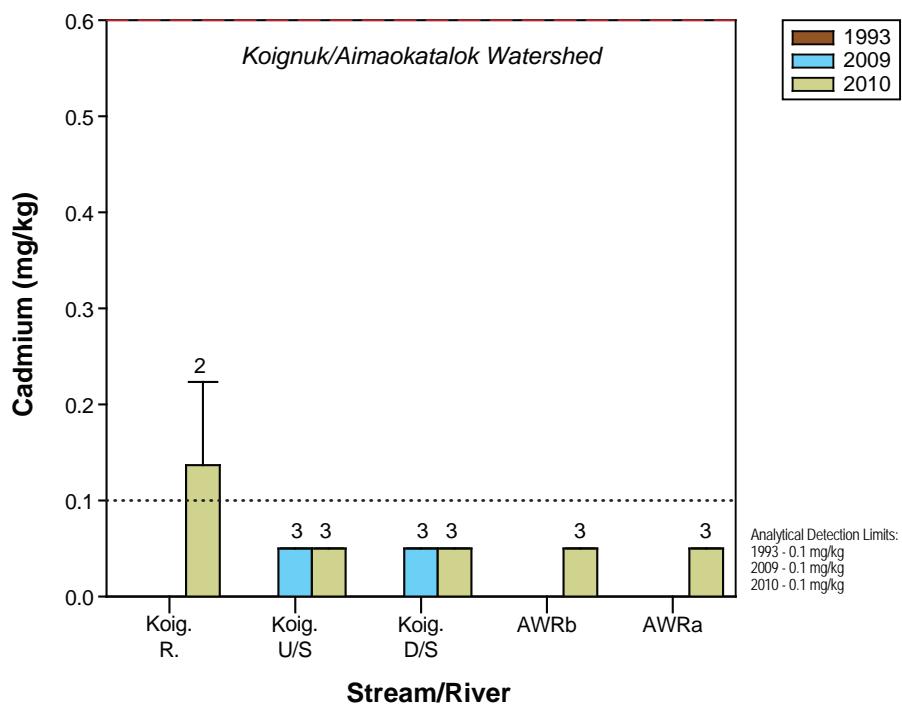
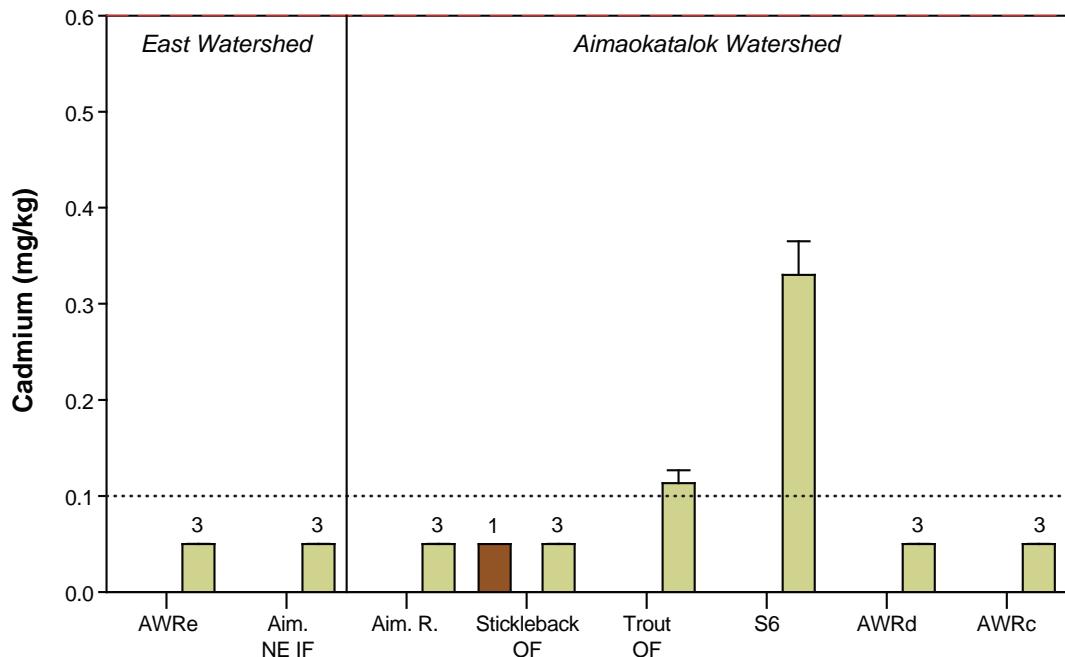
