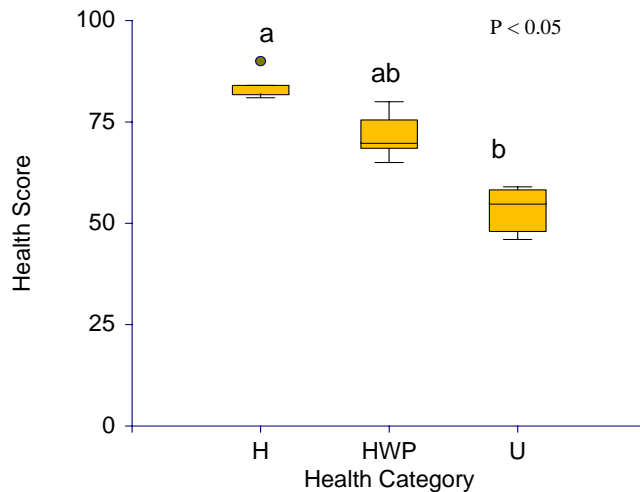
Pekisko Creek has had 15 riparian assessments of which 20% rated *healthy* and 27% rated *unhealthy*. On an overall watershed score, Pekisko Creek scored 68.7 (the middle score of the three creeks) and for fisheries sites scored 71.0 (also the middle score). Overall, the Pekisko Creek watershed trended toward *healthy with problems* based on riparian health.

The average health scores derived for the sites having fisheries data at Bob Creek and Todd Creek were significantly different (Table 4; ANOVA,  $P < 0.05$ ). Significant differences ( $P < 0.05$ ) were found among the health scores derived for the three health categories (Figure 2).

**Table 4 - Summary of the number of riparian health assessment ratings and scores.**

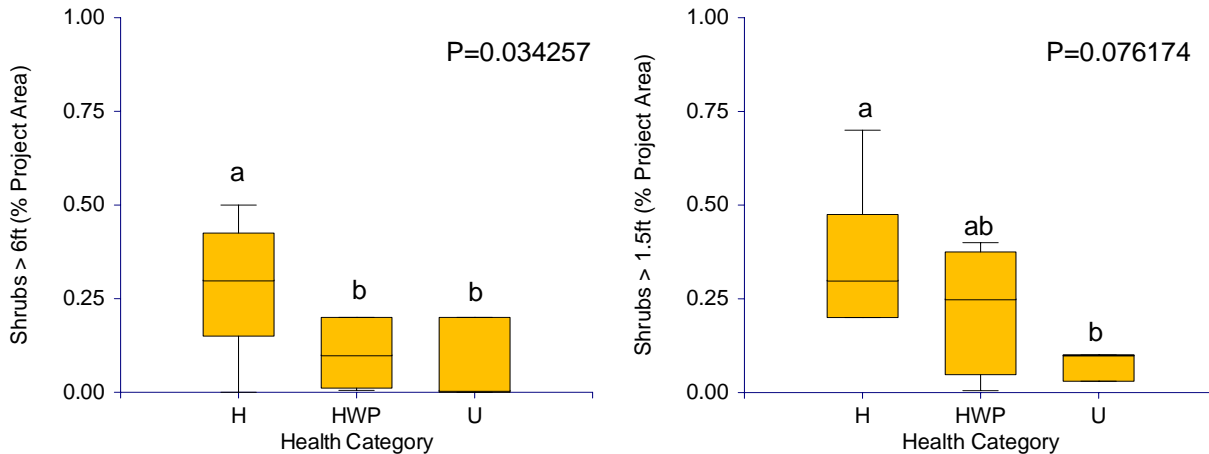
Description	Parameter	Bob Creek	Todd Creek	Pekisko Creek
No. of Watershed Riparian Scores (Fisheries Sites)	Healthy	2 (1)	7 (5)	3 (1)
	Healthy With Problems	4 (2)	12 (4)	8 (2)
	Unhealthy	3 (2)	2 (0)	4 (2)
Overall Riparian Health Scores	Watershed	64.9 (n=9)	72.7 (n=21)	68.7 (n=15)
	Fisheries Sites	61.7 <sup>a</sup> (n=5)	77.9 <sup>a</sup> (n=9)	71 (n=5)

<sup>a</sup>Significantly different (ANOVA,  $P < 0.05$ )



**Figure 2 - Comparison of health categories and actual scores used to derive the riparian health categories. Health categories having different letters are statistically different (ANOVA,  $P < 0.05$ ).**

ANOVA was used to compare results for metrics associated with *healthy*, *healthy with problems* and *unhealthy* sites. In general, *healthy* riparian areas had significantly more area covered in shrubs greater than 6 feet tall ( $P=0.034257$ ) and shrubs greater than 1.5 feet tall ( $P=0.076174$ ) compared to *unhealthy* riparian areas (Figure 3). This also resulted in greater canopy cover provided by woody species at *healthy* sites compared to *unhealthy* sites. On average, shrubs covered about 26% of *healthy* riparian areas compared to just 12% of *unhealthy* riparian sites. The canopy cover provided by shrubs was moderately and positively correlated to overall health score (Spearman Rank Correlation  $r = 0.73$ ).

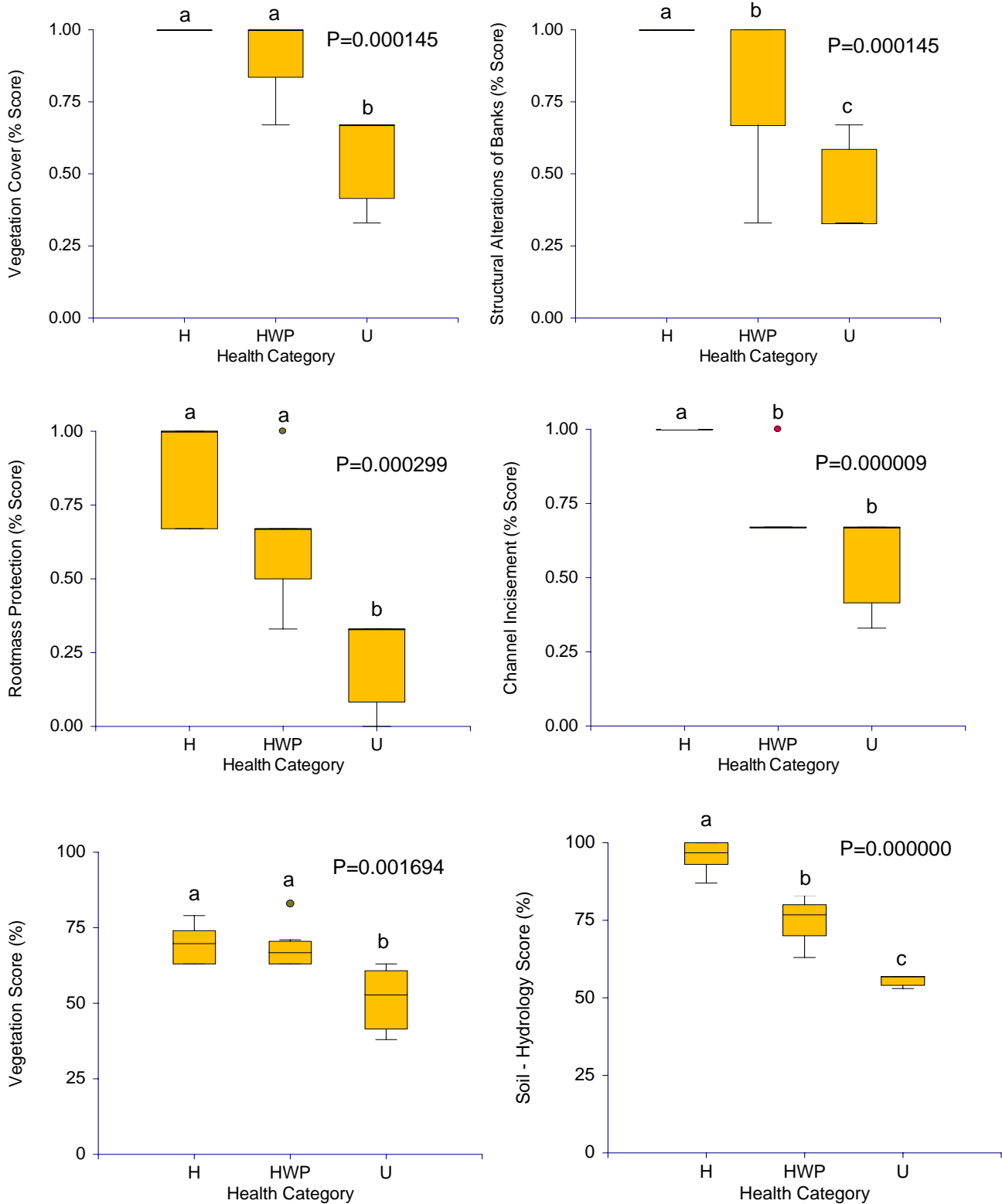


**Figure 3 - Combined scores for various riparian health metrics at Bob, Todd and Pekisko Creeks (fisheries sites only). Health categories having different letters are significantly different (ANOVA, P < 0.10).**

*Healthy* riparian areas had significantly less area impacted by bare ground (1%) (P=0.011541) compared to *unhealthy* sites (12%). The area of bare ground was moderately and negatively correlated to overall health score (Spearman Rank Correlation  $r = -0.68$ ). *Healthy* sites also scored higher in terms of overall vegetation cover, rootmass protection, structural alteration of banks and channel incisement compared to *unhealthy sites* (P<0.10) (Figure 4). These same metrics were moderately and positively correlated with health score, where Spearman Rank Correlation Coefficients were  $r = 0.72$ ,  $r = 0.78$ ,  $r = 0.78$  and  $r = 0.83$ , respectively.

Sites rated *healthy with problems* were differentiated from *healthy* riparian areas by structural alteration to banks, channel incisement and the overall soil hydrology score (Figure 4). Riparian areas rated *healthy with problems* generally scored lower than *healthy* sites for structural alterations to banks (88% vs. 63%) and channel incisement (94% vs.76%). *Healthy* riparian areas scored higher than sites rated *healthy with problems* in the overall soil hydrology score (Figure 4).

No differences were observed among the health categories for the metrics forbs, or those associated with invasive or undesirable plant species and alterations to sites. Appendix A provides the box plots which compare all metrics among the health categories.



**Figure 4 - Combined scores for various riparian health metrics at Bob, Todd and Pekisko Creeks (fisheries sites only). Health categories having different letters are significantly different (ANOVA, P < 0.05).**

## 3.2 Fisheries

### 3.2.1 Fish Species Richness

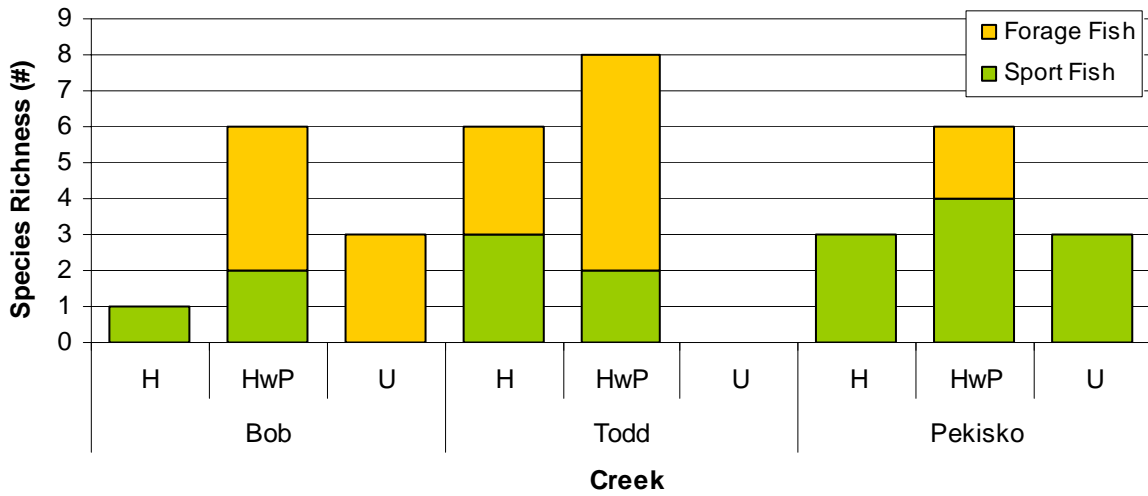
In total, five sport fish species and seven forage fish species were captured at the three creeks (Table 5) for a total of 12 fish species. Comparing the fish species richness at each of the creeks indicates a trend with overall watershed health. When considered at a watershed scale (i.e., entire stream), Todd Creek had the highest species richness (10) and was also the creek which trended toward an overall *healthy* watershed rating. Bob Creek and Pekisko Creek each had seven fish species; however, Pekisko Creek which trended towards a *healthy with problems* watershed had five sport fish species whereas Bob Creek which trended toward an *unhealthy* watershed had only three sport fish species (Table 5).

**Table 5 - Summary of fish species observed at fisheries sites in each watershed.**

Common Name	Scientific Name	Code	Bob Creek (U)	Todd Creek (H)	Pekisko Creek (HWP)
<b>Sport Fish Species</b>					
rainbow trout	<i>Oncorhynchus mykiss</i>	RNTR	x	x	x
bull trout	<i>Salvelinus confluentus</i>	BLTR	x	x	x
brook trout	<i>Salvelinus fontinalis</i>	BKTR			x
cutthroat trout	<i>Oncorhynchus clarki</i>	CTTR	x	x	x
mountain whitefish	<i>Prosopium williamsoni</i>	MNWH		x	x
<b>Forage Fish Species</b>					
trout-perch	<i>Percopsis omiscomaycus</i>	TRPR		x	
pearl dace	<i>Margariscus margarita</i>	PRDC		x	
emerald shiner	<i>Notropis atherinoides</i>	EMSH			x
white sucker	<i>Catostomus commersoni</i>	WHSC	x	x	
longnose sucker	<i>Catostomus catostomus</i>	LNCS	x	x	
lake chub	<i>Couesius plumbeus</i>	LKCH	x	x	
longnose dace	<i>Rhinichthys cataractae</i>	LNDC	x	x	x

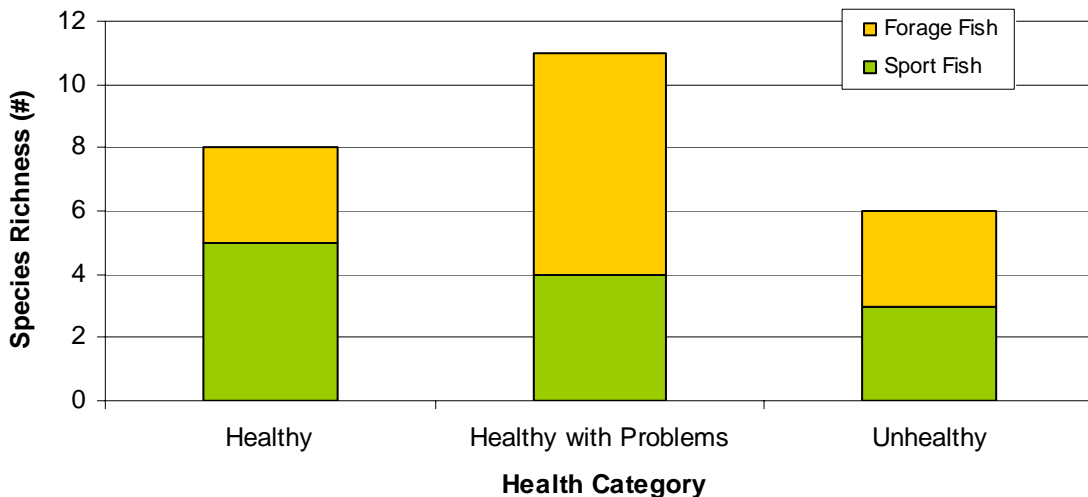
Note: Rainbow x cutthroat trout hybrids were found at each of the creeks.

Comparing the three creeks among the three riparian health categories revealed some consistent trends (Figure 5). Among the riparian sites rated *healthy* at the three creeks, the lowest species richness (one) was found at Bob Creek which trended towards an *unhealthy* watershed. Conversely, the highest species richness (six) at *healthy* riparian sites was found at Todd Creek which trended towards a *healthy* watershed. Pekisko Creek had an intermediate species richness of three at *healthy* sites and trended towards a *healthy with problems* watershed. Interestingly, the highest fish species richness at each of the three creeks was found at the *healthy with problems* sites. At Bob Creek, only forage fish species were found at *unhealthy* sites (*unhealthy* watershed) whereas only sport fish were found at *unhealthy* sites at Pekisko Creek (*healthy with problems* watershed). Unfortunately, no corresponding fisheries data was found for *unhealthy* riparian sites at Todd Creek (Figure 5).



**Figure 5 - Summary of fish species richness at Bob, Todd and Pekisko creeks.** Rainbow x cutthroat trout hybrids are not included in species richness counts.

Comparing riparian health categories with the three creeks combined, *healthy with problem* sites had the highest species richness at 11 (Figure 6), while *healthy* sites had a species richness of 8. *Unhealthy* sites had the lowest fish species richness at six species. However, the species composition differed between the health categories. *Healthy* riparian sites contained all five sport fish species found at the three creeks whereas *healthy with problems* riparian sites contained four sport fish species. The fewest number of sport fish species (three) was found at the *unhealthy* riparian sites. Three forage fish species were found at each of the *healthy* and *unhealthy* riparian sites whereas seven forage fish species were found at *healthy with problems* riparian sites (Figure 6).



**Figure 6 - Summary of sport fish and forage fish species richness by riparian health category for three creeks combined.** Rainbow x cutthroat trout hybrids are not included in species richness counts.



### 3.2.2 Fish Species Composition

Fish species composition varied by riparian health category (Figure 7), as well as by stream (Table 6). Brook trout (BKTR) was the only fish species unique to *healthy* riparian areas (Figure 7). The sport fish cutthroat trout (CTTR) and one forage fish (lake chub, LKCH) were only observed at sites rated *healthy* and *healthy with problems* and were not captured at riparian sites rated *unhealthy*. White suckers (WHSC) were found only at *healthy with problems* and *unhealthy* sites and were not found at *healthy* sites. Rainbow trout (RNTR), bull trout (BLTR), mountain whitefish (MNWH), longnose sucker (LNSC) and longnose dace (LNDC) were common to all riparian health categories. Trout-perch (TRPR), pearl dace (PRDC) and emerald shiner (EMSH) were found only at *healthy with problem* sites (Figure 7; Table 6)

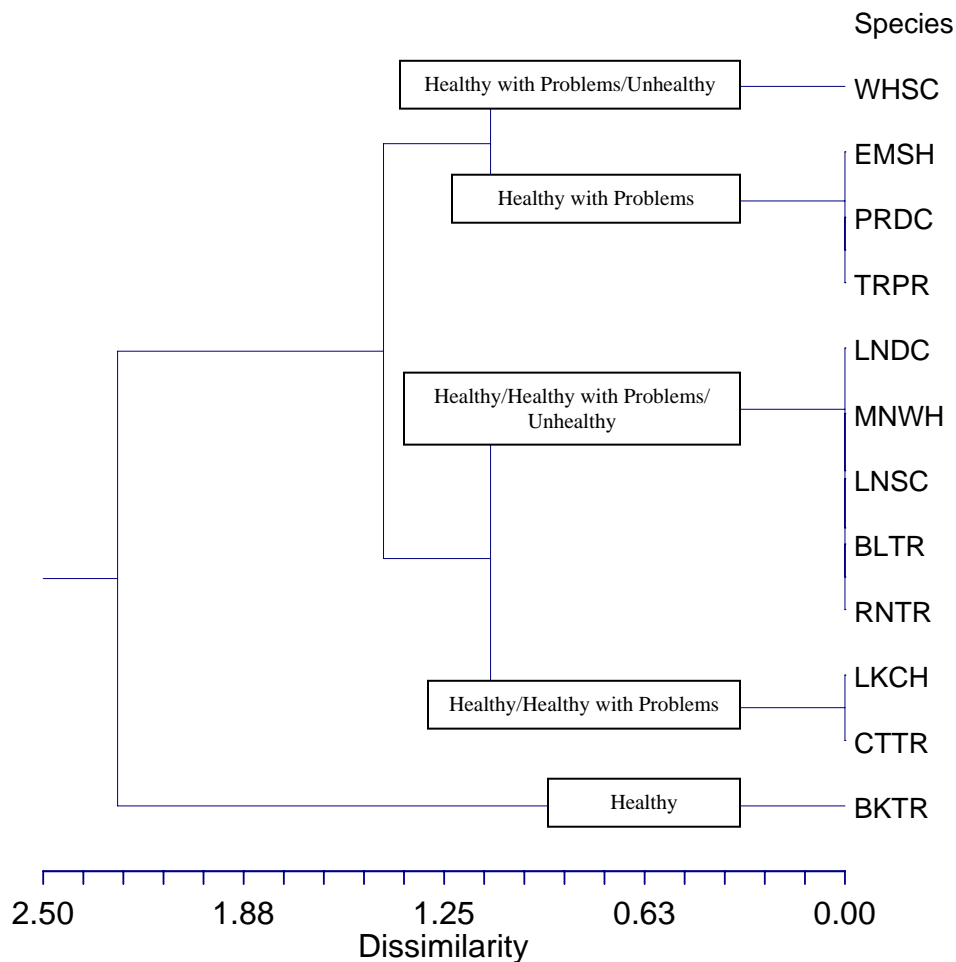


Figure 7 - Dendrogram illustrating fish composition in relationship to riparian health categories.

**Table 6 – Summary of fish species presence/absence at Bob, Todd and Prekisko creeks by riparian health categories.**

Creek	Health Rating	Sport Fish						Forage Fish						Species Richness <sup>a</sup>			
		RNTR	BLTR	BKTR	CTTR	CTTRxRNTR	MNWH	TRPR	PRDC	EMSH	WHSC	LNSC	LKCH	LNDC	Sport	Forage	Total
Bob	H <sup>b</sup>	x												1	0	1	
	HwP <sup>b</sup>		x		x	x				x	x	x	x	2	4	6	
	U <sup>b</sup>									x	x		x	0	3	3	
														<b>total</b>	<b>3</b>	<b>4</b>	<b>7</b>
Todd	H	x	x			x	x					x	x	x	3	3	6
	HwP	x			x			x	x		x	x	x	x	2	6	8
	U													-	-	-	
														<b>total</b>	<b>4</b>	<b>6</b>	<b>10</b>
Prekisko	H	x		x	x	x								3	0	3	
	HwP	x	x		x		x			x				x	4	2	6
	U	x	x				x							3	0	3	
														<b>total</b>	<b>5</b>	<b>2</b>	<b>7</b>
All	H	x	x	x	x	x	x					x	x	x	5	3	8
	HwP	x	x		x	x	x	x	x	x	x	x	x	x	4	7	11
	U	x	x				x				x	x		x	3	3	6
														<b>total</b>	<b>5</b>	<b>7</b>	<b>12</b>

<sup>a</sup> Rainbow x cutthroat trout hybrids are not included in species richness counts.

<sup>b</sup> H = Healthy, HwP = Healthy with Problems, U = Unhealthy

### 3.2.3 Fish Population Estimates

Population estimates and number of trout per kilometre have been calculated by Alberta Sustainable Resource Development and Alberta Conservation Association for Bob and Pekisko creeks (Wieliczko 2001; Table 7). Only *healthy with problems* and *unhealthy* sites have been monitored (n = 5); therefore, rigorous statistical analysis is not possible but some trends are evident.

In 1999 at Bob Creek, no trout were captured at the site rated as *unhealthy* but at the two sites rated *healthy with problems*, the population was estimated at 59 cutthroat trout and 2 trout (cutthroat and rainbow trout). Very few juvenile trout (less than 100 mm long) were captured at any of the Bob Creek sites (Table 7).

At Pekisko Creek, population estimates were completed in 1995, 1996 and 1999 at two sites. There has been a consistent trend in each of the three years for the *healthy with problems* site to contain a higher fish population estimate (trout) compared to the *unhealthy* site; although, the trend was not as strong in 1999. Both sites contained abundant numbers of juvenile trout with a trend for greater numbers of juvenile trout at the *healthy with problems* site compared to the *unhealthy* site; although, again the trend was not as strong in 1999 (Table 7).

Similar to fish species richness, overall watershed health (including riparian health) may play a larger role in determining fish numbers at a given site rather than site-specific riparian health. This trend becomes evident when comparing fish population estimates between Bob and Pekisko creeks at sites with the same riparian health rating. The *unhealthy* site at Pekisko Creek (trending towards a *healthy with problems* watershed) contained on average 153 trout/km compared to 0 trout/km at the Bob Creek *unhealthy* site (trending towards an *unhealthy* watershed). Similarly, the *healthy with problem* site at Pekisko Creek contained on average 291 trout/km compared to 102 trout/km at the Bob Creek *healthy with problem* sites (Table 7).

**Table 7 - Comparative trout population estimates for Bob and Pekisko creeks, 1995, 1996 and 1999.**

Site <sup>a</sup>	Sampling Date	Riparian Health Rating	Trout population estimate <sup>d</sup>	95% Confidence Interval	Estimated number of trout/km	Number of trout captured <100 mm
Bob Creek	August 1999 <sup>b</sup>	HWP <sup>c</sup>	59	58 to 60	197	5
Bob Creek	August 1999 <sup>b</sup>	HWP	2	-3 to 7	7	0
Bob Creek	August 1999 <sup>b</sup>	U <sup>c</sup>	0	0	0	0
Pekisko Creek	Sept. 1995 <sup>c</sup>	HWP	278	260 to 297	556	117
	Oct. 1996 <sup>b</sup>		80	52 to 108	160	1575
	August 1999 <sup>b</sup>		76	72 to 81	156	590
Pekisko Creek	August 1995 <sup>c</sup>	U	130	112 to 148	260	17
	Sept. 1996 <sup>b</sup>		28	27 to 29	56	476
	August 1999 <sup>b</sup>		72	70 to 74	144	520

<sup>a</sup> Sites at Bob Creek were 300 m long and sites at Pekisko Creek were 500 m long.

<sup>b</sup> Backpack electrofishing with Smith Root 15D.

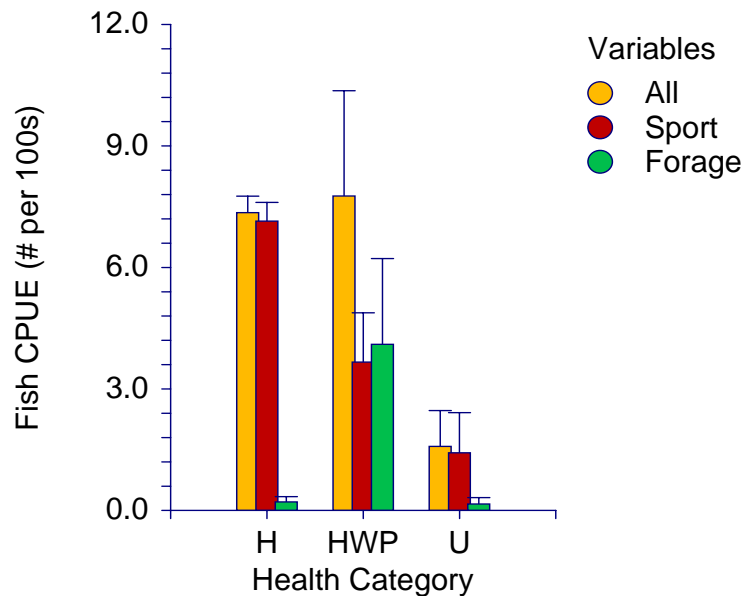
<sup>c</sup> Float electrofishing using a Coffelt VVP with generator.

<sup>d</sup> Trout with a forklength <100 mm were not included in these estimates.

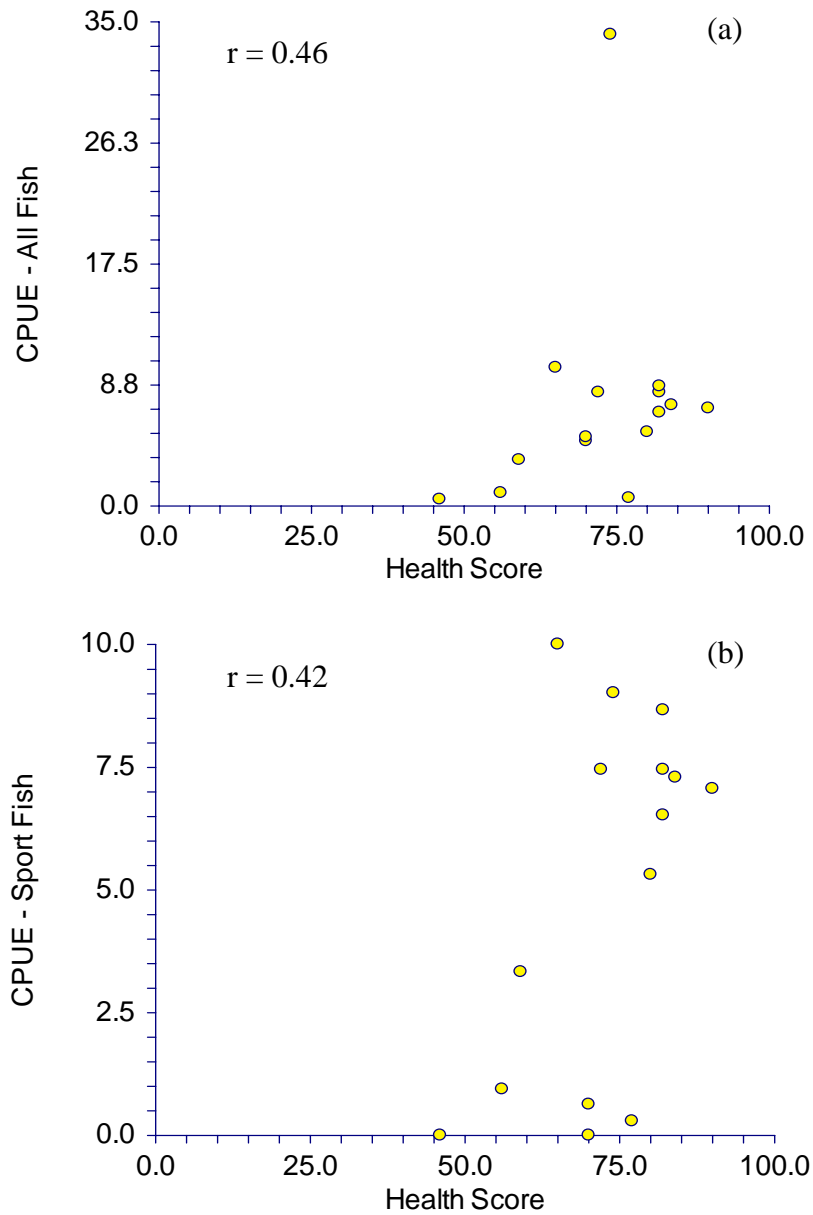
<sup>e</sup> HWP = Healthy with problems; U = Unhealthy.

### 3.2.4 Catch-per-Unit-Effort

Figure 8 summarizes the mean catch-per-unit-effort (No. fish capture per 100 seconds of electrofishing (CPUE)) for *healthy* (n = 6), *healthy with problems* (n = 12) and *unhealthy* (n = 3) riparian sites. There was not a statistical difference in the CPUE for all fish species (ANOVA P=0.39); although, the CPUE at *unhealthy* sites (1.6 fish/100 s) was considerably less than the CPUE at *healthy with problems* (7.8 fish/100 s) and *healthy* (7.2 fish/100 s) sites (Figure 8). Similarly, there was not a statistical difference in the CPUE for forage fish (ANOVA P=0.29); although, the CPUE at *unhealthy* (0.2 fish/100 s) and *healthy* (0.1 fish/100 s) riparian sites was considerably less than the CPUE at *healthy with problems* (4.1 fish/100 s) sites (Figure 8). There was a statistical difference in the CPUE for sport fish species (ANOVA P=0.04) among the health categories; with the CPUE of sport fish statistically greater at *healthy* sites (7.1 fish/100 s) compared to *unhealthy* (1.4 fish/100 s) sites (Figure 8). The relationships between all fish and riparian health score and sport fish and riparian health score were weakly and positively correlated (Spearman Rank Correlation  $r = 0.46$  (all fish) and  $r = 0.42$  (sport fish) (Figure 9).



**Figure 8 – Average fish catch per unit effort for *healthy*, *healthy with problems* and *unhealthy* riparian sites.**



**Figure 9** - Scatter plots of catch-per-unit-effort (CPUE) and health score for all fish (a) and sport fish (b).

Correlations among CPUE of all fish, sport fish and forage fish were determined. The CPUE for forage fish was moderately and negatively correlated to canopy cover of woody species (Spearman Rank Correlation  $r = -0.66$ ). The CPUE for sport fish was moderately and positively correlated to total canopy cover (Spearman Rank Correlation  $r = 0.63$ ). The CPUE for all fish and for sport fish were moderately and positively correlated to vegetation cover in the floodplain (Spearman Rank Correlation  $r = 0.64$ ). The full correlation matrix is provided in Appendix C.

## 4.0 DISCUSSION

### Watershed-Scale Processes

This study showed that watershed-scale and reach-scale processes likely influence fish species richness and abundance. Among the riparian sites rated *healthy* at the three creeks, the lowest species richness was found at Bob Creek which is considered an *unhealthy* watershed. Conversely, the highest species richness at *healthy* riparian sites was found at Todd Creek which was considered a *healthy* watershed. Pekisko Creek had intermediate species richness at *healthy* sites and was considered a *healthy with problems* watershed. Similar to fish species richness, overall watershed health may play a larger role in determining fish numbers at a given site rather than local riparian health. The *unhealthy* and *healthy with problem* sites at Pekisko Creek (a *healthy with problems* watershed) generally contained more fish than the corresponding *unhealthy* and *healthy with problem* sites at Bob Creek (an *unhealthy* watershed). This trend was particularly pronounced when fry and juvenile trout (< 100 mm length) were included in the comparison. If reach or local scale processes were the determining factors for species richness or abundance, similar numbers would have been expected to occur at riparian sites with the same health rating.

The available data for this study does not allow for the determination of the watershed-scale factor(s) that may control species richness or abundance; however, anecdotal evidence suggests sediment and water temperature may play a role. Faulter (2003) observed substantial lengths of unstable stream bank in the Bob Creek watershed and found that the majority of the creek substrate consisted of silt and mud. Coarse substrate (gravel to boulder) is particularly important to trout as it provides spawning substrate, ideal habitat for preferred food sources (e.g., benthic invertebrates) and instream cover for juvenile and adult trout (Bjornn and Reiser 1991). At Bob Creek, very few fry and juvenile trout were captured compared to Pekisko Creek which suggests that poor quality substrate could be contributing to limited spawning success at Bob Creek. Similarly, the number of adult trout per kilometre was lower at Bob Creek compared to Pekisko Creek, and suggests that factors such as reduced instream cover and poorer food sources may be limiting trout numbers in Bob Creek.

Alteration of riparian vegetation can also influence stream water temperatures. Stream temperature is strongly influenced by vegetation structure, with taller vegetation providing more cover and reducing the intensity of solar radiation. Temperature is a major factor in the maintenance of self-sustaining populations of salmonids. Only spot water temperature data is available for Bob and Todd creeks. During July 2003 water temperatures at Bob Creek ranged from 16.1 to 18.0°C. Todd Creek water temperatures were 16.2°C during August 2000, 5.8 to 13.2°C during August 2002 and 8.5°C during June 2008. This data suggests that Bob Creek is warmer than Todd Creek and may not be influenced by cooler groundwater. Optimal water temperatures for adult cutthroat trout are considered to be 12-15°C, with temperatures >22°C considered sub-lethal to lethal (Hickman and Raleigh 1982). Given that cutthroat trout were only found at two of the eight sites sampled at Bob Creek (compared to 8 out of 12 sites at Todd Creek and in higher numbers), the summer water temperatures at Bob Creek may be outside the preferred temperature range for cutthroat trout. Rainbow trout can tolerate warmer water than cutthroat trout, as optimal water temperatures for adult rainbow trout are considered to be 12-18°C, with temperatures >22°C considered sub-lethal to lethal (Raleigh et al. 1984). Rainbow trout were found at three of the eight sites at Bob Creek and at four of twelve sites at Todd Creek. The similar rate of occurrence of rainbow trout at the two creeks suggests that potentially warmer water at Bob Creek may not be limiting rainbow trout numbers to the same degree as cutthroat trout. Todd Creek had 98% canopy cover which was significantly greater than Bob Creek which had 92% canopy cover (ANOVA,  $P < 0.1$ ). The greater canopy cover at Todd Creek may have contributed to overall lower water temperatures and reduced temperature fluctuations compared to Bob Creek.

Wohl and Carline (1996) assessed relationships among riparian grazing, sediment loads, macroinvertebrates, and fishes in three streams in adjacent catchments in Pennsylvania. One creek had not been grazed while the other two creeks had 28 to 32% of their length grazed. The most notable differences among grazed and ungrazed streams were the amount of eroding streambank (81% at grazed versus 6% at ungrazed) and the predominance of fine

substrates in the streambed (63% at grazed versus 27% at ungrazed). The substrate at ungrazed sites had significantly higher densities of benthic macroinvertebrates and significantly higher permeability (i.e., larger pore spaces and less fines) at potential spawning sites for brown trout compared to grazed creeks. Densities of benthic organisms were highest in the ungrazed stream where sediment loads were lowest. Livestock disturbance increased the erosion of streambanks hence the median daily total suspended solids concentration was 5 to 7 times greater at the grazed streams compared to the ungrazed stream. Densities of wild brown trout were 5-23 times higher in the ungrazed creek. The grazed creeks had a daily median August water temperature that was 4.5°C warmer than the ungrazed creek (Wohl and Carline 1996). In this study, the Bob Creek channel was significantly more incised than the Todd Creek channel (ANOVA,  $P < 0.1$ ). Channels that are more incised create more stream energy (due to the inability of the stream to access its floodplain and dissipate water) which can result in more bank erosion, sediment inputs and unstable banks. Similarly, Bob Creek had significantly less root mass protection (score 44%) compared to Todd Creek (score 78%) (ANOVA,  $P < 0.1$ ) suggesting higher bank erosion and increased sediment inputs from the Bob Creek watershed may have contributed to the lower species richness and lower fish abundance when compared to Todd and Pekisko creeks.

When assessing overall watershed health, the impact of extensively eroded stream banks and areas denuded of trees and shrubs should be considered as an important indicator as extensive deposits of sediment and increased stream temperatures can detrimentally impact fish and fish habitat even in areas with healthy riparian habitat.

### Reach Scale Processes

Reach-scale (i.e., local) processes also determine fish species richness and abundance. The results of this study generally indicate that the highest species richness of sport fish were found at *healthy* riparian sites with the lowest species richness of sport and all (sport plus forage) species found at *unhealthy* sites. Similarly, the lowest numbers (as measured by CPUE) of sport fish and all species were found at sites rated *unhealthy* compared to *healthy* and *healthy with problem* sites. Factors influencing the greater richness and abundance of sport fish species at *healthy* sites could include food sources, instream cover, substrate conditions and water temperature.

Saunders and Fausch (2007) studied the input of terrestrial insects to brook trout and brown trout streams based on grazing strategies in Wyoming. Over two summers they sampled falling invertebrate input and trout diets in five pairs of streams that had riparian zones under two different grazing systems: high-density, short-duration (HDS) grazing (mean stocking rate of 2.7 ha/AUM) versus season-long (SL) grazing (mean stocking rate of 14.0 ha/AUM). The biomass of riparian vegetation and the input of terrestrial invertebrates were two to three times greater in riparian zones under HDS grazing management. Similarly, the afternoon diets of individual trout in HDS reaches had on average twice as much terrestrial invertebrate biomass during late summer than those of trout in SL reaches. Diel diet sampling showed that fish in HDS reaches also had consumed more aquatic invertebrate prey, primarily at night. Total trout biomass in HDS reaches was more than twice that in SL reaches. The authors concluded that in rangeland streams, improved grazing management has the potential to influence fish populations through multiple food web pathways (Saunders and Fausch 2007).

Opperman and Merenlender (2004) examined the effectiveness of riparian restoration for improving channel morphology and fish habitat in four hardwood-dominated streams in California. These streams support populations of steelhead (*Oncorhynchus mykiss*) and contain reaches with riparian corridors that were restored through exclusionary fencing implemented 10–20 years earlier. They compared channel morphology, large woody debris (LWD), and late-summer water temperature between the restored fenced reaches and geomorphically similar control reaches (unfenced). Trees were significantly more dense in fenced (0.74 plants/m<sup>2</sup>) versus unfenced (0.08 plants/m<sup>2</sup>) areas. Stream portions within fenced areas had a significantly narrower bankfull width and had greater heterogeneity in long profile elevation (i.e., more pools and riffles) than control reaches. Frequency of LWD (80 - 510 versus 10 - 150 pieces LWD/ha) and debris jams (1.5 versus 0.3 jams/10 bankfull widths) were considerably greater in fenced reaches than control reaches, respectively. Late-summer water temperature in fenced areas (17.7 – 18.2°C) was within the acceptable range for steelhead, whereas water temperature in unfenced reaches (20.2 – 22.7°C) was warmer and potentially detrimental to steelhead.

Riparian restoration in fenced areas resulted in quantitatively improved habitat characteristics and qualitatively different channel morphologies as compared with control reaches (Opperman and Merenlender 2004). Therefore, in this study the greater sport fish species richness at *healthy* sites and greater density of sport fish and all species at *healthy* and *healthy with problem* sites compared to *unhealthy* sites may be due to reduced woody debris, warmer water temperatures, and a reduction in diversity of channel morphology at *unhealthy* sites.

In a study of cumulative effects of riparian disturbance by grazing on the trophic structure of high desert trout streams (Oregon), watersheds with greater riparian canopy had higher standing crops of rainbow trout, lower daily maximum temperatures (range, 16–23°C compared with 26–31°C) and perennial flow (Li et al. 1994). Standing crops of rainbow trout were negatively correlated with solar radiation and maximum temperature in watersheds flowing northward. A different relationship was observed for a set of watersheds with a southern aspect, perhaps due to the presence of spring seeps and stream desiccation in the heavily grazed stream. Trout biomass was negatively correlated with solar radiation, whereas positive relationships were found for discharge and depth. Algal biomass was positively correlated with solar radiation ( $r = 0.91$ ) and total invertebrate biomass ( $r = 0.77$ ) in all watersheds. High irradiance apparently resulted in increased algal biomass and invertebrate abundance; however, the authors cautioned that temperature elevations to levels close to lethal may impose high metabolic costs on rainbow trout, which may offset the benefits of higher food availability (Li et al. 1994).

Elements of riparian areas, such as vegetation and soil stability characteristics, clearly influence aquatic habitat and the types of fish species that can be supported by a stream. In this study, riparian health parameters that separated *healthy*, *healthy with problems* and *unhealthy* sites included the increased presence of mature shrubs (>6 ft tall), greater streambank stability as measured by root mass protection, channel incisement, overall vegetation scores and overall soil/hydrology scores. Riparian areas that were *healthy* or *healthy with problems* scored higher in terms of vegetation and soil hydrology. Rootmass protection functions to armour streambanks and provide stability. Bank vegetation provides a root mass that protects bank soils from erosion and filters out sediments, forming stable banks that contribute less suspended sediment to the water column. Banks having dense vegetation cover will also gradually erode beneath the root mass, creating undercuts which are important cover for fish. Although the data set was somewhat limited, catch-per-unit-effort was moderately correlated to canopy cover and vegetation metrics. Forage fish were negative correlated to cover of woody species, while sport fish were correlated to total canopy cover. All fish (forage plus sport) and sport fish were correlated to vegetation cover of the floodplain. A more robust data set would likely exhibit stronger relationships.