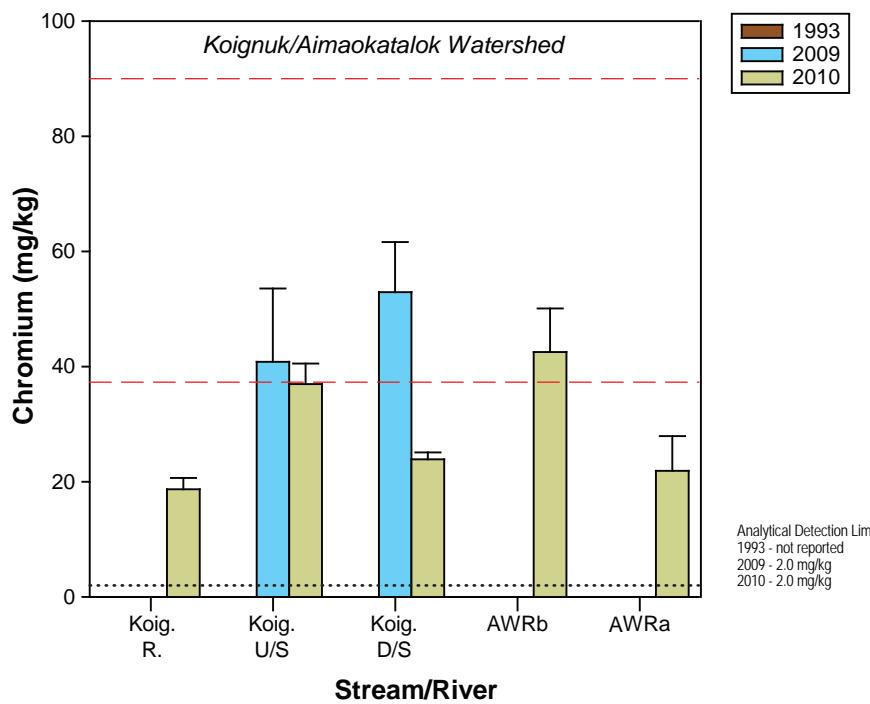
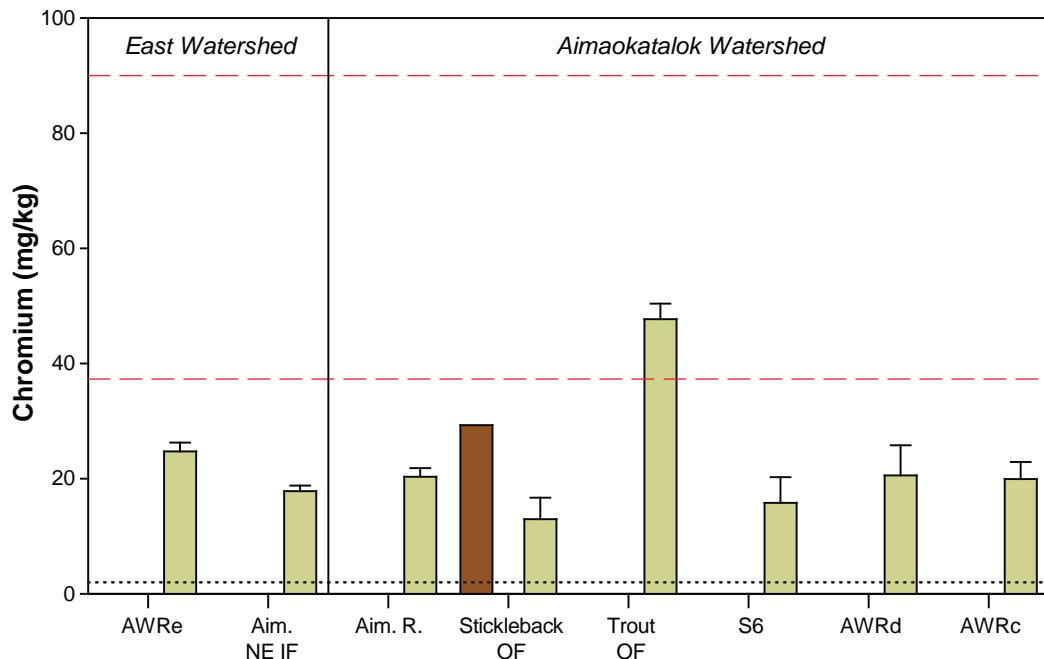


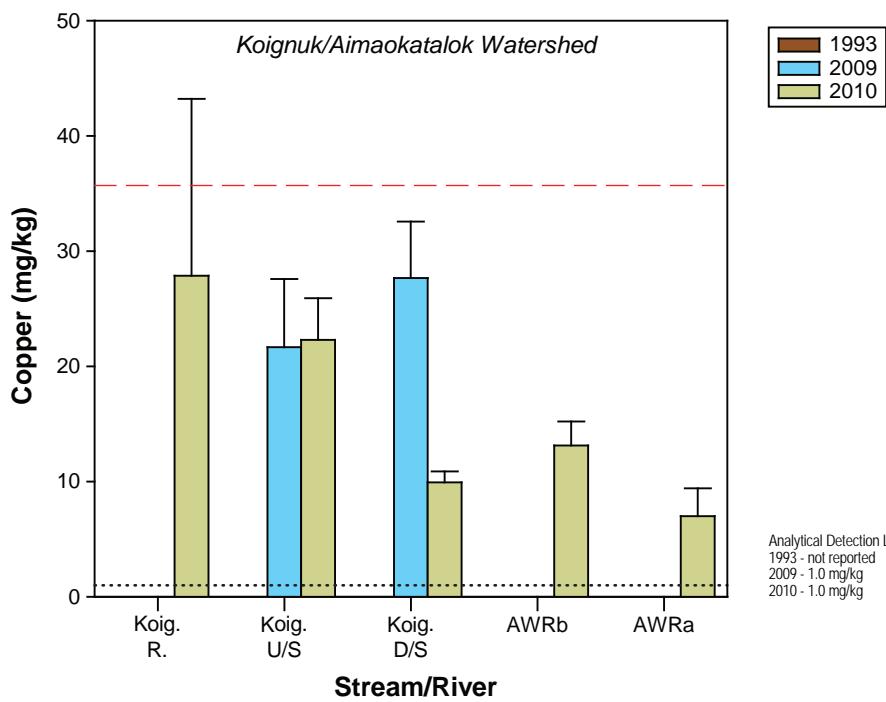
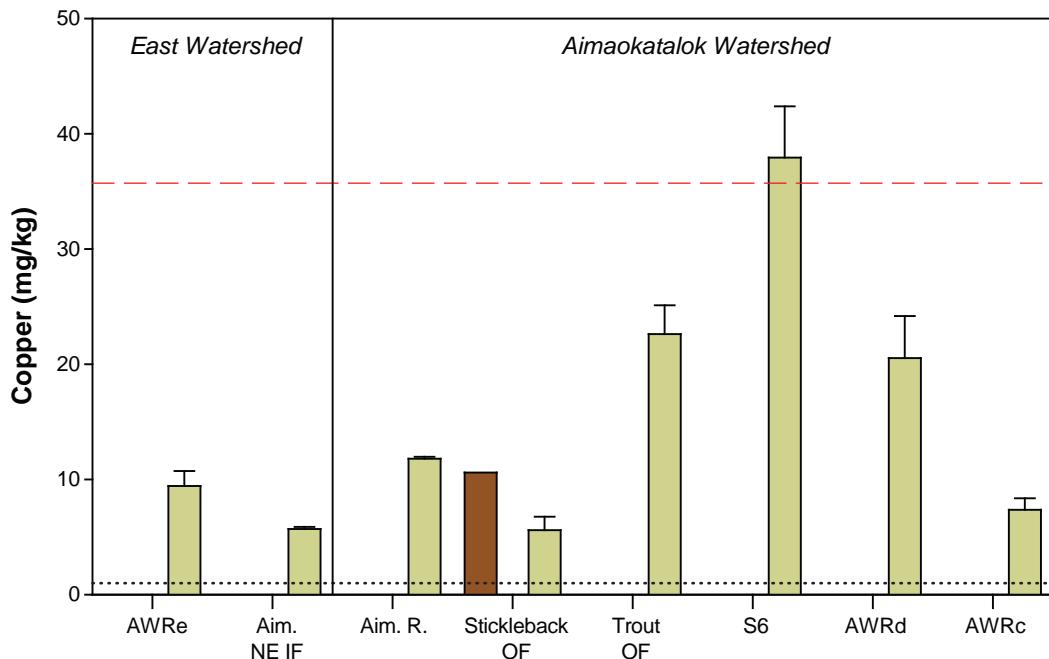
Notes: Error bars represent standard error of the mean.
 Dotted lines represent analytical detection limits; values below the detection limit are plotted at half the detection limit.
 Numbers above bars indicate number of replicates with concentrations below the analytical detection limit;
 absence of a number indicates all replicates were above the detection limit.
 Red dashed lines represent the CCME interim sediment quality guideline (5.9 mg/kg) and probable effects level (17 mg/kg).