### **Fish Species Richness**

Fish species richness revealed interesting trends and results in this study. At each creek, the overall highest species richness was always found at *healthy with problem* sites, largely as a result of greater numbers of forage fish species; however, at Bob and Pekisko creeks the highest richness of sport fish was also found at *healthy with problem* sites. Combining fish species richness data from all streams by health category also showed the highest overall species richness was found at *healthy with problem* sites, again largely as a result of forage fish species, while sport fish species richness was highest at *healthy* sites and lowest at *unhealthy* sites. Higher species richness at *healthy with problem* sites may seem counterintuitive given the common view that diversity is highest in undisturbed ecosystems; however, this is a consistent trend in ecology across many taxa and is referred to as the Intermediate Disturbance Hypothesis (Newman and Clements 2007). The hypothesis is that moderate levels of disturbance reduces competition for limited resources and allows more species to coexist. Diversity is lower under low disturbance because a small number of species are capable of excluding less competitive species. Diversity is also lower under high disturbance because fewer species are able to persist (Newman and Clements 2007). Townsend and Scarsbrook (1997) studied benthic macroinvertebrate species richness in 27 New Zealand streams and found that the highest richness occurred at streams experiencing moderate substrate disturbance (measured as substrate particle movement) and at those experiencing an intermediate frequency of disturbance. The relationship was similar when considering mobile, sedentary or both mobile and sedentary species together (Townsend and Scarsbrook 1997).



In this study, the lowest species richness at *unhealthy* sites is due to the absence of cutthroat trout, brook trout, trout-perch, pearl dace, emerald shiner and lake chub. Warmer water temperatures, higher silt/sediment and reduced instream cover may have prevented cutthroat trout and brook trout from inhabiting *unhealthy* sites. Competitive exclusion from the more aggressive and territorial trout species may be excluding less aggressive forage fish species from inhabiting *healthy* sites where food resources may also be in limited supply. However, the *healthy with problem* sites may contain habitat of sufficient quality (e.g., water temperature, instream cover) to allow trout species to occur there, but at the same time, moderate disturbance allows for the development of different habitat niches allowing forage fish species to exist in areas not occupied by trout species.

## 5.0 CONCLUSIONS AND RECOMMENDATIONS

### Summary

This study identified a number of linkages among riparian health metrics and fish populations, diversity and abundance. In general, *healthy* riparian areas tended to have greater tree and shrub cover and greater rootmass protection to stabilize streambanks, and less bare ground compared to *unhealthy* sites. When grouped by riparian health category (i.e., *healthy*, *healthy with problems* and *unhealthy*), fisheries data indicated the highest species richness was found at *healthy with problems* sites (including sport and forage fish). However, the highest sport fish species richness (five) was found at *healthy* riparian sites. Generally, *unhealthy* sites contained lower species richness and fewer sport fish species. Moderate correlations were made between catch-per-unit-effort of fish and vegetation metrics, namely between CPUE (forage fish) and canopy cover of woody species, CPUE (sport fish) and total canopy cover and CPUE (all fish and sport fish) and vegetation cover in the floodplain.

Overall watershed health likely plays a larger role in determining fish species richness compared to site-specific riparian health metrics. For example, considering *healthy* sites only, the lowest species richness was found in the creek having the poorest overall watershed health.

To support fish and fish habitat, consider riparian grazing strategies that:

1. Promote dense canopy cover for streams, such as diverse and tall woody plants that provide shade and modify water temperatures suitable for salmonids.
2. Maintain vegetative cover of preferred trees, shrubs and graminoid species that will provide a dense root mass required to maintain stable banks and reduce erosion. This will reduce silt and sediment inputs that may fill the pore spaces of coarse substrate necessary for spawning fish and benthic invertebrates.
3. Allow trees and shrubs to proliferate and contribute large woody debris (LWD) to streams, providing instream habitat diversity and diverse channel morphology.

### Future Research

In a review of fish and grazing relationships, Rinne (1999) concluded that while there was much information in the literature demonstrating the direct impact of livestock grazing on vegetation there was limited information on the indirect effects of grazing on fishes and their habitats (e.g., channel morphology, streambanks, cover, instream substrates). This study focused on riparian and fish population data collected at three creeks in southwestern Alberta over a period of several years; however, for the most part, neither data component was collected for the specific purpose of determining linkages between riparian health and fish habitat. As a result the amount of usable data and sites with coincidental data was limited. Cows and Fish may desire in the future to conduct a specific study to further examine these linkages at Bob, Todd and Pekisko creeks and/or at other creeks. The following provides recommendations for future study design.

- Establish permanent long-term monitoring sites (riparian and fisheries) in order that data trends can be followed through time (e.g., changes to fish populations and habitat as riparian condition improve/degrade).

- Establish 18 monitoring sites at three creeks that correspond with Cows and Fish sites that have been assessed for riparian health. Each site should be 200 m long. Each creek would have six monitoring sites (two for each riparian health category). Bob, Todd and Pekisko creeks would be ideal candidate sites as there is historical data; however, other creeks could be considered.
- At each site, fisheries, fish habitat and benthic invertebrate data should be collected.
- Fisheries data should consist of intensive backpack electrofishing of 200 m sections, with all captured fish measured for length and weight. The fish sampling should focus on both sport and forage fish. Data would be analysed for presence/absence, species richness, catch per unit effort (CPUE), and lifestage usage. All 18 sites should be sampled for fish.
- Each 200 m site should be habitat mapped to show channel morphology (riffle, pool, run and glide). Habitat parameters that should be measured include rooted width (m), substrate composition (%), percent instream cover (boulders, woody debris, undercut banks), unstable banks (m), and overhead cover (%). All 18 sites should be mapped and assessed.
- Benthic invertebrate data should be collected from nine sites (three from each riparian health category) with three replicates taken at each site (27 samples). The benthic invertebrate data should be analysed using standard metrics (e.g., density, richness, %Ephemeroptera-Plecoptera-Trichoptera (%EPT), etc)
- To monitor how riparian health influences water temperature, a minimum of six temperature data loggers should be installed at the three creeks for the months of June, July, August and September. Two loggers should be installed at each creek at a *healthy* and *unhealthy* site (a subset of the 18 sites).

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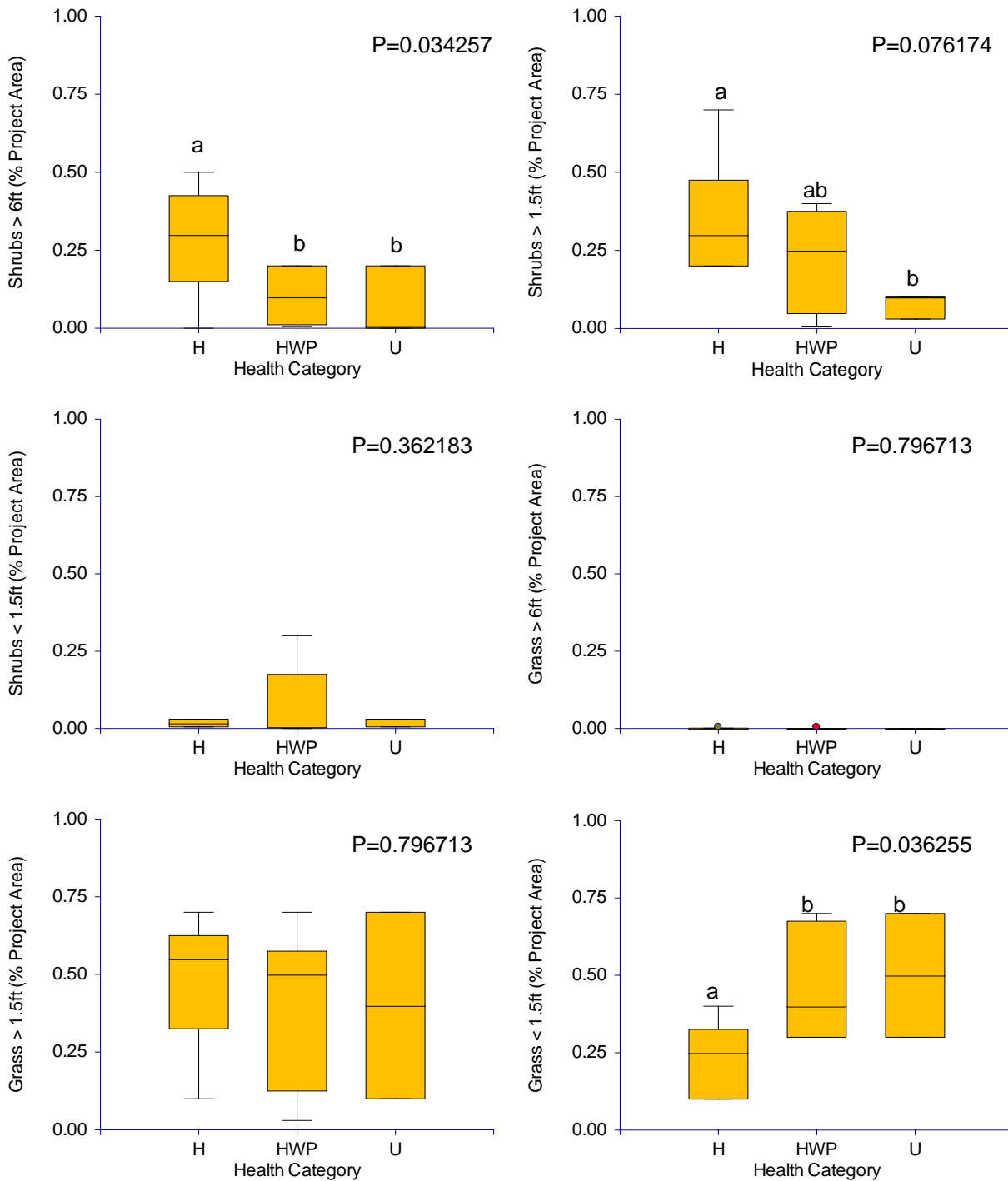
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**Appendix A.**

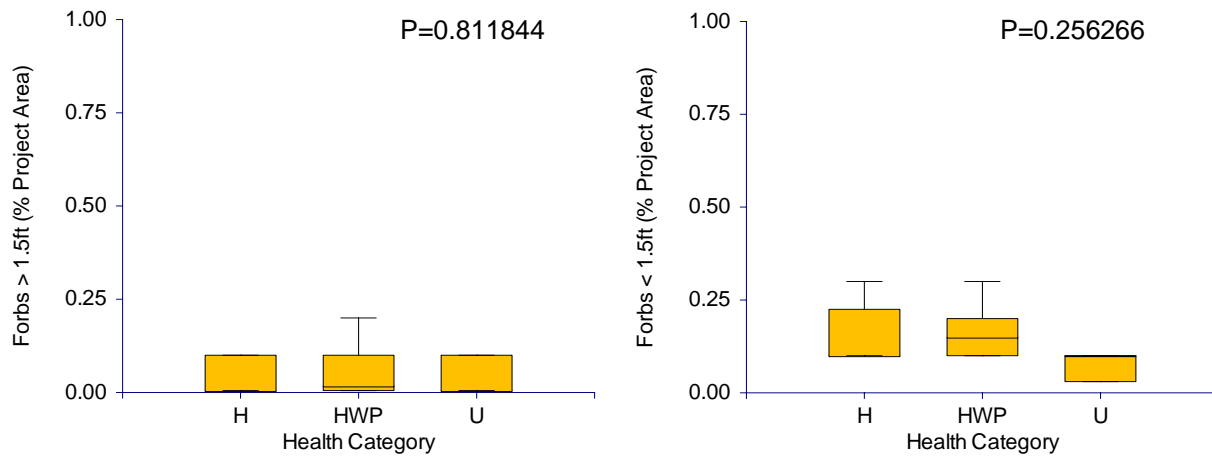
**Photos illustrating *healthy, healthy with problems* and *unhealthy* riparian areas at Bob, Pekisko and Todd creeks.**

Rating	Bob Creek	Pekisko Creek	Todd Creek
<b>Healthy</b>			
<b>Healthy with Problems</b>			
<b>Unhealthy</b>			

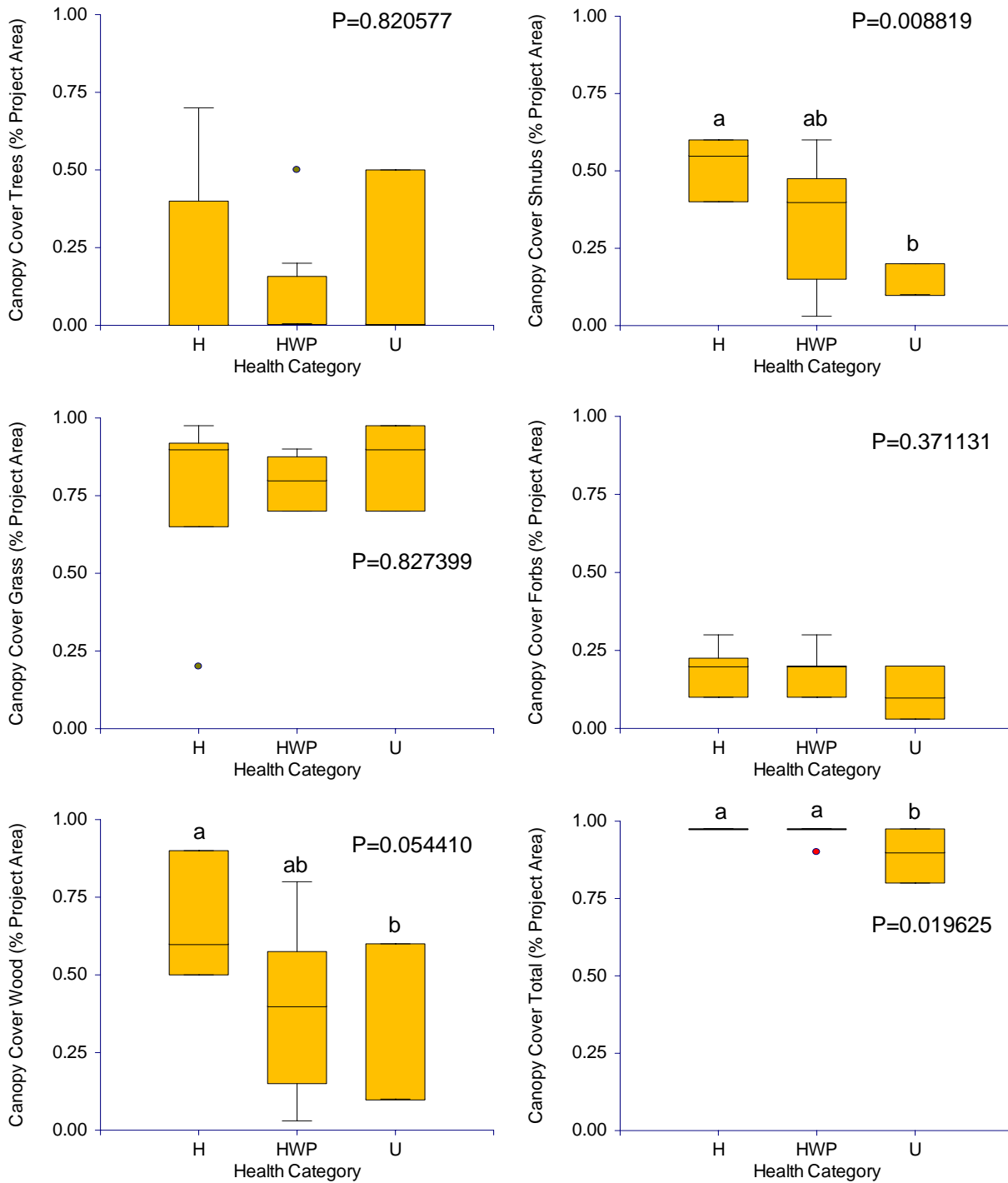
**Appendix B.**  
**Boxplots comparing health categories for the various riparian health metrics (fisheries sites only).**



**Appendix B-1: Comparison of shrub and grass cover in riparian areas having corresponding fisheries data. Health categories having different letters are significantly different (ANOVA, P < 0.10).**

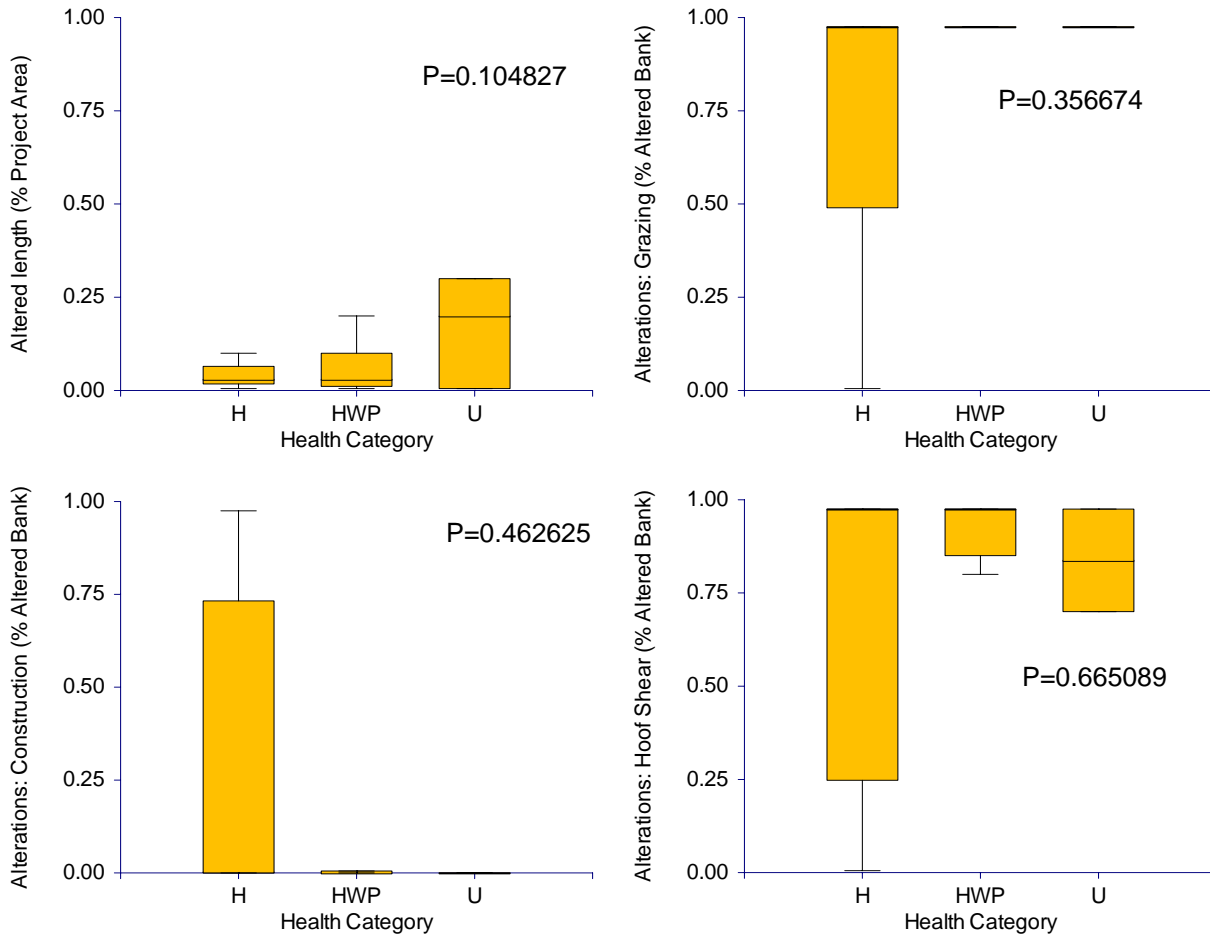


**Appendix B-2: Comparison of forbs data in assessed riparian areas having corresponding fisheries data.**

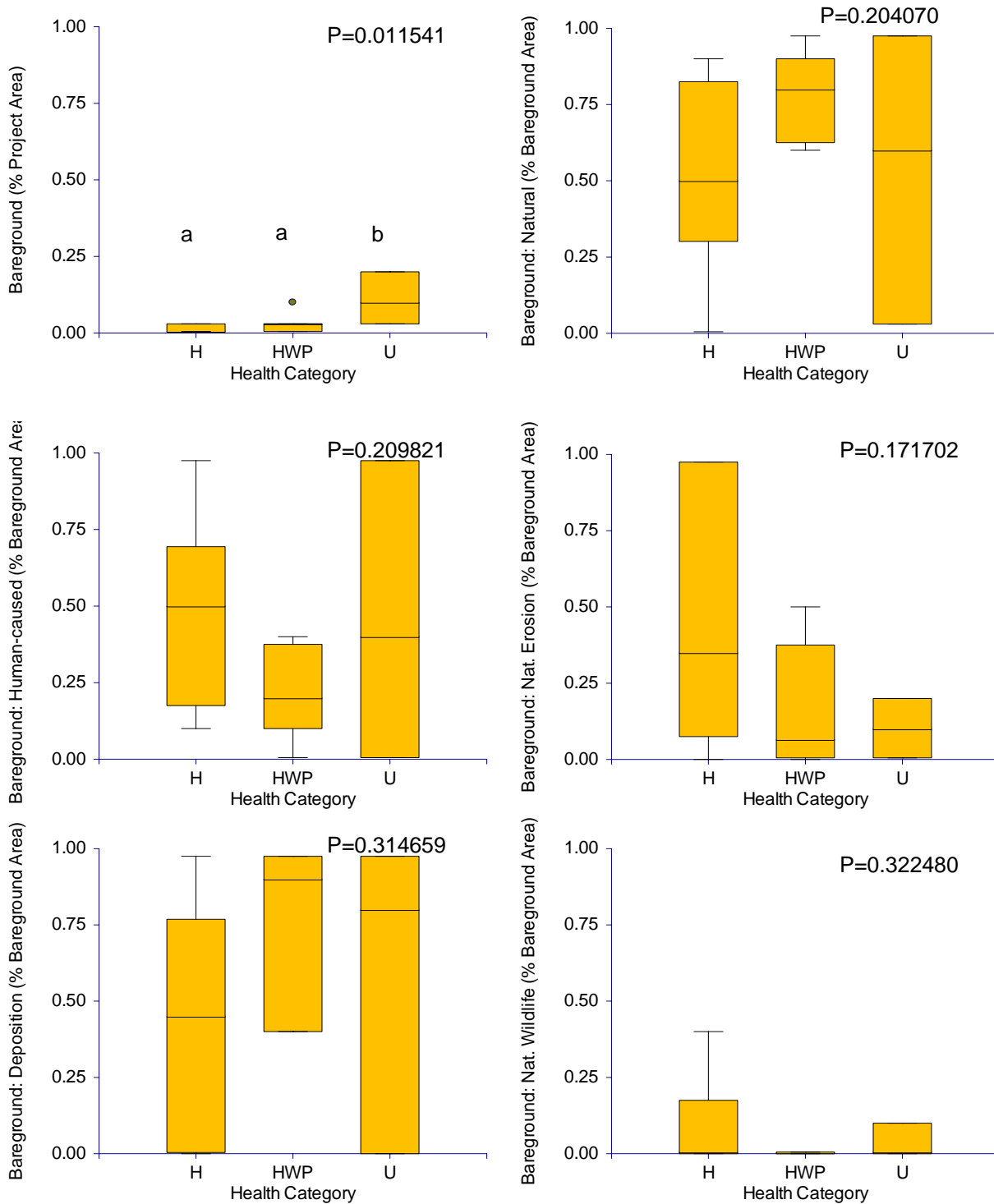


**Appendix B-3: Comparison of canopy cover in assessed riparian areas having corresponding fisheries data. Health categories having different letters are significantly different (ANOVA,  $P < 0.10$ ).**