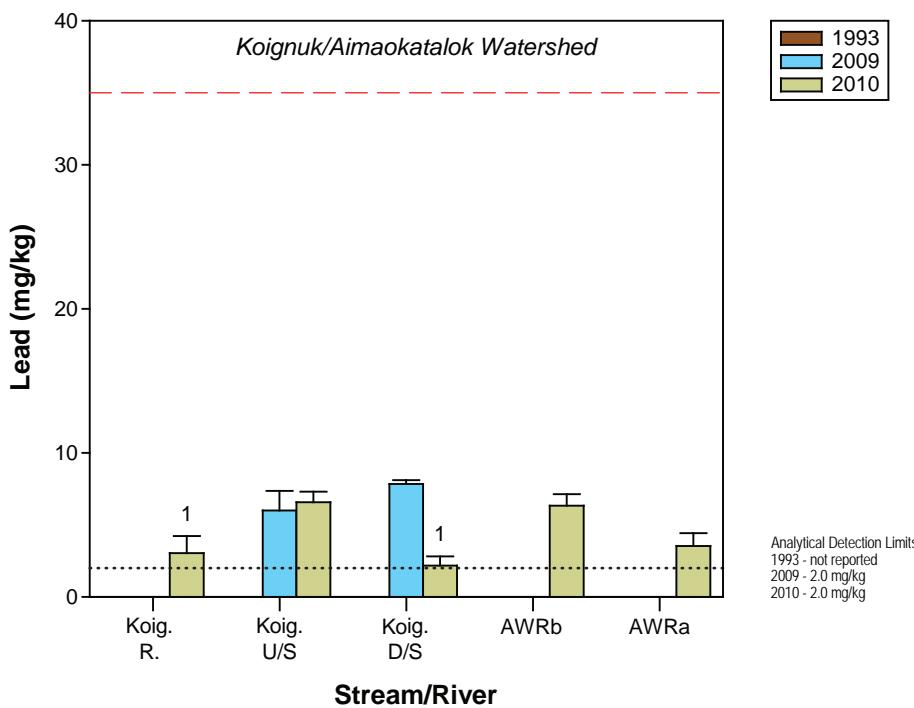
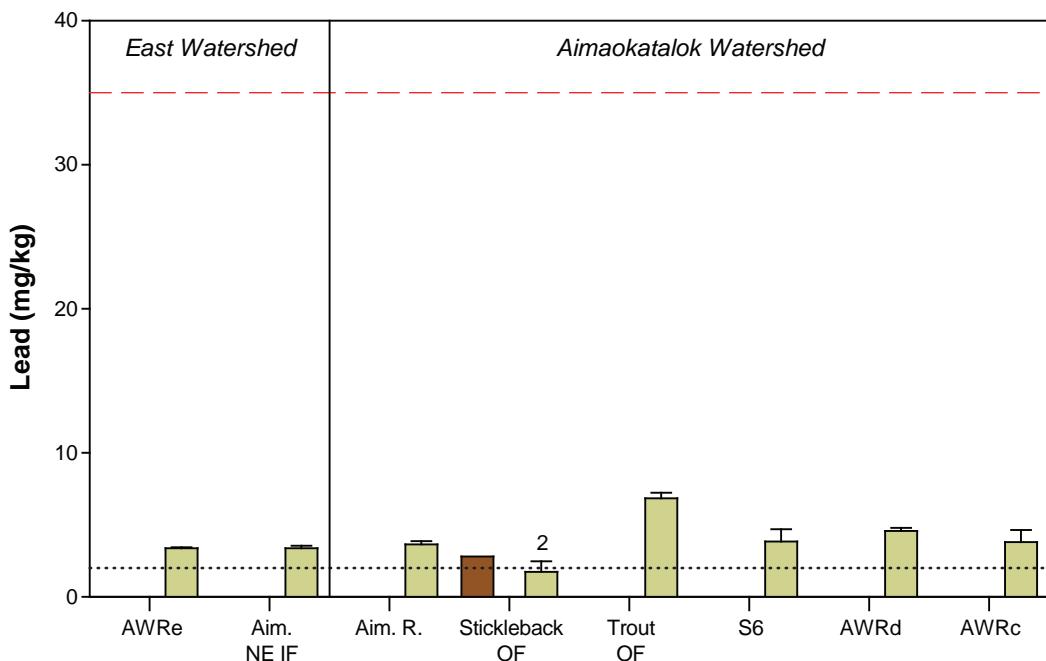


Analytical Detection Limits:
 1993 - not reported
 2009 - 2.0 mg/kg
 2010 - 2.0 mg/kg

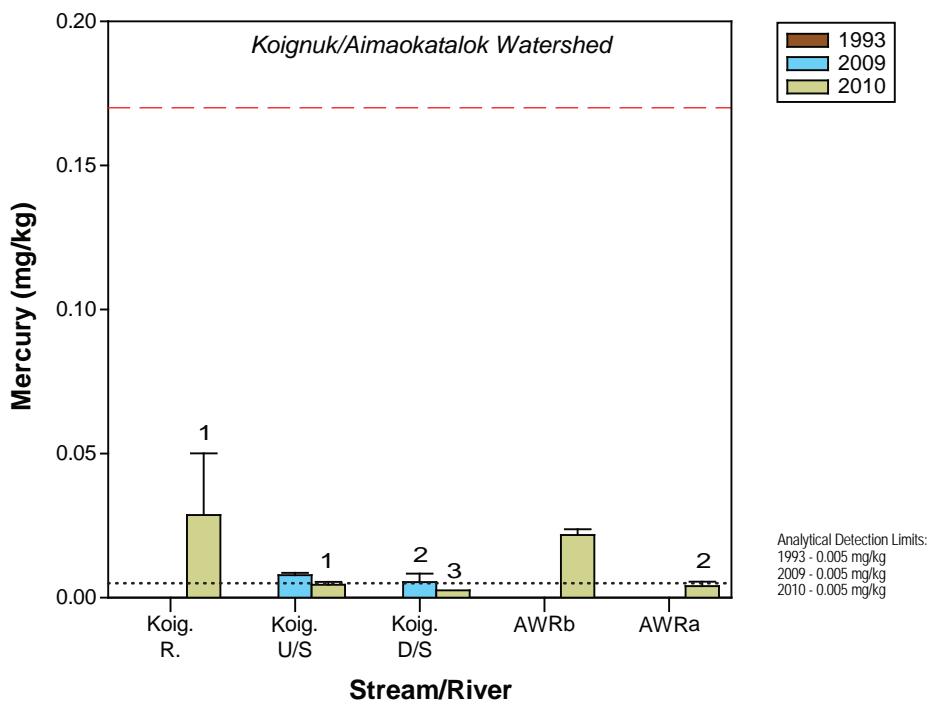
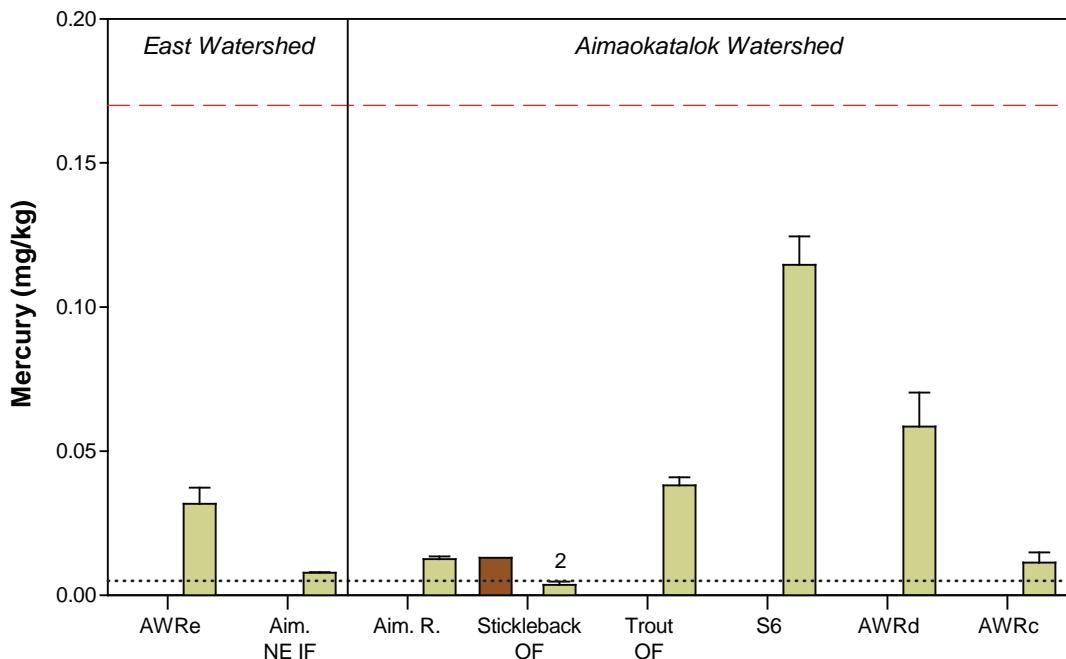
Notes: Error bars represent standard error of the mean.
 Dotted lines represent analytical detection limits; values below the detection limit are plotted at half the detection limit.
 Numbers above bars indicate number of replicates with concentrations below the analytical detection limit;
 absence of a number indicates all replicates were above the detection limit.
 Red dashed lines represent the CCME interim sediment quality guideline (37.3 mg/kg) and probable effects level (90 mg/kg).