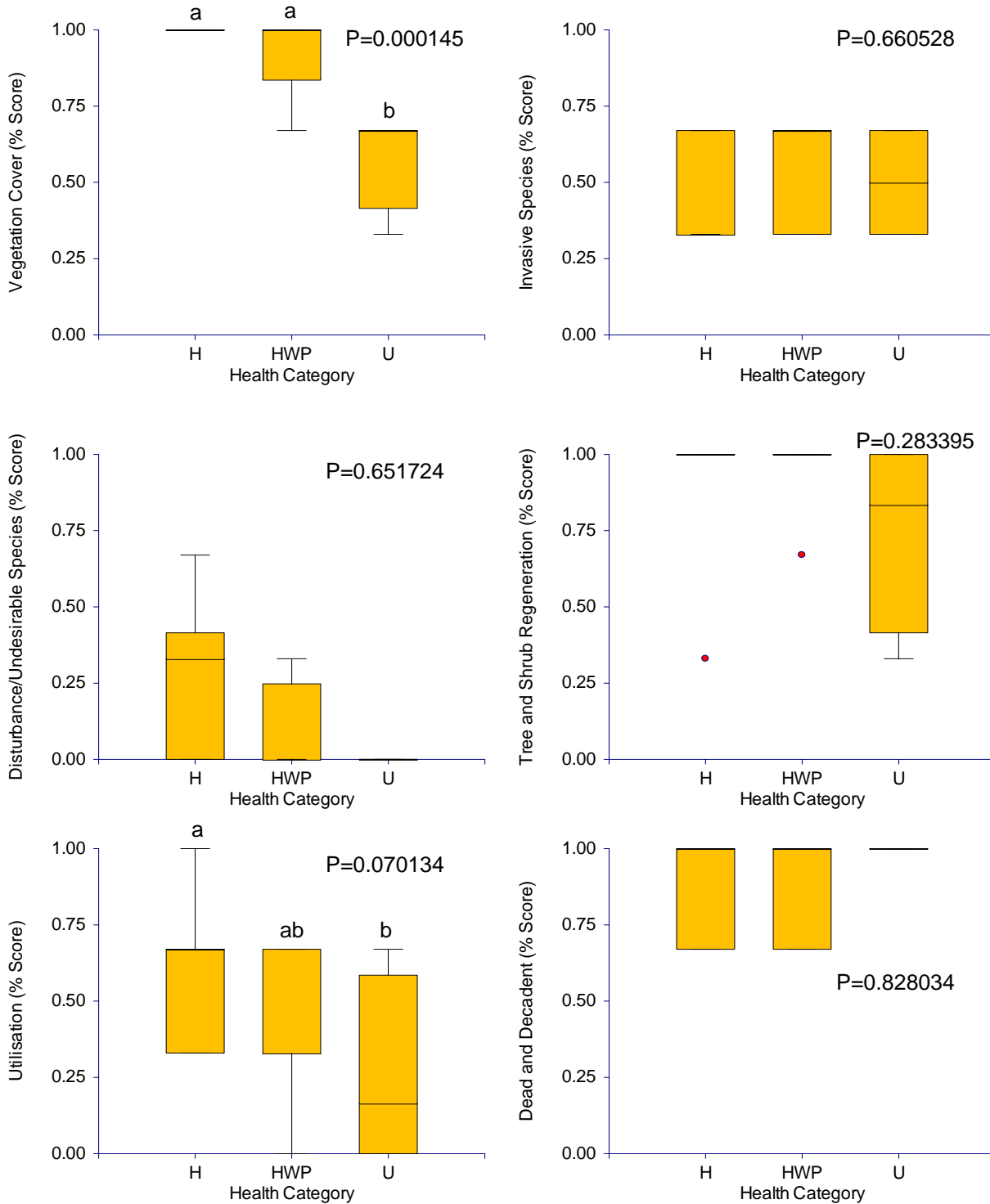




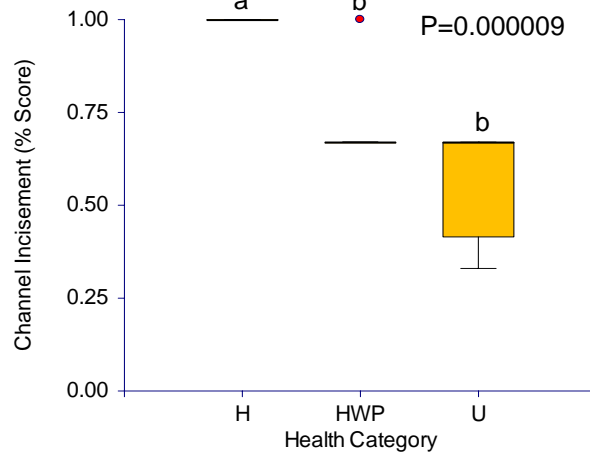
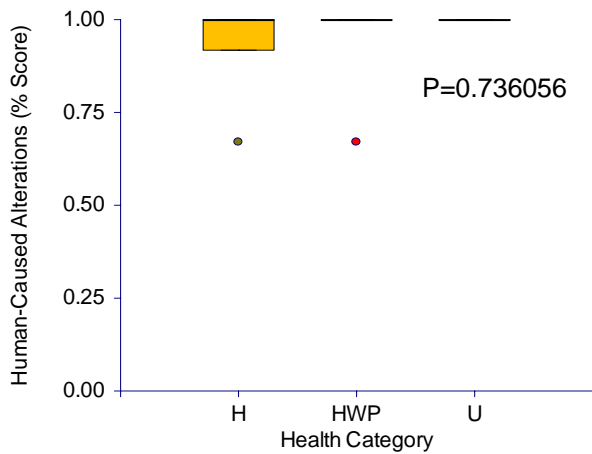
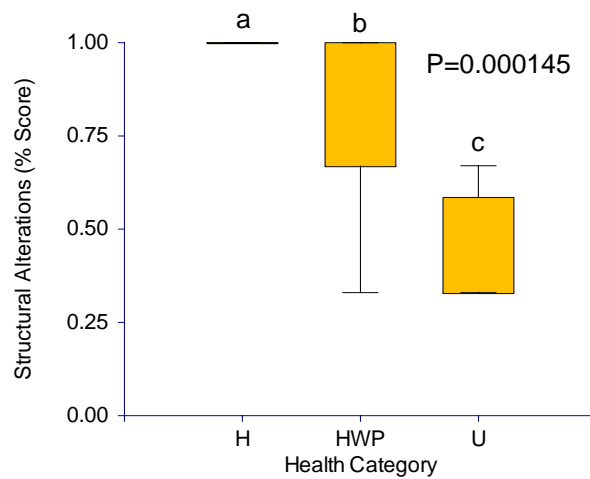
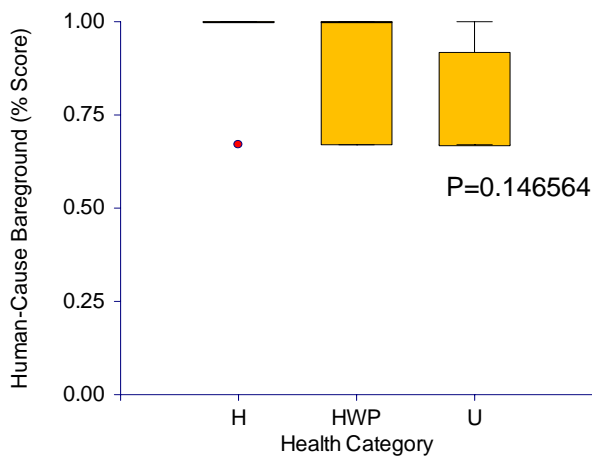
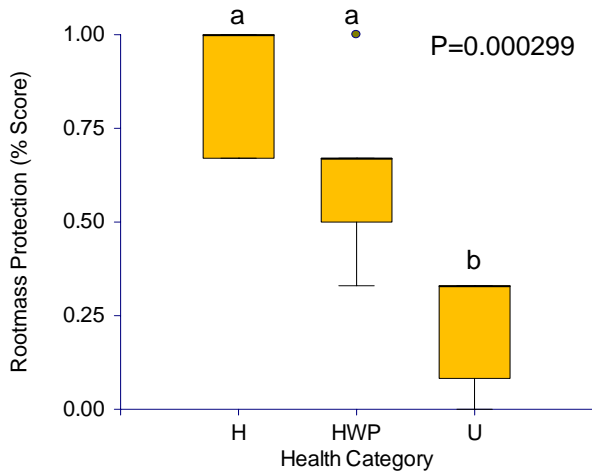
**Appendix B-4: Comparison of alterations to sites in assessed riparian areas having corresponding fisheries data. Health categories having different letters are significantly different (ANOVA,  $P < 0.10$ ).**



**Appendix B-5: Comparison of bareground in assessed riparian areas having corresponding fisheries data. Health categories having different letters are significantly different (ANOVA, P < 0.10).**



**Appendix B-6: Comparison of riparian health assessment (RHA) metrics in assessed riparian areas having corresponding fisheries data. Health categories having different letters are significantly different (ANOVA,  $P < 0.10$ ).**



**Appendix B-7: Comparison of riparian health assessment (RHA) metrics in assessed riparian areas having corresponding fisheries data. Health categories having different letters are significantly different (ANOVA,  $P < 0.10$ ).**

**Appendix C.  
Spearman Rank Correlation matrix.**

**Correlation Report**

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Database

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**Spearman Correlations Section (Pair-Wise Deletion)**

	Health_Score Treesle1_5ft	Size	Trees	Treesgr6ft	Treesgr1_5ft	
Health_Score	1.000000	-0.008299	0.313221	0.048113	-0.146870	0.091099
Size	-0.008299	1.000000	0.311805	0.055241	0.111187	0.123718
Trees	0.313221	0.311805	1.000000	0.288563	0.314598	0.202464
Treesgr6ft	0.048113	0.055241	0.288563	1.000000	0.666491	0.743039
Treesgr1_5ft	-0.146870	0.111187	0.314598	0.666491	1.000000	0.750653
Treesle1_5ft	0.091099	0.123718	0.202464	0.743039	0.750653	1.000000
Shrubsgr6ft	0.669851	0.485460	-0.073393	0.053948	-0.090704	0.304881
Shrubsgr1_5ft	0.510322	0.250721	0.219624	0.135503	-0.079166	-0.036968
Shrubsle1_5ft	-0.293645	0.238042	0.218903	0.169688	-0.130543	-0.234819
Grassgr6ft	0.355353	0.077152	-0.021517	0.291548	0.127141	0.292745
Grassgr1_5ft	0.070497	0.248286	0.012201	0.051219	-0.102491	0.199486
Grassle1_5ft	-0.469794	0.243744	-0.272055	-0.389660	-0.057311	-0.178852
Forbsgr1_5ft	-0.059447	0.095695	0.150460	0.148271	0.053883	0.057863
Forbsle1_5ft	0.188889	0.172898	0.122235	0.274241	0.338325	0.002329
CC_Trees	-0.069328	0.094643	0.376638	0.911274	0.840033	0.772960
CC_Shrubs	0.730480	0.459565	0.135242	0.089502	-0.159543	0.174305
CC_Grass	0.224318	-0.094785	-0.224341	-0.137751	-0.148736	0.210183
CC_Forbs	0.267700	-0.058328	0.117214	0.369552	0.445146	0.188364
CC_Wood	0.600895	0.128328	0.073070	0.529989	0.286434	0.522837
CC_Total	0.562963	0.385758	0.488940	0.321392	0.091269	0.210149
Alterations_	-0.384148	-0.077152	-0.235702	-0.026615	-0.087047	-0.200429
Length	-0.414039	-0.095346	0.211289	-0.249608	-0.176592	-0.442336
Grazing	-0.309200	0.305699	0.258199	0.263965	0.345697	0.251416
Construction	0.516398	0.298142	0.000000	-0.544915	-0.188562	-0.210229
Hoof_Shear_Trampling	0.148768	0.168325	0.066870	-0.048930	0.128046	0.207650
Roads	0.000000	-0.131014	0.250000	-0.261861	0.102827	-0.243975
Trails	-0.641533	0.073398	-0.122336	0.234978	-0.042592	-0.063315
Rip_Rap	0.068041	0.251040	0.513809	0.219313	0.327957	0.620484
Otherx	0.598764	0.045644	-0.428174	-0.344635	-0.491935	-0.354562
AreaBare	-0.683138	-0.041239	-0.077753	0.335344	0.407641	0.228909
Amtnatural	-0.100442	0.094717	0.073208	-0.197095	-0.110266	0.035573
Amthuman	0.084275	-0.094717	-0.073254	0.197220	0.120945	-0.035595
Naterosion	0.213669	-0.236458	0.194365	-0.212369	0.022520	-0.117361
NatDeposition	-0.173172	0.185174	-0.196338	-0.063249	-0.234591	-0.150821
Natwildlife	0.109329	0.223631	0.012959	0.077122	0.134379	0.205203
Nattype	0.384148	0.077152	0.235702	0.026615	0.087047	0.200429
NatSaline	0.384148	0.077152	0.235702	0.026615	0.087047	0.200429
Natvegbottom	0.286891	0.245698	0.493421	-0.220988	-0.178857	-0.133782
Natother	0.026352	0.077152	-0.042949	0.264733	0.417998	0.491046
Hcgrazing	-0.384148	-0.077152	-0.235702	-0.026615	-0.087047	-0.200429
Hcother	0.384148	0.077152	0.235702	0.026615	0.087047	0.200429
Bankmaterial	-0.253170	0.077152	0.292770	0.265251	0.345697	0.251416
MedBoulders	-0.407300	-0.088248	-0.109109	0.309624	0.195308	0.299695

SmBoulders	-0.407300	-0.088248	-0.109109	0.309624	0.195308	0.299695
LgCobble	-0.167197	0.141397	-0.081248	0.214229	0.185036	0.447021
SmCobble	-0.254561	0.080369	-0.065372	0.259906	0.382774	0.505533
Coagravel	-0.244791	-0.272430	-0.113747	0.379464	0.236551	0.475861
Fngravel	0.128146	-0.036601	0.197450	0.390079	0.536547	0.546517
Sand	0.424884	-0.377602	0.500501	0.288991	0.034541	0.264375
SiandCl	0.065963	-0.093391	-0.424918	-0.682134	-0.572047	-0.401940
NoIndsSi	0.466075	-0.192186	-0.071270	-0.165463	-0.203690	-0.044468
TameSi	0.116840	0.052414	0.332592	0.086094	-0.203690	-0.044468
NativeSi	-0.317945	0.156447	-0.080312	0.103460	0.351573	0.156389

	Shrubsgr6ft Grassle1_5ft	Shrubsgr1_5ft	Shrubsle1_5ft	Grassgr6ft	Grassgr1_5ft	
Health_Score	0.669851	0.510322	-0.293645	0.355353	0.070497	-0.469794
Size	0.485460	0.250721	0.238042	0.077152	0.248286	0.243744
Trees	-0.073393	0.219624	0.218903	-0.021517	0.012201	-0.272055
Treesgr6ft	0.053948	0.135503	0.169688	0.291548	0.051219	-0.389660
Treesgr1_5ft	-0.090704	-0.079166	-0.130543	0.127141	-0.102491	-0.057311
Treesle1_5ft	0.304881	-0.036968	-0.234819	0.292745	0.199486	-0.178852
Shrubsgr6ft	1.000000	0.219343	-0.276180	0.341101	0.451961	-0.236401
Shrubsgr1_5ft	0.219343	1.000000	0.359990	0.056707	-0.293190	-0.416012
Shrubsle1_5ft	-0.276180	0.359990	1.000000	-0.279278	0.070534	-0.345296
Grassgr6ft	0.341101	0.056707	-0.279278	1.000000	-0.037804	0.172418
Grassgr1_5ft	0.451961	-0.293190	0.070534	-0.037804	1.000000	-0.439017
Grassle1_5ft	-0.236401	-0.416012	-0.345296	0.172418	-0.439017	1.000000
Forbsgr1_5ft	-0.012755	-0.072804	0.179030	0.063570	0.564762	-0.440577
Forbsle1_5ft	-0.159723	0.280739	-0.106660	0.084163	-0.371278	0.011381
CC_Trees	-0.040976	0.051902	0.052036	0.213944	-0.151813	-0.170960
CC_Shrubs	0.746507	0.719208	0.000671	0.380937	0.123256	-0.309728
CC_Grass	0.486205	-0.324606	-0.490750	0.077233	0.543587	-0.189954
CC_Forbs	-0.070846	0.067302	-0.171886	0.201764	0.015479	-0.279667
CC_Wood	0.564043	0.640026	0.007970	0.358464	0.019509	-0.463702
CC_Total	0.448444	0.291969	-0.096784	0.168325	0.273253	-0.434386
Alterations_	-0.363278	0.051766	0.191209	-0.684653	-0.362361	0.131163
Length	-0.449020	-0.269065	0.296662	-0.349149	-0.231846	0.231881
Grazing	-0.142894	-0.113707	-0.148577	0.066667	-0.255841	0.314848
Construction	0.461521	0.151673	-0.315447	0.000000	0.032890	0.129701
Hoof_Shear_Trampling	0.000000	0.192615	-0.481527	0.000000	-0.303204	0.202841
Roads	-0.251279	-0.344559	-0.455983	0.000000	-0.377964	0.411755
Trails	-0.220758	-0.557939	0.310918	0.000000	0.059432	0.214841
Rip_Rap	0.212909	-0.102778	-0.319210	0.000000	0.194145	0.041015
Otherx	0.515102	0.130186	0.072548	0.000000	0.402158	-0.293942
AreaBare	-0.431683	-0.248445	0.407075	-0.401514	0.040849	-0.082124
Amtnatural	-0.115677	-0.112863	-0.266832	-0.189022	-0.261665	0.361694
Amthuman	0.102467	0.104732	0.275656	0.189141	0.249211	-0.349773
Naterosion	-0.138455	0.088513	-0.091425	-0.301109	-0.190837	-0.171783
NatDeposition	-0.021615	-0.007610	0.138530	0.190104	-0.024731	0.275072
Natwildlife	0.421613	-0.204247	-0.065726	0.120454	0.391752	-0.181894
Natype	0.363278	-0.051766	-0.191209	0.684653	0.362361	-0.131163
NatSaline	0.363278	-0.051766	-0.191209	0.684653	0.362361	-0.131163
Natvegbottom	0.178939	0.199614	-0.196055	0.021840	-0.177758	0.053162
Natother	0.329309	-0.295186	-0.278732	0.399218	0.528227	-0.191201
Hcgrazing	-0.363278	0.051766	0.191209	-0.684653	-0.362361	0.131163
Hcother	0.363278	-0.051766	-0.191209	0.684653	0.362361	-0.131163
Bankmaterial	-0.283624	-0.141812	0.208007	0.066667	-0.199441	0.115560