Notes: Error bars represent standard error of the mean.
 Dotted lines represent analytical detection limits; values below the detection limit are plotted at half the detection limit.
 Numbers above bars indicate number of replicates with concentrations below the analytical detection limit;
 absence of a number indicates all replicates were above the detection limit.
 Red dashed line represents the CCME interim sediment quality guideline (35.7 mg/kg); the CCME probable effects level (197 mg/kg) is not shown.



Notes: Error bars represent standard error of the mean.
 Dotted lines represent analytical detection limits; values below the detection limit are plotted at half the detection limit.
 Numbers above bars indicate number of replicates with concentrations below the analytical detection limit;
 absence of a number indicates all replicates were above the detection limit.
 Red dashed line represents the CCME interim sediment quality guideline (35 mg/kg); the CCME probable effects level (91.3) is not shown.



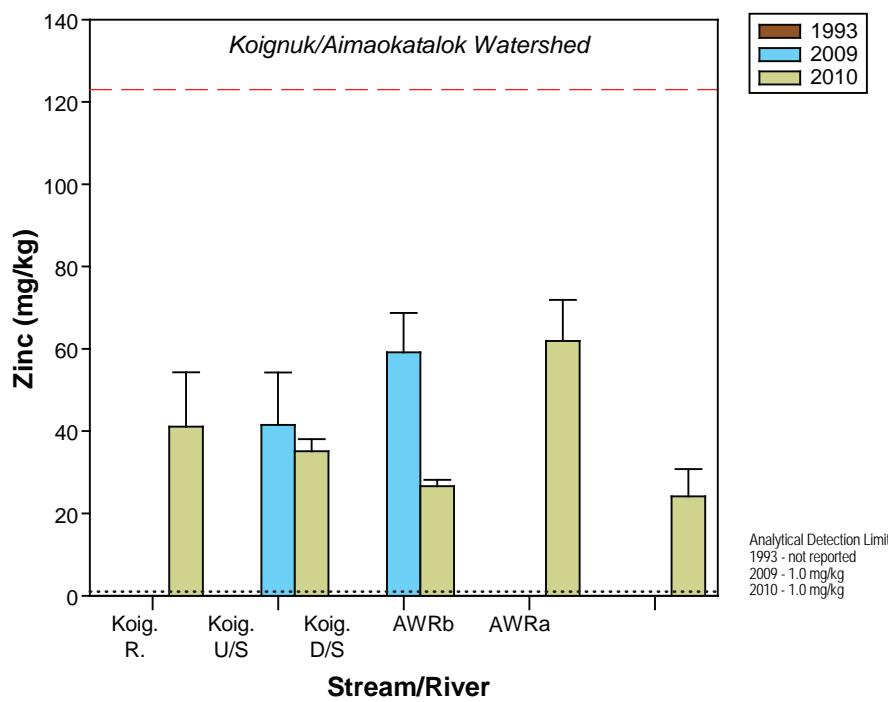
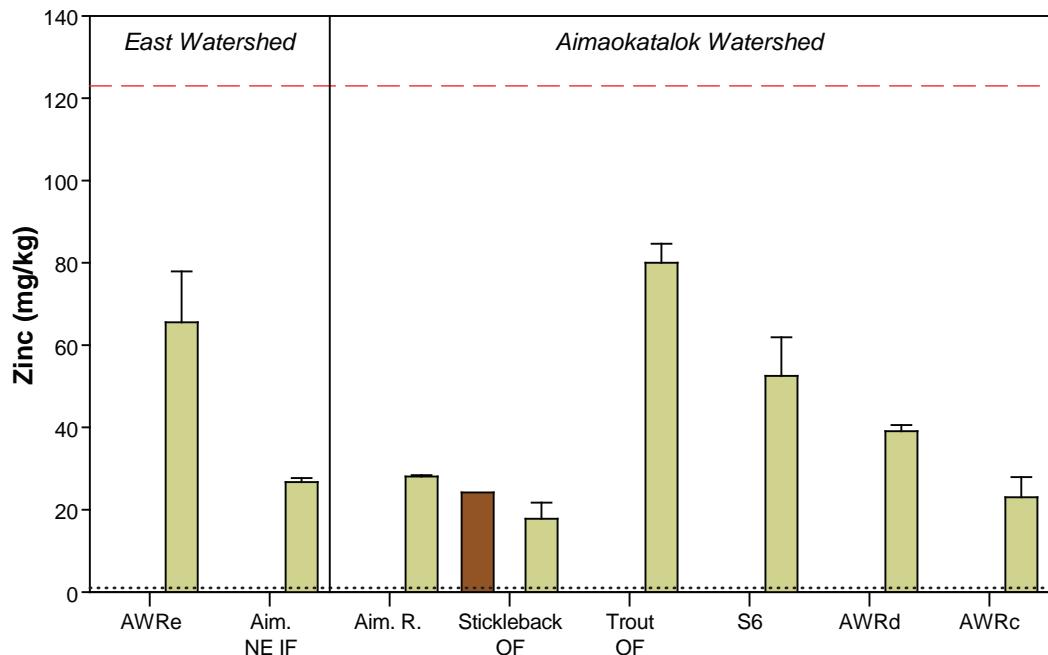
Notes: Error bars represent standard error of the mean.

Dotted lines represent analytical detection limits; values below the detection limit are plotted at half the detection limit.

Numbers above bars indicate number of replicates with concentrations below the analytical detection limit;

absence of a number indicates all replicates were above the detection limit.