MedBoulders	0.023013	-0.511617	0.106396	-0.214286	0.176383	0.033785
SmBoulders	0.023013	-0.511617	0.106396	-0.214286	0.176383	0.033785
LgCobble	0.298173	-0.287363	0.045596	0.000000	0.328359	0.045284
SmCobble	0.283907	-0.553636	-0.170750	-0.032097	0.339683	0.097732
Coagravel	0.178530	-0.436643	0.033955	0.063827	0.391216	-0.161325
Fngravel	0.363449	-0.226739	-0.257375	0.032315	0.084548	-0.122279
Sand	0.070056	-0.045022	-0.048806	0.327655	0.111733	-0.285740
SiandCl	0.042304	0.168906	-0.192216	0.000000	-0.271746	0.390926
NoIndsSi	0.340469	0.090619	-0.027126	0.632924	0.408344	-0.325706
TameSi	0.054371	0.090619	0.111218	0.632924	0.253589	-0.168787
NativeSi	-0.178339	-0.150986	-0.137555	-0.576066	-0.373690	0.346597
	Forbsgr1_5ft	Forbsle1_5ft	CC_Trees	CC_Shrubs	CC_Grass	CC_Forbs
Health_Score	-0.059447	0.188889	-0.069328	0.730480	0.224318	0.267700
Size	0.095695	0.172898	0.094643	0.459565	-0.094785	-0.058328
Trees	0.150460	0.122235	0.376638	0.135242	-0.224341	0.117214
Treesgr6ft	0.148271	0.274241	0.911274	0.089502	-0.137751	0.369552
Treesgr1_5ft	0.053883	0.338325	0.840033	-0.159543	-0.148736	0.445146
Treesle1_5ft	0.057863	0.002329	0.772960	0.174305	0.210183	0.188364
Shrubsgr6ft	-0.012755	-0.159723	-0.040976	0.746507	0.486205	-0.070846
Shrubsgr1_5ft	-0.072804	0.280739	0.051902	0.719208	-0.324606	0.067302
Shrubsle1_5ft	0.179030	-0.106660	0.052036	0.000671	-0.490750	-0.171886
Grassgr6ft	0.063570	0.084163	0.213944	0.380937	0.077233	0.201764
Grassgr1_5ft	0.564762	-0.371278	-0.151813	0.123256	0.543587	0.015479
Grassle1_5ft	-0.440577	0.011381	-0.170960	-0.309728	-0.189954	-0.279667
Forbsgr1_5ft	1.000000	0.014949	-0.024728	-0.131765	0.253429	0.442883
Forbsle1_5ft	0.014949	1.000000	0.265036	0.014144	-0.442342	0.791114
CC_Trees	-0.024728	0.265036	1.000000	-0.028111	-0.262432	0.295701
CC_Shrubs	-0.131765	0.014144	-0.028111	1.000000	0.103838	-0.085450
CC_Grass	0.253429	-0.442342	-0.262432	0.103838	1.000000	-0.151933
CC_Forbs	0.442883	0.791114	0.295701	-0.085450	-0.151933	1.000000
CC_Wood	-0.179198	0.114886	0.449399	0.781266	-0.001929	0.123602
CC_Total	0.189881	0.215625	0.267684	0.486567	-0.014338	0.346612
Alterations_	-0.290158	0.144055	0.053265	-0.339053	-0.396583	-0.138139
Length	-0.326213	-0.210846	-0.161393	-0.441902	-0.105180	-0.461687
Grazing	-0.324978	0.155842	0.348045	-0.028623	0.058424	-0.150585
Construction	-0.025000	0.141030	-0.367065	0.212258	-0.120443	0.246622
Hoof_Shear_Trampling	-0.642024	0.383074	-0.062315	0.236532	0.288916	0.011330
Roads	-0.211779	0.280745	-0.032252	-0.444262	-0.097135	0.165494
Trails	0.316228	-0.292008	0.186551	-0.422892	0.165823	-0.259099
Rip_Rap	0.221359	-0.245287	0.420776	0.061959	0.152350	-0.007255
Otherx	0.221359	0.089195	-0.558617	0.289140	0.087057	0.319210
AreaBare	0.189181	-0.090942	0.360374	-0.531732	-0.041043	-0.082917
Amtnatural	-0.118042	0.018950	-0.143379	-0.198227	0.187422	-0.081436
Amthuman	0.118116	-0.018962	0.150610	0.182458	-0.199140	0.081487
Naterosion	-0.028853	0.166308	-0.072344	-0.057563	-0.104522	0.230504
NatDeposition	-0.024170	-0.086116	-0.182696	-0.018530	-0.044695	-0.238259
Natwildlife	0.204946	-0.195301	0.077863	0.050609	0.450103	-0.042888
Natype	0.290158	-0.144055	-0.053265	0.339053	0.396583	0.138139
NatSaline	0.290158	-0.144055	-0.053265	0.339053	0.396583	0.138139
Natvegbottom	-0.097187	-0.038925	-0.107194	0.280424	0.169670	-0.213070
Natother	0.422975	-0.209995	0.230654	0.071566	0.578114	0.201370
Hcgrazing	-0.290158	0.144055	0.053265	-0.339053	-0.396583	-0.138139
Hcother	0.290158	-0.144055	-0.053265	0.339053	0.396583	0.138139
Bankmaterial	0.219989	0.129352	0.353669	-0.344798	-0.174574	0.240935
MedBoulders	-0.137102	-0.584885	0.375335	-0.389258	0.202311	-0.439609

SmBoulders	-0.137102	-0.584885	0.375335	-0.389258	0.202311	-0.439609
LgCobble	-0.009188	-0.477693	0.255443	-0.115314	0.184586	-0.354137
SmCobble	0.003080	-0.523544	0.403999	-0.319412	0.294740	-0.293320
Coagravel	0.009188	-0.740058	0.389989	-0.240079	0.372978	-0.416632
Fngravel	-0.279121	-0.252967	0.614068	-0.013399	0.119468	-0.135604
Sand	-0.248419	-0.154539	0.278278	0.225140	-0.063497	-0.012222
SiandCl	-0.280316	-0.148232	-0.633455	0.157805	0.018182	-0.380119
NolndsSi	0.413118	-0.188931	-0.294604	0.258362	0.188581	0.219943
TameSi	0.413118	-0.188931	-0.043047	0.258362	0.188581	-0.083853
NativeSi	-0.523723	0.239514	0.267177	-0.260475	-0.127953	-0.067384
	CC_Wood Construction	CC_Total	Alterations_	Length	Grazing	
Health_Score	0.600895	0.562963	-0.384148	-0.414039	-0.309200	0.516398
Size	0.128328	0.385758	-0.077152	-0.095346	0.305699	0.298142
Trees	0.073070	0.488940	-0.235702	0.211289	0.258199	0.000000
Treesgr6ft	0.529989	0.321392	-0.026615	-0.249608	0.263965	-0.544915
Treesgr1_5ft	0.286434	0.091269	-0.087047	-0.176592	0.345697	-0.188562
Treesle1_5ft	0.522837	0.210149	-0.200429	-0.442336	0.251416	-0.210229
Shrubsgr6ft	0.564043	0.448444	-0.363278	-0.449020	-0.142894	0.461521
Shrubsgr1_5ft	0.640026	0.291969	0.051766	-0.269065	-0.113707	0.151673
Shrubsle1_5ft	0.007970	-0.096784	0.191209	0.296662	-0.148577	-0.315447
Grassgr6ft	0.358464	0.168325	-0.684653	-0.349149	0.066667	0.000000
Grassgr1_5ft	0.019509	0.273253	-0.362361	-0.231846	-0.255841	0.032890
Grassle1_5ft	-0.463702	-0.434386	0.131163	0.231881	0.314848	0.129701
Forbsgr1_5ft	-0.179198	0.189881	-0.290158	-0.326213	-0.324978	-0.025000
Forbsle1_5ft	0.114886	0.215625	0.144055	-0.210846	0.155842	0.141030
CC_Trees	0.449399	0.267684	0.053265	-0.161393	0.348045	-0.367065
CC_Shrubs	0.781266	0.486567	-0.339053	-0.441902	-0.028623	0.212258
CC_Grass	-0.001929	-0.014338	-0.396583	-0.105180	0.058424	-0.120443
CC_Forbs	0.123602	0.346612	-0.138139	-0.461687	-0.150585	0.246622
CC_Wood	1.000000	0.511850	-0.180839	-0.549595	-0.028298	0.113489
CC_Total	0.511850	1.000000	-0.115244	-0.471405	-0.123443	0.449073
Alterations_	-0.180839	-0.115244	1.000000	0.000000	0.000000	0.000000
Length	-0.549595	-0.471405	0.000000	1.000000	0.349149	-0.466322
Grazing	-0.028298	-0.123443	0.000000	0.349149	1.000000	-0.586302
Construction	0.113489	0.449073	0.000000	-0.466322	-0.586302	1.000000
Hoof_Shear_Trampling	0.240206	0.080648	0.000000	-0.016648	0.579108	-0.061733
Roads	-0.438529	0.132894	0.000000	0.354433	0.071429	0.351781
Trails	-0.537103	-0.522545	0.000000	0.517773	0.317837	-0.519517
Rip_Rap	-0.006836	0.284019	0.000000	-0.405081	0.148324	0.047434
Otherx	0.225583	0.284019	0.000000	-0.454828	-0.741620	0.711512
AreaBare	-0.261344	-0.572484	0.274898	0.343390	0.301169	-0.757072
Amtnatural	-0.332285	-0.110424	0.284712	-0.010872	0.170820	0.296007
Amthuman	0.320530	0.092702	-0.284892	0.024092	-0.170950	-0.296721
Naterosion	0.003133	0.167705	0.025769	-0.055411	-0.310352	0.625034
NatDeposition	-0.254438	-0.397167	0.052062	0.164336	0.172133	-0.501242
Natwildlife	0.076197	0.019878	-0.439837	0.196597	-0.153348	0.338502
Natype	0.180839	0.115244	-1.000000	0.000000	0.000000	0.000000
NatSaline	0.180839	0.115244	-1.000000	0.000000	0.000000	0.000000
Natvegbottom	0.025450	0.330862	-0.209341	0.238961	0.170437	0.382745
Natother	0.263615	0.167996	-0.637760	-0.349149	0.066667	0.000000
Hcgrazing	-0.180839	-0.115244	1.000000	0.000000	0.000000	0.000000
Hcother	0.180839	0.115244	-1.000000	0.000000	0.000000	0.000000
Bankmaterial	-0.227414	-0.123443	-0.066667	0.096664	-0.071429	0.234521
MedBoulders	-0.164970	-0.242163	0.214286	0.296106	0.235004	-0.514344



SmBoulders	-0.164970	-0.242163	0.214286	0.296106	0.235004	-0.514344
LgCobble	-0.093300	-0.327226	0.000000	0.053677	0.000000	-0.312779
SmCobble	-0.104159	-0.120761	0.032097	0.035047	0.035387	-0.120040
Coagravel	0.081171	-0.100279	-0.063827	0.092941	-0.071273	-0.309168
Fngravel	0.350501	0.313977	-0.032315	0.000000	-0.035679	0.356534
Sand	0.300783	0.434854	-0.327655	0.051065	-0.036828	0.000000
SiandCl	-0.129494	-0.370247	0.000000	0.075833	-0.287130	0.345122
NolndsSi	0.177757	0.180300	-0.632924	-0.386654	-1.000000	0.586302
TameSi	0.067470	0.180300	-0.632924	0.193327	0.071429	-0.234521
NativeSi	-0.106369	-0.228571	0.576066	0.169801	0.731925	-0.316228

	Hoof_Shear_Trampling AreaBare	Roads	Trails	Rip_Rap	Otherx	
Health_Score	0.148768	0.000000	-0.641533	0.068041	0.598764	-0.683138
Size	0.168325	-0.131014	0.073398	0.251040	0.045644	-0.041239
Trees	0.066870	0.250000	-0.122336	0.513809	-0.428174	-0.077753
Treesgr6ft	-0.048930	-0.261861	0.234978	0.219313	-0.344635	0.335344
Treesgr1_5ft	0.128046	0.102827	-0.042592	0.327957	-0.491935	0.407641
Treesle1_5ft	0.207650	-0.243975	-0.063315	0.620484	-0.354562	0.228909
Shrubsgr6ft	0.000000	-0.251279	-0.220758	0.212909	0.515102	-0.431683
Shrubsgr1_5ft	0.192615	-0.344559	-0.557939	-0.102778	0.130186	-0.248445
Shrubsle1_5ft	-0.481527	-0.455983	0.310918	-0.319210	0.072548	0.407075
Grassgr6ft	0.000000	0.000000	0.000000	0.000000	0.000000	-0.401514
Grassgr1_5ft	-0.303204	-0.377964	0.059432	0.194145	0.402158	0.040849
Grassle1_5ft	0.202841	0.411755	0.214841	0.041015	-0.293942	-0.082124
Forbsgr1_5ft	-0.642024	-0.211779	0.316228	0.221359	0.221359	0.189181
Forbsle1_5ft	0.383074	0.280745	-0.292008	-0.245287	0.089195	-0.090942
CC_Trees	-0.062315	-0.032252	0.186551	0.420776	-0.558617	0.360374
CC_Shrubs	0.236532	-0.444262	-0.422892	0.061959	0.289140	-0.531732
CC_Grass	0.288916	-0.097135	0.165823	0.152350	0.087057	-0.041043
CC_Forbs	0.011330	0.165494	-0.259099	-0.007255	0.319210	-0.082917
CC_Wood	0.240206	-0.438529	-0.537103	-0.006836	0.225583	-0.261344
CC_Total	0.080648	0.132894	-0.522545	0.284019	0.284019	-0.572484
Alterations_	0.000000	0.000000	0.000000	0.000000	0.000000	0.274898
Length	-0.016648	0.354433	0.517773	-0.405081	-0.454828	0.343390
Grazing	0.579108	0.071429	0.317837	0.148324	-0.741620	0.301169
Construction	-0.061733	0.351781	-0.519517	0.047434	0.711512	-0.757072
Hoof_Shear_Trampling	1.000000	0.231643	-0.457366	-0.124939	-0.312348	-0.254926
Roads	0.231643	1.000000	-0.317837	-0.148324	-0.148324	-0.333037
Trails	-0.457366	-0.317837	1.000000	0.128571	-0.185714	0.720294
Rip_Rap	-0.124939	-0.148324	0.128571	1.000000	-0.220000	-0.087057
Otherx	-0.312348	-0.148324	-0.185714	-0.220000	1.000000	-0.478814
AreaBare	-0.254926	-0.333037	0.720294	-0.087057	-0.478814	1.000000
Amtnatural	0.357347	0.220684	-0.004953	0.436826	-0.020801	-0.107146
Amthuman	-0.390774	-0.220889	0.044682	-0.437880	0.020851	0.124636
Naterosion	-0.052766	0.187086	-0.308909	-0.027029	0.547347	-0.140679
NatDeposition	0.005441	-0.157778	0.288647	0.062706	-0.404105	0.101698
Natwildlife	-0.334348	0.135333	0.244671	-0.513809	0.428174	0.162873
Natype	0.000000	0.000000	0.000000	0.000000	0.000000	-0.274898
NatSaline	0.000000	0.000000	0.000000	0.000000	0.000000	-0.274898
Natvegbottom	0.195122	0.442486	-0.089242	0.046852	-0.031235	-0.366756
Natother	0.000000	-0.071429	0.000000	0.000000	0.000000	0.087218
Hcgrazing	0.000000	0.000000	0.000000	0.000000	0.000000	0.274898
Hcother	0.000000	0.000000	0.000000	0.000000	0.000000	-0.274898
Bankmaterial	-0.231643	0.071429	0.317837	0.148324	0.148324	0.301169

MedBoulders	-0.367118	-0.235004	0.681269	0.384900	-0.320750	0.526199
SmBoulders	-0.367118	-0.235004	0.681269	0.384900	-0.320750	0.526199
LgCobble	-0.422508	-0.353459	0.491697	0.489898	-0.195052	0.428536
SmCobble	-0.450556	-0.035387	0.376933	0.505291	-0.243288	0.374133
Coagravel	-0.539073	-0.178182	0.350470	0.283393	-0.171894	0.357113
Fngravel	-0.215133	0.285428	-0.378215	0.286888	-0.100411	0.012054
Sand	0.053846	0.036828	-0.274790	0.375186	0.000000	-0.424700
SiandCl	-0.166024	0.000000	0.053738	-0.308158	0.391312	-0.224480
NoInndsSi	-0.579108	-0.071429	-0.317837	-0.148324	0.741620	-0.439886
TameSi	-0.231643	-0.071429	0.317837	-0.148324	-0.148324	-0.136090
NativeSi	0.624695	0.104561	0.042857	0.220000	-0.500000	0.346212

	Amtnatural	Amthuman	Naterosion	NatDeposition	Natwildlife	Nattype
Health_Score	-0.100442	0.084275	0.213669	-0.173172	0.109329	0.384148
Size	0.094717	-0.094717	-0.236458	0.185174	0.223631	0.077152
Trees	0.073208	-0.073254	0.194365	-0.196338	0.012959	0.235702
Treesgr6ft	-0.197095	0.197220	-0.212369	-0.063249	0.077122	0.026615
Treesgr1_5ft	-0.110266	0.120945	0.022520	-0.234591	0.134379	0.087047
Treesle1_5ft	0.035573	-0.035595	-0.117361	-0.150821	0.205203	0.200429
Shrubsgr6ft	-0.115677	0.102467	-0.138455	-0.021615	0.421613	0.363278
Shrubsgr1_5ft	-0.112863	0.104732	0.088513	-0.007610	-0.204247	-0.051766
Shrubsle1_5ft	-0.266832	0.275656	-0.091425	0.138530	-0.065726	-0.191209
Grassgr6ft	-0.189022	0.189141	-0.301109	0.190104	0.120454	0.684653
Grassgr1_5ft	-0.261665	0.249211	-0.190837	-0.024731	0.391752	0.362361
Grassle1_5ft	0.361694	-0.349773	-0.171783	0.275072	-0.181894	-0.131163
Forbsgr1_5ft	-0.118042	0.118116	-0.028853	-0.024170	0.204946	0.290158
Forbsle1_5ft	0.018950	-0.018962	0.166308	-0.086116	-0.195301	-0.144055
CC_Trees	-0.143379	0.150610	-0.072344	-0.182696	0.077863	-0.053265
CC_Shrubs	-0.198227	0.182458	-0.057563	-0.018530	0.050609	0.339053
CC_Grass	0.187422	-0.199140	-0.104522	-0.044695	0.450103	0.396583
CC_Forbs	-0.081436	0.081487	0.230504	-0.238259	-0.042888	0.138139
CC_Wood	-0.332285	0.320530	0.003133	-0.254438	0.076197	0.180839
CC_Total	-0.110424	0.092702	0.167705	-0.397167	0.019878	0.115244
Alterations_	0.284712	-0.284892	0.025769	0.052062	-0.439837	-1.000000
Length	-0.010872	0.024092	-0.055411	0.164336	0.196597	0.000000
Grazing	0.170820	-0.170950	-0.310352	0.172133	-0.153348	0.000000
Construction	0.296007	-0.296721	0.625034	-0.501242	0.338502	0.000000
Hoof_Shear_Trampling	0.357347	-0.390774	-0.052766	0.005441	-0.334348	0.000000
Roads	0.220684	-0.220889	0.187086	-0.157778	0.135333	0.000000
Trails	-0.004953	0.044682	-0.308909	0.288647	0.244671	0.000000
Rip_Rap	0.436826	-0.437880	-0.027029	0.062706	-0.513809	0.000000
Otherx	-0.020801	0.020851	0.547347	-0.404105	0.428174	0.000000
AreaBare	-0.107146	0.124636	-0.140679	0.101698	0.162873	-0.274898
Amtnatural	1.000000	-0.999369	0.069053	0.106533	-0.225676	-0.284712
Amthuman	-0.999369	1.000000	-0.057162	-0.112946	0.235200	0.284892
Naterosion	0.069053	-0.057162	1.000000	-0.857998	0.222686	-0.025769
NatDeposition	0.106533	-0.112946	-0.857998	1.000000	-0.399382	-0.052062
Natwildlife	-0.225676	0.235200	0.222686	-0.399382	1.000000	0.439837
Nattype	-0.284712	0.284892	-0.025769	-0.052062	0.439837	1.000000
NatSaline	-0.284712	0.284892	-0.025769	-0.052062	0.439837	1.000000
Natvegbottom	0.267366	-0.267535	0.454778	-0.435949	0.370625	0.209341
Natother	-0.295186	0.295372	-0.037565	-0.337054	0.577522	0.637760
Hcgrazing	0.284712	-0.284892	0.025769	0.052062	-0.439837	-1.000000
Hcother	-0.284712	0.284892	-0.025769	-0.052062	0.439837	1.000000
Bankmaterial	0.427049	-0.398882	0.424795	-0.341639	0.301169	0.066667

MedBoulders	0.014726	-0.014726	-0.472374	0.322179	0.026643	-0.214286
SmBoulders	0.014726	-0.014726	-0.472374	0.322179	0.026643	-0.214286
LgCobble	0.018798	-0.018798	-0.543503	0.576717	0.107134	0.000000
SmCobble	-0.011344	0.011344	-0.441436	0.267925	0.254410	-0.032097
Coagravel	-0.132527	0.132527	-0.438911	0.149554	0.300570	0.063827
Fngravel	-0.228419	0.228419	0.085105	-0.365342	0.488173	0.032315
Sand	-0.151505	0.151505	0.263666	-0.261989	-0.082496	0.327655
SiandCl	0.091696	-0.091696	0.469613	-0.158875	0.161625	0.000000
NoIndsSi	-0.283284	0.283500	0.202940	-0.152038	0.379402	0.632924
TameSi	-0.283284	0.283500	0.071094	-0.152038	0.379402	0.632924
NativeSi	0.322886	-0.323132	-0.243618	0.222945	-0.404301	-0.576066

	NatSaline Bankmaterial	Natvegbottom	Natother	Hcgrazing	Hcother	
Health_Score	0.384148	0.286891	0.026352	-0.384148	0.384148	-0.253170
Size	0.077152	0.245698	0.077152	-0.077152	0.077152	0.077152
Trees	0.235702	0.493421	-0.042949	-0.235702	0.235702	0.292770
Treesgr6ft	0.026615	-0.220988	0.264733	-0.026615	0.026615	0.265251
Treesgr1_5ft	0.087047	-0.178857	0.417998	-0.087047	0.087047	0.345697
Treesle1_5ft	0.200429	-0.133782	0.491046	-0.200429	0.200429	0.251416
Shrubsgr6ft	0.363278	0.178939	0.329309	-0.363278	0.363278	-0.283624
Shrubsgr1_5ft	-0.051766	0.199614	-0.295186	0.051766	-0.051766	-0.141812
Shrubsle1_5ft	-0.191209	-0.196055	-0.278732	0.191209	-0.191209	0.208007
Grassgr6ft	0.684653	0.021840	0.399218	-0.684653	0.684653	0.066667
Grassgr1_5ft	0.362361	-0.177758	0.528227	-0.362361	0.362361	-0.199441
Grassle1_5ft	-0.131163	0.053162	-0.191201	0.131163	-0.131163	0.115560
Forbsgr1_5ft	0.290158	-0.097187	0.422975	-0.290158	0.290158	0.219989
Forbsle1_5ft	-0.144055	-0.038925	-0.209995	0.144055	-0.144055	0.129352
CC_Trees	-0.053265	-0.107194	0.230654	0.053265	-0.053265	0.353669
CC_Shrubs	0.339053	0.280424	0.071566	-0.339053	0.339053	-0.344798
CC_Grass	0.396583	0.169670	0.578114	-0.396583	0.396583	-0.174574
CC_Forbs	0.138139	-0.213070	0.201370	-0.138139	0.138139	0.240935
CC_Wood	0.180839	0.025450	0.263615	-0.180839	0.180839	-0.227414
CC_Total	0.115244	0.330862	0.167996	-0.115244	0.115244	-0.123443
Alterations_ Length	-1.000000	-0.209341	-0.637760	1.000000	-1.000000	-0.066667
Grazing	0.000000	0.238961	-0.349149	0.000000	0.000000	0.096664
Construction	0.000000	0.170437	0.066667	0.000000	0.000000	-0.071429
Hoof_Shear_Trampling	0.000000	0.382745	0.000000	0.000000	0.000000	0.234521
Roads	0.000000	0.195122	0.000000	0.000000	0.000000	-0.231643
Trails	0.000000	0.442486	-0.071429	0.000000	0.000000	0.071429
Rip_Rap	0.000000	-0.089242	0.000000	0.000000	0.000000	0.317837
Otherx	0.000000	0.046852	0.000000	0.000000	0.000000	0.148324
AreaBare	0.000000	-0.031235	0.000000	0.000000	0.000000	0.148324
AreaBare	-0.274898	-0.366756	0.087218	0.274898	-0.274898	0.301169
Amtnatural	-0.284712	0.267366	-0.295186	0.284712	-0.284712	0.427049
Amthuman	0.284892	-0.267535	0.295372	-0.284892	0.284892	-0.398882
Naterosion	-0.025769	0.454778	-0.037565	0.025769	-0.025769	0.424795
NatDeposition	-0.052062	-0.435949	-0.337054	0.052062	-0.052062	-0.341639
Natwildlife	0.439837	0.370625	0.577522	-0.439837	0.439837	0.301169
Natype	1.000000	0.209341	0.637760	-1.000000	1.000000	0.066667
NatSaline	1.000000	0.209341	0.637760	-1.000000	1.000000	0.066667
Natvegbottom	0.209341	1.000000	0.005129	-0.209341	0.209341	0.193460
Natother	0.637760	0.005129	1.000000	-0.637760	0.637760	0.097373
Hcgrazing	-1.000000	-0.209341	-0.637760	1.000000	-1.000000	-0.066667
Hcother	1.000000	0.209341	0.637760	-1.000000	1.000000	0.066667

Bankmaterial	0.066667	0.193460	0.097373	-0.066667	0.066667	1.000000
MedBoulders	-0.214286	-0.384700	0.076678	0.214286	-0.214286	0.000000
SmBoulders	-0.214286	-0.384700	0.076678	0.214286	-0.214286	0.000000
LgCobble	0.000000	-0.436470	0.000000	0.000000	0.000000	0.000000
SmCobble	-0.032097	-0.325830	0.278779	0.032097	-0.032097	0.000000
Coagravel	0.063827	-0.328134	0.392419	-0.063827	0.063827	0.000000
Fngravel	0.032315	0.109700	0.350055	-0.032315	0.032315	0.000000
Sand	0.327655	0.117646	-0.006395	-0.327655	0.327655	0.000000
SiandCl	0.000000	0.370881	-0.250588	0.000000	0.000000	0.000000
NoIndsSi	0.632924	-0.017660	0.357778	-0.632924	0.632924	0.097373
TameSi	0.632924	0.507737	0.357778	-0.632924	0.632924	0.097373
NativeSi	-0.576066	-0.261201	-0.298621	0.576066	-0.576066	-0.123443
	MedBoulders	SmBoulders	LgCobble	SmCobble	Coagravel	Fngravel
Health_Score	-0.407300	-0.407300	-0.167197	-0.254561	-0.244791	0.128146
Size	-0.088248	-0.088248	0.141397	0.080369	-0.272430	-0.036601
Trees	-0.109109	-0.109109	-0.081248	-0.065372	-0.113747	0.197450
Treesgr6ft	0.309624	0.309624	0.214229	0.259906	0.379464	0.390079
Treesgr1_5ft	0.195308	0.195308	0.185036	0.382774	0.236551	0.536547
Treesle1_5ft	0.299695	0.299695	0.447021	0.505533	0.475861	0.546517
Shrubsgr6ft	0.023013	0.023013	0.298173	0.283907	0.178530	0.363449
Shrubsgr1_5ft	-0.511617	-0.511617	-0.287363	-0.553636	-0.436643	-0.226739
Shrubsle1_5ft	0.106396	0.106396	0.045596	-0.170750	0.033955	-0.257375
Grassgr6ft	-0.214286	-0.214286	0.000000	-0.032097	0.063827	0.032315
Grassgr1_5ft	0.176383	0.176383	0.328359	0.339683	0.391216	0.084548
Grassle1_5ft	0.033785	0.033785	0.045284	0.097732	-0.161325	-0.122279
Forbsgr1_5ft	-0.137102	-0.137102	-0.009188	0.003080	0.009188	-0.279121
Forbsle1_5ft	-0.584885	-0.584885	-0.477693	-0.523544	-0.740058	-0.252967
CC_Trees	0.375335	0.375335	0.255443	0.403999	0.389989	0.614068
CC_Shrubs	-0.389258	-0.389258	-0.115314	-0.319412	-0.240079	-0.013399
CC_Grass	0.202311	0.202311	0.184586	0.294740	0.372978	0.119468
CC_Forbs	-0.439609	-0.439609	-0.354137	-0.293320	-0.416632	-0.135604
CC_Wood	-0.164970	-0.164970	-0.093300	-0.104159	0.081171	0.350501
CC_Total	-0.242163	-0.242163	-0.327226	-0.120761	-0.100279	0.313977
Alterations_	0.214286	0.214286	0.000000	0.032097	-0.063827	-0.032315
Length	0.296106	0.296106	0.053677	0.035047	0.092941	0.000000
Grazing	0.235004	0.235004	0.000000	0.035387	-0.071273	-0.035679
Construction	-0.514344	-0.514344	-0.312779	-0.120040	-0.309168	0.356534
Hoof_Shear_Trampling	-0.367118	-0.367118	-0.422508	-0.450556	-0.539073	-0.215133
Roads	-0.235004	-0.235004	-0.353459	-0.035387	-0.178182	0.285428
Trails	0.681269	0.681269	0.491697	0.376933	0.350470	-0.378215
Rip_Rap	0.384900	0.384900	0.489898	0.505291	0.283393	0.286888
Otherx	-0.320750	-0.320750	-0.195052	-0.243288	-0.171894	-0.100411
AreaBare	0.526199	0.526199	0.428536	0.374133	0.357113	0.012054
Amtnatural	0.014726	0.014726	0.018798	-0.011344	-0.132527	-0.228419
Amthuman	-0.014726	-0.014726	-0.018798	0.011344	0.132527	0.228419
Naterosion	-0.472374	-0.472374	-0.543503	-0.441436	-0.438911	0.085105
NatDeposition	0.322179	0.322179	0.576717	0.267925	0.149554	-0.365342
Natwildlife	0.026643	0.026643	0.107134	0.254410	0.300570	0.488173
Natype	-0.214286	-0.214286	0.000000	-0.032097	0.063827	0.032315
NatSaline	-0.214286	-0.214286	0.000000	-0.032097	0.063827	0.032315
Natvegbottom	-0.384700	-0.384700	-0.436470	-0.325830	-0.328134	0.109700
Natother	0.076678	0.076678	0.000000	0.278779	0.392419	0.350055
Hcgrazing	0.214286	0.214286	0.000000	0.032097	-0.063827	-0.032315
Hcother	-0.214286	-0.214286	0.000000	-0.032097	0.063827	0.032315

Bankmaterial	0.000000	0.000000	0.000000	0.000000	0.000000	0.000000
MedBoulders	1.000000	1.000000	0.714861	0.823824	0.831877	0.428716
SmBoulders	1.000000	1.000000	0.714861	0.823824	0.831877	0.428716
LgCobble	0.714861	0.714861	1.000000	0.836534	0.663498	0.321488
SmCobble	0.823824	0.823824	0.836534	1.000000	0.835578	0.658292
Coagravel	0.831877	0.831877	0.663498	0.835578	1.000000	0.625651
Fngravel	0.428716	0.428716	0.321488	0.658292	0.625651	1.000000
Sand	0.096112	0.096112	0.021471	0.014723	0.206901	0.298448
SiandCl	-0.436520	-0.436520	-0.169219	-0.355769	-0.371899	-0.274934
NoIndsSi	-0.313682	-0.313682	0.000000	-0.046985	0.093433	0.047305
TameSi	-0.313682	-0.313682	-0.274070	-0.322632	-0.105891	-0.204987
NativeSi	0.398683	0.398683	0.188683	0.249485	0.018472	0.113566
	Sand	SiandCl	NoIndsSi	TameSi	NativeSi	Tame
Health_Score	0.424884	0.065963	0.466075	0.116840	-0.317945	0.128070
Size	-0.377602	-0.093391	-0.192186	0.052414	0.156447	-0.209766
Trees	0.500501	-0.424918	-0.071270	0.332592	-0.080312	0.083438
Treesgr6ft	0.288991	-0.682134	-0.165463	0.086094	0.103460	-0.056696
Treesgr1_5ft	0.034541	-0.572047	-0.203690	-0.203690	0.351573	-0.120913
Treesle1_5ft	0.264375	-0.401940	-0.044468	-0.044468	0.156389	-0.094715
Shrubsgr6ft	0.070056	0.042304	0.340469	0.054371	-0.178339	0.060017
Shrubsgr1_5ft	-0.045022	0.168906	0.090619	0.090619	-0.150986	-0.136402
Shrubsle1_5ft	-0.048806	-0.192216	-0.027126	0.111218	-0.137555	-0.125760
Grassgr6ft	0.327655	0.000000	0.632924	0.632924	-0.576066	0.444591
Grassgr1_5ft	0.111733	-0.271746	0.408344	0.253589	-0.373690	0.305106
Grassle1_5ft	-0.285740	0.390926	-0.325706	-0.168787	0.346597	-0.179696
Forbsgr1_5ft	-0.248419	-0.280316	0.413118	0.413118	-0.523723	0.499773
Forbsle1_5ft	-0.154539	-0.148232	-0.188931	-0.188931	0.239514	-0.143081
CC_Trees	0.278278	-0.633455	-0.294604	-0.043047	0.267177	-0.103943
CC_Shrubs	0.225140	0.157805	0.258362	0.258362	-0.260475	-0.038692
CC_Grass	-0.063497	0.018182	0.188581	0.188581	-0.127953	0.205230
CC_Forbs	-0.012222	-0.380119	0.219943	-0.083853	-0.067384	0.160290
CC_Wood	0.300783	-0.129494	0.177757	0.067470	-0.106369	-0.021874
CC_Total	0.434854	-0.370247	0.180300	0.180300	-0.228571	0.316624
Alterations_	-0.327655	0.000000	-0.632924	-0.632924	0.576066	-0.444591
Length	0.051065	0.075833	-0.386654	0.193327	0.169801	-0.109985
Grazing	-0.036828	-0.287130	-1.000000	0.071429	0.731925	-0.516785
Construction	0.000000	0.345122	0.586302	-0.234521	-0.316228	0.428661
Hoof_Shear_Trampling	0.053846	-0.166024	-0.579108	-0.231643	0.624695	-0.443563
Roads	0.036828	0.000000	-0.071429	-0.071429	0.104561	0.397527
Trails	-0.274790	0.053738	-0.317837	0.317837	0.042857	-0.165985
Rip_Rap	0.375186	-0.308158	-0.148324	-0.148324	0.220000	-0.284019
Otherx	0.000000	0.391312	0.741620	-0.148324	-0.500000	0.335659
AreaBare	-0.424700	-0.224480	-0.439886	-0.136090	0.346212	-0.291612
Amtnatural	-0.151505	0.091696	-0.283284	-0.283284	0.322886	-0.237327
Amthuman	0.151505	-0.091696	0.283500	0.283500	-0.323132	0.237508
Naterosion	0.263666	0.469613	0.202940	0.071094	-0.243618	0.296002
NatDeposition	-0.261989	-0.158875	-0.152038	-0.152038	0.222945	-0.443620
Natwildlife	-0.082496	0.161625	0.379402	0.379402	-0.404301	0.544600
Natype	0.327655	0.000000	0.632924	0.632924	-0.576066	0.444591
NatSaline	0.327655	0.000000	0.632924	0.632924	-0.576066	0.444591
Natvegbottom	0.117646	0.370881	-0.017660	0.507737	-0.261201	0.392837
Natother	-0.006395	-0.250588	0.357778	0.357778	-0.298621	0.490147
Hcgrazing	-0.327655	0.000000	-0.632924	-0.632924	0.576066	-0.444591
Hcother	0.327655	0.000000	0.632924	0.632924	-0.576066	0.444591
Bankmaterial	0.000000	0.000000	0.097373	0.097373	-0.123443	0.170996

MedBoulders	0.096112	-0.436520	-0.313682	-0.313682	0.398683	-0.365215
SmBoulders	0.096112	-0.436520	-0.313682	-0.313682	0.398683	-0.365215
LgCobble	0.021471	-0.169219	0.000000	-0.274070	0.188683	-0.363834
SmCobble	0.014723	-0.355769	-0.046985	-0.322632	0.249485	-0.131955
Coagravel	0.206901	-0.371899	0.093433	-0.105891	0.018472	0.046306
Fngravel	0.298448	-0.274934	0.047305	-0.204987	0.113566	0.157414
Sand	1.000000	-0.187478	0.223831	0.223831	-0.216750	0.080369
SiandCl	-0.187478	1.000000	0.225529	0.225529	-0.346360	0.217338
NoInndsSi	0.223831	0.225529	1.000000	0.357778	-0.841398	0.649366
TameSi	0.223831	0.225529	0.357778	1.000000	-0.745614	0.649366
NativeSi	-0.216750	-0.346360	-0.841398	-0.745614	1.000000	-0.823222

	Native	Rec	Develop_	Perforage	Roadsx	Vegcovfl
Health_Score	-0.246003	-0.413433	0.061767	0.028130	0.452502	0.715120
Size	0.245298	0.385758	0.154303	-0.231455	0.040974	0.385758
Trees	-0.211007	-0.071270	-0.047619	0.227710	0.421637	0.648886
Treesgr6ft	-0.110096	0.478900	0.517718	0.206307	0.070489	0.131112
Treesgr1_5ft	0.076445	0.430331	0.414039	0.094281	0.174574	-0.161750
Treesle1_5ft	-0.023661	0.516398	0.506048	0.219989	0.098198	-0.040832
Shrubsgr6ft	-0.165083	0.165704	0.394424	-0.056725	0.310725	0.356581
Shrubsgr1_5ft	0.113341	-0.400019	0.062277	-0.425436	0.040482	0.442923
Shrubsle1_5ft	0.118748	0.103080	-0.043499	-0.208007	-0.307207	0.007082
Grassgr6ft	-0.339771	-0.097373	-0.097590	-0.066667	0.452623	0.201187
Grassgr1_5ft	-0.291243	0.540990	0.145976	0.199441	-0.154971	0.067110
Grassle1_5ft	0.357225	0.009231	-0.380617	-0.115560	-0.062410	-0.333279
Forbsgr1_5ft	-0.509630	0.068853	0.046004	0.282843	-0.135780	0.026331
Forbsle1_5ft	0.224745	-0.188931	-0.189352	-0.129352	0.036177	0.272662
CC_Trees	-0.065716	0.478900	0.517718	0.206307	0.177360	0.062147
CC_Shrubs	0.038274	-0.136394	0.105153	-0.316065	0.129683	0.554510
CC_Grass	-0.293206	0.096946	0.425918	0.174574	0.258150	-0.209081
CC_Forbs	-0.114248	-0.048113	-0.066130	0.150585	0.022074	0.247136
CC_Wood	-0.009055	0.195922	0.457738	-0.312694	0.104176	0.375105
CC_Total	-0.400358	0.180300	0.180702	0.123443	0.228571	0.856581
Alterations_	0.339771	0.097373	0.097590	0.066667	-0.452623	-0.137743
Length	0.067235	-0.169801	-0.141863	-0.096664	0.401946	-0.257222
Grazing	0.454127	0.104561	0.104828	0.071429	0.104828	-0.147920
Construction	-0.328188	0.000000	0.000000	-0.234521	0.351781	0.449073
Hoof_Shear_Trampling	0.581042	0.000000	0.000000	-0.347465	0.231643	0.080648
Roads	-0.349329	-0.104561	-0.104828	-0.071429	0.681385	0.159719
Trails	-0.011189	0.000000	0.000000	0.423783	-0.317837	-0.522545
Rip_Rap	-0.031330	0.000000	0.000000	0.741620	-0.148324	0.284019
Otherx	-0.266309	0.000000	0.000000	-0.148324	-0.148324	0.284019
AreaBare	0.220646	0.342286	0.330650	0.090351	-0.300903	-0.712760
Amtnatural	0.131908	-0.166332	-0.020838	0.227759	0.051618	-0.020133
Amthuman	-0.132008	0.166459	0.020854	-0.227933	-0.051657	0.003358
Naterosion	-0.278825	-0.257230	-0.082912	-0.056639	0.062270	0.160357
NatDeposition	0.403968	-0.192321	-0.270892	0.170820	-0.108727	-0.155235
Natwildlife	-0.572110	0.342286	0.529040	-0.301169	0.540230	-0.171062
Nattype	-0.339771	-0.097373	-0.097590	-0.066667	0.452623	0.137743
NatSaline	-0.339771	-0.097373	-0.097590	-0.066667	0.452623	0.137743
Natvegbottom	-0.449108	-0.282567	0.094399	-0.193460	0.590812	0.395456
Natother	-0.400397	0.500000	0.463253	-0.097373	0.214106	-0.224416
Hcgrazing	0.339771	0.097373	0.097590	0.066667	-0.452623	-0.137743

Hcother	-0.339771	-0.097373	-0.097590	-0.066667	0.452623	0.137743
Bankmaterial	-0.216218	0.097373	0.097590	0.066667	0.123443	-0.147920
MedBoulders	0.127615	0.418243	0.419314	0.500000	-0.067924	-0.378002
SmBoulders	0.127615	0.418243	0.419314	0.500000	-0.067924	-0.378002
LgCobble	0.171051	0.261612	0.187345	0.446788	-0.063334	-0.304472
SmCobble	-0.067406	0.519970	0.447503	0.449359	0.110145	-0.318185
Coagravel	-0.226068	0.545026	0.538616	0.287221	0.097640	-0.325880
Fngravel	-0.317036	0.526659	0.616536	0.032315	0.487666	0.062625
Sand	-0.146862	-0.006395	-0.216390	0.327655	0.176109	0.556820
SiandCl	-0.078472	-0.404073	-0.329739	-0.385164	-0.084931	-0.177036
NoIndsSi	-0.568169	-0.142222	-0.142539	-0.097373	0.214106	0.216051
TameSi	-0.568169	-0.142222	-0.142539	-0.097373	0.214106	0.216051
NativeSi	0.739947	0.180300	0.180702	0.123443	-0.149206	-0.273895
	Inv_CC	Inv_DD	Dis_Und	TrShReg	Utilis	DD
Health_Score	-0.104933	0.463985	0.059355	0.395587	0.576479	0.000000
Size	0.247436	-0.025482	-0.156447	0.104828	0.005878	-0.178174
Trees	-0.100504	0.335030	-0.118643	0.000000	0.167270	0.277778
Treesgr6ft	0.112916	0.752326	0.475556	-0.356314	0.497037	0.000000
Treesgr1_5ft	0.314598	0.591608	0.417239	-0.570496	0.406226	0.200308
Treesle1_5ft	0.202464	0.647339	0.299661	-0.284259	0.632748	-0.051434
Shrubsgr6ft	0.012232	0.192879	-0.070652	0.297888	0.463384	-0.314847
Shrubsgr1_5ft	0.146416	0.116267	-0.002202	0.200044	0.322690	0.451683
Shrubsle1_5ft	-0.154520	0.013710	0.053457	-0.294149	-0.374746	0.186004
Grassgr6ft	-0.021517	0.280306	0.198068	0.200739	0.356824	0.192450
Grassgr1_5ft	-0.597864	0.012949	-0.167375	0.030132	-0.052900	-0.520171
Grassle1_5ft	0.420449	-0.535959	0.073658	0.028843	-0.288849	-0.137862
Forbsgr1_5ft	-0.711266	0.000000	-0.377737	0.207368	-0.195700	0.206878
Forbsle1_5ft	0.421032	0.473671	0.166699	-0.037268	0.245844	0.050970
CC_Trees	0.326419	0.614701	0.527993	-0.500379	0.501452	0.093002
CC_Shrubs	0.073768	0.158389	0.031068	0.293506	0.549706	-0.046571
CC_Grass	-0.423755	0.191943	-0.425176	0.387307	0.148600	-0.209568
CC_Forbs	-0.013024	0.603249	0.070523	-0.048245	0.300682	0.094572
CC_Wood	0.158318	0.479107	0.437431	-0.135339	0.801244	0.067848
CC_Total	-0.144871	0.280306	0.022880	0.195035	0.543702	-0.192450
Alterations_	0.265165	-0.280306	0.180810	-0.137437	-0.244300	-0.192450
Length	0.156170	-0.093937	-0.149071	-0.165006	-0.535119	0.107417
Grazing	0.292770	0.265606	0.195180	-0.147542	0.089443	-0.213201
Construction	0.203101	-0.244989	-0.449073	0.349603	0.338955	0.204124
Hoof_Shear_Trampling	0.401218	0.053255	0.040324	0.172657	0.404064	0.000000
Roads	0.250000	-0.265606	-0.186512	0.159246	-0.066130	0.213201
Trails	-0.122336	0.241249	-0.116804	-0.157935	-0.512175	-0.351763
Rip_Rap	-0.085635	0.177302	-0.284019	0.221108	0.214374	-0.250000
Otherx	-0.085635	0.068193	-0.284019	0.221108	0.214374	-0.125000
AreaBare	0.012959	0.323669	0.170749	-0.564495	-0.322357	0.051434
Amtnatural	0.207422	-0.246028	-0.594621	0.523127	-0.046949	0.090337
Amthuman	-0.195344	0.246028	0.594997	-0.539370	0.040362	-0.090337
Naterosion	0.242956	0.270658	-0.241191	-0.163333	0.362751	0.248076
NatDeposition	-0.122711	-0.287588	-0.002215	0.334192	-0.579910	-0.227454
Natwildlife	0.038876	0.164523	-0.198817	-0.125344	0.209286	0.145037
Natype	-0.265165	0.280306	-0.180810	0.137437	0.244300	0.192450
NatSaline	-0.265165	0.280306	-0.180810	0.137437	0.244300	0.192450
Natvegbottom	0.183271	-0.214886	-0.519099	0.394576	0.284218	0.364364
Natother	-0.386541	0.280306	0.085274	-0.197401	0.356126	0.192450
Hcgrazing	0.265165	-0.280306	0.180810	-0.137437	-0.244300	-0.192450
Hcother	-0.265165	0.280306	-0.180810	0.137437	0.244300	0.192450

Bankmaterial	0.258199	0.280306	-0.344265	-0.147542	0.089443	0.433013
MedBoulders	-0.107143	0.161494	0.303466	-0.321146	-0.233260	-0.469018
SmBoulders	-0.107143	0.161494	0.303466	-0.321146	-0.233260	-0.469018
LgCobble	0.047870	0.085769	0.097526	-0.124511	-0.231812	-0.346844
SmCobble	-0.048146	-0.028992	0.227275	-0.239721	-0.128328	-0.320358
Coagravel	-0.287221	0.024595	0.287821	-0.273924	-0.037012	-0.144791
Fngravel	0.258522	0.181202	0.409469	-0.384240	0.418175	-0.058358
Sand	0.049148	0.745356	0.170954	-0.119313	0.456001	-0.344931
SiandCl	0.288873	-0.626856	-0.284692	0.223024	-0.029388	0.200450
NoIndsSi	-0.377124	-0.037796	-0.251416	0.215499	0.114310	0.283279
TameSi	-0.377124	-0.037796	-0.251416	0.215499	0.114310	0.283279
NativeSi	0.478091	0.146385	0.318728	-0.273195	-0.069007	-0.362372

	RtMss	HCBGr	StrAlt	HCAIt	ChIns	VegSc
Health_Score	0.784260	0.621600	0.781022	-0.267202	0.832336	0.698872
Size	-0.237878	0.048795	0.168466	0.056980	-0.288675	0.225226
Trees	0.092450	0.204124	0.396863	-0.361551	0.246812	0.372984
Treesgr6ft	-0.121792	-0.366915	-0.014086	0.174929	-0.077942	0.403333
Treesgr1_5ft	-0.232739	-0.385733	-0.118247	-0.127141	-0.187259	0.215929
Treesle1_5ft	0.033125	-0.267857	0.001515	0.041821	-0.116462	0.364067
Shrubsgr6ft	0.442288	0.383284	0.461441	-0.075800	0.419361	0.414339
Shrubsgr1_5ft	0.274152	0.178414	0.589043	0.283533	0.291969	0.507687
Shrubsle1_5ft	-0.442416	-0.322782	0.088187	0.458814	-0.269613	-0.195872
Grassgr6ft	0.279278	0.269680	0.041067	-0.433333	0.084163	0.458891
Grassgr1_5ft	0.168350	-0.076463	0.160275	-0.037804	0.106681	-0.290835
Grassle1_5ft	-0.302134	0.038748	-0.560903	-0.172418	-0.486550	-0.113769
Forbsgr1_5ft	0.133527	-0.042859	0.142818	-0.063570	-0.133756	-0.352494
Forbsle1_5ft	0.148139	-0.056742	0.169258	-0.084163	0.201563	0.441590
CC_Trees	-0.234846	-0.406498	-0.116991	0.077798	-0.181987	0.404258
CC_Shrubs	0.458628	0.333876	0.652906	0.057141	0.424332	0.628539
CC_Grass	0.278001	0.247334	-0.008396	-0.231699	0.239453	-0.198707
CC_Forbs	0.227287	0.027206	0.270509	-0.201764	0.271196	0.273678
CC_Wood	0.263008	0.038159	0.440266	0.169799	0.397898	0.660148
CC_Total	0.253812	0.321540	0.441188	-0.168325	0.516667	0.575535
Alterations_	-0.355102	-0.184637	-0.224934	0.684653	-0.288111	-0.209454
Length	-0.393048	-0.189122	-0.372314	-0.349149	-0.117369	-0.277528
Grazing	-0.393533	-0.200000	-0.244282	-0.066667	-0.318728	0.115290
Construction	0.240927	0.560612	0.235702	-0.351781	0.483190	0.425919
Hoof_Shear_Trampling	0.005804	0.138433	-0.116405	-0.231643	0.314294	0.509260
Roads	0.066130	0.218218	-0.408627	-1.000000	0.313682	0.160177
Trails	-0.472523	-0.379888	-0.282170	0.317837	-0.745356	-0.597486
Rip_Rap	-0.081762	0.354562	0.409946	0.148324	-0.327957	0.163043
Otherx	0.319616	0.354562	0.409946	0.148324	0.491935	0.163043
AreaBare	-0.506017	-0.730893	-0.387007	0.401514	-0.620191	-0.546657
Amtnatural	-0.169681	0.395060	-0.152055	0.037804	-0.137562	0.095670
Amthuman	0.153808	-0.408061	0.142556	-0.037828	0.119390	-0.102750
Naterosion	0.168275	-0.101504	0.245495	-0.131735	0.341000	0.181610
NatDeposition	-0.048184	0.230702	-0.079907	0.171093	-0.364227	-0.212961
Natwildlife	0.145586	-0.257166	-0.173135	-0.401514	0.220645	-0.004742
Natype	0.355102	0.184637	0.224934	-0.684653	0.288111	0.209454
NatSaline	0.355102	0.184637	0.224934	-0.684653	0.288111	0.209454
Natvegbottom	0.198361	0.206145	0.053815	-0.458643	0.321131	0.379519
Natother	0.011711	-0.134576	-0.149481	-0.399218	0.064234	-0.098783
Hcgrazing	-0.355102	-0.184637	-0.224934	0.684653	-0.288111	-0.209454
Hcother	0.355102	0.184637	0.224934	-0.684653	0.288111	0.209454



Bankmaterial	-0.356584	-0.200000	-0.218777	-0.097590	-0.282843	0.115560
MedBoulders	-0.557696	-0.109109	-0.270148	0.314485	-0.441479	-0.380082
SmBoulders	-0.557696	-0.109109	-0.270148	0.314485	-0.441479	-0.380082
LgCobble	-0.072880	-0.097497	0.005071	0.257599	-0.438097	-0.241516
SmCobble	-0.242681	-0.065372	-0.242786	0.047106	-0.358132	-0.307428
Coagravel	-0.302355	-0.113747	-0.315440	0.093672	-0.207629	-0.301895
Fngravel	-0.024932	-0.098725	-0.155084	-0.237129	0.226011	0.252200
Sand	0.224478	0.100100	0.315531	-0.240433	0.444464	0.554045
SiandCl	0.418006	-0.049029	-0.051006	0.000000	0.017750	-0.047443
NoIndsSi	0.520825	0.292119	0.319544	-0.391983	0.413118	0.088349
TameSi	0.267194	-0.121716	0.004280	-0.391983	0.047336	0.088349
NativeSi	-0.483736	-0.082295	-0.185669	0.331286	-0.269135	-0.032319

	SIHySc	Overall	Total_CPUE	Sport_CPUE	Forage_CPUE
Health_Score	0.958565	1.000000	0.463199	0.410603	-0.152055
Size	-0.124311	-0.008299	-0.493728	-0.393309	0.042563
Trees	0.279692	0.313221	0.325050	0.325341	0.095923
Treesgr6ft	-0.113466	0.048113	0.087343	0.100583	-0.187476
Treesgr1_5ft	-0.262166	-0.146870	-0.399782	-0.332480	-0.030921
Treesle1_5ft	-0.036760	0.091099	-0.085710	-0.061306	-0.265403
Shrubsgr6ft	0.588957	0.669851	0.213172	0.284622	-0.567808
Shrubsgr1_5ft	0.468346	0.510322	-0.345006	-0.352475	-0.106232
Shrubsle1_5ft	-0.258714	-0.293645	-0.070701	-0.014160	-0.178443
Grassgr6ft	0.169163	0.355353	0.000000	0.000000	-0.376098
Grassgr1_5ft	0.191226	0.070497	0.388010	0.451667	-0.464491
Grassle1_5ft	-0.529321	-0.469794	-0.320697	-0.321140	0.217773
Forbsgr1_5ft	0.035846	-0.059447	0.063850	0.018268	0.044707
Forbsle1_5ft	0.141674	0.188889	-0.086244	-0.220705	0.531220
CC_Trees	-0.249017	-0.069328	-0.091851	-0.016060	-0.146368
CC_Shrubs	0.651352	0.730480	-0.085083	-0.039109	-0.391797
CC_Grass	0.230557	0.224318	0.118303	0.072792	-0.054925
CC_Forbs	0.268363	0.267700	0.143740	0.047979	0.291523
CC_Wood	0.467463	0.600895	-0.207905	-0.077369	-0.663828
CC_Total	0.521098	0.562963	0.472377	0.626326	-0.328219
Alterations_	-0.308847	-0.384148	-0.077258	-0.077365	0.352550
Length	-0.420687	-0.414039	0.122172	0.063048	0.380301
Grazing	-0.396178	-0.309200	-0.306235	-0.306774	0.396523
Construction	0.445439	0.516398	0.314864	0.409172	-0.459177
Hoof_Shear_Trampling	0.084814	0.148768	-0.246970	-0.303687	0.246970
Roads	-0.062306	0.000000	0.150342	0.150687	0.151734
Trails	-0.625506	-0.641533	-0.128469	-0.174488	0.603806
Rip_Rap	0.074673	0.068041	0.219529	0.331295	0.329293
Otherx	0.570229	0.598764	0.462578	0.465390	-0.384175
AreaBare	-0.671221	-0.683138	-0.355801	-0.397055	0.246143
Amtnatural	-0.125394	-0.100442	0.087095	-0.015474	0.586904
Amthuman	0.106025	0.084275	-0.104102	0.000000	-0.582040
Naterosion	0.240949	0.213669	0.072124	0.119446	0.057667
NatDeposition	-0.143137	-0.173172	-0.025286	-0.198345	0.309122
Natwildlife	-0.002664	0.109329	0.041802	0.083719	-0.451149
Natype	0.308847	0.384148	0.077258	0.077365	-0.352550
NatSaline	0.308847	0.384148	0.077258	0.077365	-0.352550
Natvegbottom	0.174585	0.286891	0.028620	0.075862	0.061459
Natother	-0.046346	0.026352	-0.192450	-0.070078	-0.518940
Hcgrazing	-0.308847	-0.384148	-0.077258	-0.077365	0.352550
Hcother	0.308847	0.384148	0.077258	0.077365	-0.352550

Bankmaterial	-0.394405	-0.253170	0.043748	0.043825	0.133609
MedBoulders	-0.446120	-0.407300	0.160265	0.273075	0.000000
SmBoulders	-0.446120	-0.407300	0.160265	0.273075	0.000000
LgCobble	-0.162238	-0.167197	0.192101	0.098619	0.040768
SmCobble	-0.289979	-0.254561	0.152902	0.244246	-0.161408
Coagravel	-0.267924	-0.244791	0.204687	0.349697	-0.454767
Fngravel	0.024407	0.128146	0.120056	0.368214	-0.577607
Sand	0.410237	0.424884	0.670177	0.749763	-0.299531
SiandCl	0.108159	0.065963	-0.251484	-0.348083	-0.132393
NoIndsSi	0.518202	0.466075	0.274634	0.275118	-0.526274
TameSi	0.059150	0.116840	0.043748	0.043825	-0.356289
NativeSi	-0.355368	-0.317945	-0.259554	-0.260011	0.528463

	Health_Score Treesle1_5ft	Size	Trees	Treesgr6ft	Treesgr1_5ft	
Tame	0.128070	-0.209766	0.083438	-0.056696	-0.120913	-0.094715
Native	-0.246003	0.245298	-0.211007	-0.110096	0.076445	-0.023661
Rec	-0.413433	0.385758	-0.071270	0.478900	0.430331	0.516398
Develop_	0.061767	0.154303	-0.047619	0.517718	0.414039	0.506048
Perforage	0.028130	-0.231455	0.227710	0.206307	0.094281	0.219989
Roadsx	0.452502	0.040974	0.421637	0.070489	0.174574	0.098198
Vegcovfl	0.715120	0.385758	0.648886	0.131112	-0.161750	-0.040832
Inv_CC	-0.104933	0.247436	-0.100504	0.112916	0.314598	0.202464
Inv_DD	0.463985	-0.025482	0.335030	0.752326	0.591608	0.647339
Dis_Und	0.059355	-0.156447	-0.118643	0.475556	0.417239	0.299661
TrShReg	0.395587	0.104828	0.000000	-0.356314	-0.570496	-0.284259
Utilis	0.576479	0.005878	0.167270	0.497037	0.406226	0.632748
DD	0.000000	-0.178174	0.277778	0.000000	0.200308	-0.051434
RtMss	0.784260	-0.237878	0.092450	-0.121792	-0.232739	0.033125
HCBrg	0.621600	0.048795	0.204124	-0.366915	-0.385733	-0.267857
StrAlt	0.781022	0.168466	0.396863	-0.014086	-0.118247	0.001515
HCAlt	-0.267202	0.056980	-0.361551	0.174929	-0.127141	0.041821
ChIns	0.832336	-0.288675	0.246812	-0.077942	-0.187259	-0.116462
VegSc	0.698872	0.225226	0.372984	0.403333	0.215929	0.364067
SIHySc	0.958565	-0.124311	0.279692	-0.113466	-0.262166	-0.036760
Overall	1.000000	-0.008299	0.313221	0.048113	-0.146870	0.091099
Total_CPUE	0.463199	-0.493728	0.325050	0.087343	-0.399782	-0.085710
Sport_CPUE	0.410603	-0.393309	0.325341	0.100583	-0.332480	-0.061306
Forage__CPUE	-0.152055	0.042563	0.095923	-0.187476	-0.030921	-0.265403

	Shrubsgr6ft Grassle1_5ft	Shrubsgr1_5ft	Shrubsle1_5ft	Grassgr6ft	Grassgr1_5ft	
Tame	0.060017	-0.136402	-0.125760	0.444591	0.305106	-0.179696
Native	-0.165083	0.113341	0.118748	-0.339771	-0.291243	0.357225
Rec	0.165704	-0.400019	0.103080	-0.097373	0.540990	0.009231
Develop_	0.394424	0.062277	-0.043499	-0.097590	0.145976	-0.380617
Perforage	-0.056725	-0.425436	-0.208007	-0.066667	0.199441	-0.115560
Roadsx	0.310725	0.040482	-0.307207	0.452623	-0.154971	-0.062410
Vegcovfl	0.356581	0.442923	0.007082	0.201187	0.067110	-0.333279
Inv_CC	0.012232	0.146416	-0.154520	-0.021517	-0.597864	0.420449
Inv_DD	0.192879	0.116267	0.013710	0.280306	0.012949	-0.535959
Dis_Und	-0.070652	-0.002202	0.053457	0.198068	-0.167375	0.073658
TrShReg	0.297888	0.200044	-0.294149	0.200739	0.030132	0.028843
Utilis	0.463384	0.322690	-0.374746	0.356824	-0.052900	-0.288849
DD	-0.314847	0.451683	0.186004	0.192450	-0.520171	-0.137862

RtMss	0.442288	0.274152	-0.442416	0.279278	0.168350	-0.302134
HCBGr	0.383284	0.178414	-0.322782	0.269680	-0.076463	0.038748
StrAlt	0.461441	0.589043	0.088187	0.041067	0.160275	-0.560903
HCAIt	-0.075800	0.283533	0.458814	-0.433333	-0.037804	-0.172418
ChIns	0.419361	0.291969	-0.269613	0.084163	0.106681	-0.486550
VegSc	0.414339	0.507687	-0.195872	0.458891	-0.290835	-0.113769
SIHySc	0.588957	0.468346	-0.258714	0.169163	0.191226	-0.529321
Overall	0.669851	0.510322	-0.293645	0.355353	0.070497	-0.469794
Total_CPUE	0.213172	-0.345006	-0.070701	0.000000	0.388010	-0.320697
Sport_CPUE	0.284622	-0.352475	-0.014160	0.000000	0.451667	-0.321140
Forage__CPUE	-0.567808	-0.106232	-0.178443	-0.376098	-0.464491	0.217773

	Forbsgr1_5ft	Forbsle1_5ft	CC_Trees	CC_Shrubs	CC_Grass	CC_Forbs
Tame	0.499773	-0.143081	-0.103943	-0.038692	0.205230	0.160290
Native	-0.509630	0.224745	-0.065716	0.038274	-0.293206	-0.114248
Rec	0.068853	-0.188931	0.478900	-0.136394	0.096946	-0.048113
Develop_	0.046004	-0.189352	0.517718	0.105153	0.425918	-0.066130
Perforage	0.282843	-0.129352	0.206307	-0.316065	0.174574	0.150585
Roadsx	-0.135780	0.036177	0.177360	0.129683	0.258150	0.022074
Vegcovfl	0.026331	0.272662	0.062147	0.554510	-0.209081	0.247136
Inv_CC	-0.711266	0.421032	0.326419	0.073768	-0.423755	-0.013024
Inv_DD	0.000000	0.473671	0.614701	0.158389	0.191943	0.603249
Dis_Und	-0.377737	0.166699	0.527993	0.031068	-0.425176	0.070523
TrShReg	0.207368	-0.037268	-0.500379	0.293506	0.387307	-0.048245
Utilis	-0.195700	0.245844	0.501452	0.549706	0.148600	0.300682
DD	0.206878	0.050970	0.093002	-0.046571	-0.209568	0.094572
RtMss	0.133527	0.148139	-0.234846	0.458628	0.278001	0.227287
HCBGr	-0.042859	-0.056742	-0.406498	0.333876	0.247334	0.027206
StrAlt	0.142818	0.169258	-0.116991	0.652906	-0.008396	0.270509
HCAIt	-0.063570	-0.084163	0.077798	0.057141	-0.231699	-0.201764
ChIns	-0.133756	0.201563	-0.181987	0.424332	0.239453	0.271196
VegSc	-0.352494	0.441590	0.404258	0.628539	-0.198707	0.273678
SIHySc	0.035846	0.141674	-0.249017	0.651352	0.230557	0.268363
Overall	-0.059447	0.188889	-0.069328	0.730480	0.224318	0.267700
Total_CPUE	0.063850	-0.086244	-0.091851	-0.085083	0.118303	0.143740
Sport_CPUE	0.018268	-0.220705	-0.016060	-0.039109	0.072792	0.047979
Forage__CPUE	0.044707	0.531220	-0.146368	-0.391797	-0.054925	0.291523

	CC_Wood Construction	CC_Total	Alterations_	Length	Grazing	
Tame	-0.021874	0.316624	-0.444591	-0.109985	-0.516785	0.428661
Native	-0.009055	-0.400358	0.339771	0.067235	0.454127	-0.328188
Rec	0.195922	0.180300	0.097373	-0.169801	0.104561	0.000000
Develop_	0.457738	0.180702	0.097590	-0.141863	0.104828	0.000000
Perforage	-0.312694	0.123443	0.066667	-0.096664	0.071429	-0.234521
Roadsx	0.104176	0.228571	-0.452623	0.401946	0.104828	0.351781
Vegcovfl	0.375105	0.856581	-0.137743	-0.257222	-0.147920	0.449073
Inv_CC	0.158318	-0.144871	0.265165	0.156170	0.292770	0.203101
Inv_DD	0.479107	0.280306	-0.280306	-0.093937	0.265606	-0.244989
Dis_Und	0.437431	0.022880	0.180810	-0.149071	0.195180	-0.449073
TrShReg	-0.135339	0.195035	-0.137437	-0.165006	-0.147542	0.349603
Utilis	0.801244	0.543702	-0.244300	-0.535119	0.089443	0.338955
DD	0.067848	-0.192450	-0.192450	0.107417	-0.213201	0.204124
RtMss	0.263008	0.253812	-0.355102	-0.393048	-0.393533	0.240927
HCBGr	0.038159	0.321540	-0.184637	-0.189122	-0.200000	0.560612

StrAlt	0.440266	0.441188	-0.224934	-0.372314	-0.244282	0.235702
HCAIt	0.169799	-0.168325	0.684653	-0.349149	-0.066667	-0.351781
ChIns	0.397898	0.516667	-0.288111	-0.117369	-0.318728	0.483190
VegSc	0.660148	0.575535	-0.209454	-0.277528	0.115290	0.425919
SIHySc	0.467463	0.521098	-0.308847	-0.420687	-0.396178	0.445439
Overall	0.600895	0.562963	-0.384148	-0.414039	-0.309200	0.516398
Total_CPUE	-0.207905	0.472377	-0.077258	0.122172	-0.306235	0.314864
Sport_CPUE	-0.077369	0.626326	-0.077365	0.063048	-0.306774	0.409172
Forage__CPUE	-0.663828	-0.328219	0.352550	0.380301	0.396523	-0.459177

	Hoof_Shear_Trampling AreaBare	Roads	Trails	Rip_Rap	Otherx	
Tame	-0.443563	0.397527	-0.165985	-0.284019	0.335659	-0.291612
Native	0.581042	-0.349329	-0.011189	-0.031330	-0.266309	0.220646
Rec	0.000000	-0.104561	0.000000	0.000000	0.000000	0.342286
Develop_	0.000000	-0.104828	0.000000	0.000000	0.000000	0.330650
Perforage	-0.347465	-0.071429	0.423783	0.741620	-0.148324	0.090351
Roadsx	0.231643	0.681385	-0.317837	-0.148324	-0.148324	-0.300903
Vegcovfl	0.080648	0.159719	-0.522545	0.284019	0.284019	-0.712760
Inv_CC	0.401218	0.250000	-0.122336	-0.085635	-0.085635	0.012959
Inv_DD	0.053255	-0.265606	0.241249	0.177302	0.068193	0.323669
Dis_Und	0.040324	-0.186512	-0.116804	-0.284019	-0.284019	0.170749
TrShReg	0.172657	0.159246	-0.157935	0.221108	0.221108	-0.564495
Utilis	0.404064	-0.066130	-0.512175	0.214374	0.214374	-0.322357
DD	0.000000	0.213201	-0.351763	-0.250000	-0.125000	0.051434
RtMss	0.005804	0.066130	-0.472523	-0.081762	0.319616	-0.506017
HCBGr	0.138433	0.218218	-0.379888	0.354562	0.354562	-0.730893
StrAlt	-0.116405	-0.408627	-0.282170	0.409946	0.409946	-0.387007
HCAIt	-0.231643	-1.000000	0.317837	0.148324	0.148324	0.401514
ChIns	0.314294	0.313682	-0.745356	-0.327957	0.491935	-0.620191
VegSc	0.509260	0.160177	-0.597486	0.163043	0.163043	-0.546657
SIHySc	0.084814	-0.062306	-0.625506	0.074673	0.570229	-0.671221
Overall	0.148768	0.000000	-0.641533	0.068041	0.598764	-0.683138
Total_CPUE	-0.246970	0.150342	-0.128469	0.219529	0.462578	-0.355801
Sport_CPUE	-0.303687	0.150687	-0.174488	0.331295	0.465390	-0.397055
Forage__CPUE	0.246970	0.151734	0.603806	0.329293	-0.384175	0.246143

	Amtnatural	Amthuman	Naterosion	NatDeposition	Natwildlife	Nattype
Tame	-0.237327	0.237508	0.296002	-0.443620	0.544600	0.444591
Native	0.131908	-0.132008	-0.278825	0.403968	-0.572110	-0.339771
Rec	-0.166332	0.166459	-0.257230	-0.192321	0.342286	-0.097373
Develop_	-0.020838	0.020854	-0.082912	-0.270892	0.529040	-0.097590
Perforage	0.227759	-0.227933	-0.056639	0.170820	-0.301169	-0.066667
Roadsx	0.051618	-0.051657	0.062270	-0.108727	0.540230	0.452623
Vegcovfl	-0.020133	0.003358	0.160357	-0.155235	-0.171062	0.137743
Inv_CC	0.207422	-0.195344	0.242956	-0.122711	0.038876	-0.265165
Inv_DD	-0.246028	0.246028	0.270658	-0.287588	0.164523	0.280306
Dis_Und	-0.594621	0.594997	-0.241191	-0.002215	-0.198817	-0.180810
TrShReg	0.523127	-0.539370	-0.163333	0.334192	-0.125344	0.137437
Utilis	-0.046949	0.040362	0.362751	-0.579910	0.209286	0.244300
DD	0.090337	-0.090337	0.248076	-0.227454	0.145037	0.192450
RtMss	-0.169681	0.153808	0.168275	-0.048184	0.145586	0.355102
HCBGr	0.395060	-0.408061	-0.101504	0.230702	-0.257166	0.184637
StrAlt	-0.152055	0.142556	0.245495	-0.079907	-0.173135	0.224934
HCAIt	0.037804	-0.037828	-0.131735	0.171093	-0.401514	-0.684653
ChIns	-0.137562	0.119390	0.341000	-0.364227	0.220645	0.288111

VegSc	0.095670	-0.102750	0.181610	-0.212961	-0.004742	0.209454
SIHySc	-0.125394	0.106025	0.240949	-0.143137	-0.002664	0.308847
Overall	-0.100442	0.084275	0.213669	-0.173172	0.109329	0.384148
Total_CPUE	0.087095	-0.104102	0.072124	-0.025286	0.041802	0.077258
Sport_CPUE	-0.015474	0.000000	0.119446	-0.198345	0.083719	0.077365
Forage__CPUE	0.586904	-0.582040	0.057667	0.309122	-0.451149	-0.352550

	NatSaline Bankmaterial	Natvegbottom	Natother	Hcgrazing	Hcother	
Tame	0.444591	0.392837	0.490147	-0.444591	0.444591	0.170996
Native	-0.339771	-0.449108	-0.400397	0.339771	-0.339771	-0.216218
Rec	-0.097373	-0.282567	0.500000	0.097373	-0.097373	0.097373
Develop_	-0.097590	0.094399	0.463253	0.097590	-0.097590	0.097590
Perforage	-0.066667	-0.193460	-0.097373	0.066667	-0.066667	0.066667
Roadsx	0.452623	0.590812	0.214106	-0.452623	0.452623	0.123443
Vegcovfl	0.137743	0.395456	-0.224416	-0.137743	0.137743	-0.147920
Inv_CC	-0.265165	0.183271	-0.386541	0.265165	-0.265165	0.258199
Inv_DD	0.280306	-0.214886	0.280306	-0.280306	0.280306	0.280306
Dis_Und	-0.180810	-0.519099	0.085274	0.180810	-0.180810	-0.344265
TrShReg	0.137437	0.394576	-0.197401	-0.137437	0.137437	-0.147542
Utilis	0.244300	0.284218	0.356126	-0.244300	0.244300	0.089443
DD	0.192450	0.364364	0.192450	-0.192450	0.192450	0.433013
RtMss	0.355102	0.198361	0.011711	-0.355102	0.355102	-0.356584
HCBGr	0.184637	0.206145	-0.134576	-0.184637	0.184637	-0.200000
StrAlt	0.224934	0.053815	-0.149481	-0.224934	0.224934	-0.218777
HCAlt	-0.684653	-0.458643	-0.399218	0.684653	-0.684653	-0.097590
ChIns	0.288111	0.321131	0.064234	-0.288111	0.288111	-0.282843
VegSc	0.209454	0.379519	-0.098783	-0.209454	0.209454	0.115560
SIHySc	0.308847	0.174585	-0.046346	-0.308847	0.308847	-0.394405
Overall	0.384148	0.286891	0.026352	-0.384148	0.384148	-0.253170
Total_CPUE	0.077258	0.028620	-0.192450	-0.077258	0.077258	0.043748
Sport_CPUE	0.077365	0.075862	-0.070078	-0.077365	0.077365	0.043825
Forage__CPUE	-0.352550	0.061459	-0.518940	0.352550	-0.352550	0.133609
	MedBoulders	SmBoulders	LgCobble	SmCobble	Coagravel	Fngravel
Tame	-0.365215	-0.365215	-0.363834	-0.131955	0.046306	0.157414
Native	0.127615	0.127615	0.171051	-0.067406	-0.226068	-0.317036
Rec	0.418243	0.418243	0.261612	0.519970	0.545026	0.526659
Develop_	0.419314	0.419314	0.187345	0.447503	0.538616	0.616536
Perforage	0.500000	0.500000	0.446788	0.449359	0.287221	0.032315
Roadsx	-0.067924	-0.067924	-0.063334	0.110145	0.097640	0.487666
Vegcovfl	-0.378002	-0.378002	-0.304472	-0.318185	-0.325880	0.062625
Inv_CC	-0.107143	-0.107143	0.047870	-0.048146	-0.287221	0.258522
Inv_DD	0.161494	0.161494	0.085769	-0.028992	0.024595	0.181202
Dis_Und	0.303466	0.303466	0.097526	0.227275	0.287821	0.409469
TrShReg	-0.321146	-0.321146	-0.124511	-0.239721	-0.273924	-0.384240
Utilis	-0.233260	-0.233260	-0.231812	-0.128328	-0.037012	0.418175
DD	-0.469018	-0.469018	-0.346844	-0.320358	-0.144791	-0.058358
RtMss	-0.557696	-0.557696	-0.072880	-0.242681	-0.302355	-0.024932
HCBGr	-0.109109	-0.109109	-0.097497	-0.065372	-0.113747	-0.098725
StrAlt	-0.270148	-0.270148	0.005071	-0.242786	-0.315440	-0.155084
HCAlt	0.314485	0.314485	0.257599	0.047106	0.093672	-0.237129
ChIns	-0.441479	-0.441479	-0.438097	-0.358132	-0.207629	0.226011
VegSc	-0.380082	-0.380082	-0.241516	-0.307428	-0.301895	0.252200
SIHySc	-0.446120	-0.446120	-0.162238	-0.289979	-0.267924	0.024407
Overall	-0.407300	-0.407300	-0.167197	-0.254561	-0.244791	0.128146
Total_CPUE	0.160265	0.160265	0.192101	0.152902	0.204687	0.120056
Sport_CPUE	0.273075	0.273075	0.098619	0.244246	0.349697	0.368214
Forage__CPUE	0.000000	0.000000	0.040768	-0.161408	-0.454767	-0.577607
	Sand	SiandCl	NoIndsSi	TameSi	NativeSi	Tame
Tame	0.080369	0.217338	0.649366	0.649366	-0.823222	1.000000
Native	-0.146862	-0.078472	-0.568169	-0.568169	0.739947	-0.903185

Rec	-0.006395	-0.404073	-0.142222	-0.142222	0.180300	0.068683
Develop_	-0.216390	-0.329739	-0.142539	-0.142539	0.180702	0.050063
Perforage	0.327655	-0.385164	-0.097373	-0.097373	0.123443	-0.170996
Roadsx	0.176109	-0.084931	0.214106	0.214106	-0.149206	0.329816
Vegcovfl	0.556820	-0.177036	0.216051	0.216051	-0.273895	0.165991
Inv_CC	0.049148	0.288873	-0.377124	-0.377124	0.478091	-0.430473
Inv_DD	0.745356	-0.626856	-0.037796	-0.037796	0.146385	-0.298807
Dis_Und	0.170954	-0.284692	-0.251416	-0.251416	0.318728	-0.242831
TrShReg	-0.119313	0.223024	0.215499	0.215499	-0.273195	0.179758
Utilis	0.456001	-0.029388	0.114310	0.114310	-0.069007	0.114708
DD	-0.344931	0.200450	0.283279	0.283279	-0.362372	0.438854
RtMss	0.224478	0.418006	0.520825	0.267194	-0.483736	0.327739
HCBGr	0.100100	-0.049029	0.292119	-0.121716	-0.082295	0.000000
StrAlt	0.315531	-0.051006	0.319544	0.004280	-0.185669	-0.194399
HCAlt	-0.240433	0.000000	-0.391983	-0.391983	0.331286	-0.550689
ChIns	0.444464	0.017750	0.413118	0.047336	-0.269135	0.272054
VegSc	0.554045	-0.047443	0.088349	0.088349	-0.032319	-0.053724
SIHySc	0.410237	0.108159	0.518202	0.059150	-0.355368	0.124647
Overall	0.424884	0.065963	0.466075	0.116840	-0.317945	0.128070
Total_CPUE	0.670177	-0.251484	0.274634	0.043748	-0.259554	0.194282
Sport_CPUE	0.749763	-0.348083	0.275118	0.043825	-0.260011	0.269962
Forage__CPUE	-0.299531	-0.132393	-0.526274	-0.356289	0.528463	-0.535928

	Native	Rec	Develop_	Perforage	Roadsx	Vegcovfl
Tame	-0.903185	0.068683	0.050063	-0.170996	0.329816	0.165991
Native	1.000000	-0.019738	-0.271295	-0.092665	-0.467084	-0.254864
Rec	-0.019738	1.000000	0.463253	-0.097373	-0.180300	-0.214363
Develop_	-0.271295	0.463253	1.000000	-0.097590	0.331286	-0.189466
Perforage	-0.092665	-0.097373	-0.097590	1.000000	-0.123443	0.147920
Roadsx	-0.467084	-0.180300	0.331286	-0.123443	1.000000	0.273895
Vegcovfl	-0.254864	-0.214363	-0.189466	0.147920	0.273895	1.000000
Inv_CC	0.418704	-0.023570	0.000000	-0.258199	0.199205	-0.173908
Inv_DD	0.187552	0.000000	0.280306	0.280306	0.146385	0.280306
Dis_Und	0.348920	0.502831	0.125988	-0.172133	-0.318728	-0.059343
TrShReg	-0.269167	-0.538748	-0.161985	0.147542	0.273195	0.276756
Utilis	-0.165764	0.146969	0.392792	-0.089443	0.262225	0.299488
DD	-0.388022	-0.433013	0.192450	-0.433013	0.362372	-0.192450
RtMss	-0.333009	-0.434021	-0.195745	0.029715	0.231552	0.437923
HCBGr	-0.108109	-0.486864	-0.097590	0.200000	0.370328	0.585002
StrAlt	0.080549	-0.443652	-0.137253	0.218777	-0.004823	0.659125
HCAlt	0.452158	0.142539	0.142857	0.097590	-0.752923	-0.230697
ChIns	-0.303048	-0.275412	0.069007	-0.188562	0.523723	0.608581
VegSc	-0.026771	-0.167468	0.063436	-0.115560	0.481447	0.547435
SIHySc	-0.199869	-0.435907	-0.082479	0.056344	0.259734	0.718391
Overall	-0.246003	-0.413433	0.061767	0.028130	0.452502	0.715120
Total_CPUE	-0.374960	0.021540	-0.306235	0.481227	0.169627	0.646074
Sport_CPUE	-0.422572	0.221173	-0.131474	0.394423	0.169926	0.642034
Forage__CPUE	0.365812	-0.526274	-0.356289	0.489898	-0.098676	0.014299

	Inv_CC	Inv_DD	Dis_Und	TrShReg	Utilis	DD
Tame	-0.430473	-0.298807	-0.242831	0.179758	0.114708	0.438854
Native	0.418704	0.187552	0.348920	-0.269167	-0.165764	-0.388022
Rec	-0.023570	0.000000	0.502831	-0.538748	0.146969	-0.433013
Develop_	0.000000	0.280306	0.125988	-0.161985	0.392792	0.192450
Perforage	-0.258199	0.280306	-0.172133	0.147542	-0.089443	-0.433013
Roadsx	0.199205	0.146385	-0.318728	0.273195	0.262225	0.362372

Vegcovfl	-0.173908	0.280306	-0.059343	0.276756	0.299488	-0.192450
Inv_CC	1.000000	0.323669	0.109304	-0.224733	0.261509	-0.051434
Inv_DD	0.323669	1.000000	0.264575	-0.560612	0.712931	-0.180937
Dis_Und	0.109304	0.264575	1.000000	-0.536730	0.373481	-0.362372
TrShReg	-0.224733	-0.560612	-0.536730	1.000000	-0.066955	0.141639
Utilis	0.261509	0.712931	0.373481	-0.066955	1.000000	0.047656
DD	-0.051434	-0.180937	-0.362372	0.141639	0.047656	1.000000
RtMss	-0.157957	-0.029881	0.028336	0.420340	0.374575	-0.024411
HCBGr	-0.328244	-0.208928	-0.282543	0.608581	0.018969	0.030429
StrAlt	-0.208928	0.536745	-0.019619	0.180769	0.322257	-0.136574
HCAlt	0.054845	0.000000	0.256406	-0.175893	-0.083746	-0.284268
ChIns	-0.128989	0.335030	-0.015617	0.248963	0.450916	0.051434
VegSc	0.383788	0.673154	0.340231	0.189750	0.781925	0.115563
SIHySc	-0.245963	0.230921	-0.014259	0.397396	0.420326	-0.111976
Overall	-0.104933	0.463985	0.059355	0.395587	0.576479	0.000000
Total_CPUE	-0.216700	0.364110	-0.155015	0.268783	0.036170	-0.478311
Sport_CPUE	-0.216894	0.364110	-0.062266	0.139636	0.121325	-0.478311
Forage__CPUE	0.191846	0.293972	-0.419231	0.243243	-0.389734	-0.132698

	RtMss	HCBGr	StrAlt	HCAlt	ChIns	VegSc
Tame	0.327739	0.000000	-0.194399	-0.550689	0.272054	-0.053724
Native	-0.333009	-0.108109	0.080549	0.452158	-0.303048	-0.026771
Rec	-0.434021	-0.486864	-0.443652	0.142539	-0.275412	-0.167468
Develop_	-0.195745	-0.097590	-0.137253	0.142857	0.069007	0.063436
Perforage	0.029715	0.200000	0.218777	0.097590	-0.188562	-0.115560
Roadsx	0.231552	0.370328	-0.004823	-0.752923	0.523723	0.481447
Vegcovfl	0.437923	0.585002	0.659125	-0.230697	0.608581	0.547435
Inv_CC	-0.157957	-0.328244	-0.208928	0.054845	-0.128989	0.383788
Inv_DD	-0.029881	-0.208928	0.536745	0.000000	0.335030	0.673154
Dis_Und	0.028336	-0.282543	-0.019619	0.256406	-0.015617	0.340231
TrShReg	0.420340	0.608581	0.180769	-0.175893	0.248963	0.189750
Utilis	0.374575	0.018969	0.322257	-0.083746	0.450916	0.781925
DD	-0.024411	0.030429	-0.136574	-0.284268	0.051434	0.115563
RtMss	1.000000	0.320812	0.555591	-0.285597	0.626120	0.421177
HCBGr	0.320812	1.000000	0.501486	-0.292509	0.493727	0.253783
StrAlt	0.555591	0.501486	1.000000	0.084643	0.512141	0.410337
HCAlt	-0.285597	-0.292509	0.084643	1.000000	-0.431595	-0.177095
ChIns	0.626120	0.493727	0.512141	-0.431595	1.000000	0.491408
VegSc	0.421177	0.253783	0.410337	-0.177095	0.491408	1.000000
SIHySc	0.822593	0.633363	0.834973	-0.205149	0.827945	0.515393
Overall	0.784260	0.621600	0.781022	-0.267202	0.832336	0.698872
Total_CPUE	0.359387	0.393143	0.300084	-0.228117	0.549841	0.306966
Sport_CPUE	0.189321	0.360704	0.221572	-0.228369	0.541262	0.311882
Forage__CPUE	-0.019537	0.186111	0.151415	0.077771	-0.226747	-0.172415

	SIHySc	Overall	Total_CPUE	Sport_CPUE	Forage__CPUE
Tame	0.124647	0.128070	0.194282	0.269962	-0.535928
Native	-0.199869	-0.246003	-0.374960	-0.422572	0.365812
Rec	-0.435907	-0.413433	0.021540	0.221173	-0.526274
Develop_	-0.082479	0.061767	-0.306235	-0.131474	-0.356289
Perforage	0.056344	0.028130	0.481227	0.394423	0.489898
Roadsx	0.259734	0.452502	0.169627	0.169926	-0.098676
Vegcovfl	0.718391	0.715120	0.646074	0.642034	0.014299
Inv_CC	-0.245963	-0.104933	-0.216700	-0.216894	0.191846
Inv_DD	0.230921	0.463985	0.364110	0.364110	0.293972



Dis_Und	-0.014259	0.059355	-0.155015	-0.062266	-0.419231
TrShReg	0.397396	0.395587	0.268783	0.139636	0.243243
Utilis	0.420326	0.576479	0.036170	0.121325	-0.389734
DD	-0.111976	0.000000	-0.478311	-0.478311	-0.132698
RtMss	0.822593	0.784260	0.359387	0.189321	-0.019537
HCBGr	0.633363	0.621600	0.393143	0.360704	0.186111
StrAlt	0.834973	0.781022	0.300084	0.221572	0.151415
HCAlt	-0.205149	-0.267202	-0.228117	-0.228369	0.077771
ChIns	0.827945	0.832336	0.549841	0.541262	-0.226747
VegSc	0.515393	0.698872	0.306966	0.311882	-0.172415
SIHySc	1.000000	0.958565	0.486899	0.410196	-0.060872
Overall	0.958565	1.000000	0.463199	0.410603	-0.152055
Total_CPUE	0.486899	0.463199	1.000000	0.941809	0.018477
Sport_CPUE	0.410196	0.410603	0.941809	1.000000	-0.201578
Forage__CPUE	-0.060872	-0.152055	0.018477	-0.201578	1.000000