Red dashed line represents the CCME interim sediment quality guideline (0.17 mg/kg); the CCME probable effects level (0.486 mg/kg) is not shown.



3.6 PHYTOPLANKTON

Phytoplankton biomass, abundance, and taxonomy samples were collected from lakes in August 2010. Raw phytoplankton biomass data are provided in Appendix 3.6-1 and phytoplankton abundance and taxonomy data are provided in Appendix 3.6-2.

3.6.1 Biomass

August phytoplankton biomass (as chlorophyll *a*) was low at all lake sites, and ranged from 0.45 µg chl *a*/L in Windy Deep to 1.0 µg chl *a*/L in Aim. Stn 5 (Figure 3.6-1). Windy Lake had the lowest average concentrations, and Stickleback, Trout, and Aimaokatalok lakes all had similar, low concentrations. All phytoplankton biomass levels measured in August 2010 were indicative of ultra-oligotrophic lakes (Vollenweider and Kerekes 1982).

Trophic status of a lake can be categorized by phytoplankton biomass or total phosphorus concentration (as well as other parameters, such as Secchi depth). The trophic status of some of the lakes differed based on total phosphorus concentrations compared to phytoplankton biomass concentrations. Overall, Windy Lake could be considered the lake with the lowest trophic classification (ultra-oligotrophic to oligotrophic), followed by Aimaokatalok Lake, Stickleback Lake, and Trout Lake.

3.6.2 Abundance

Phytoplankton abundance in August averaged 237 cells/mL, and ranged from 129 cells/mL at Windy Lake to 337 cells/mL at Stickleback Lake. There were no clear spatial trends in phytoplankton abundance (Figure 3.6-1).

3.6.3 Taxonomic Composition

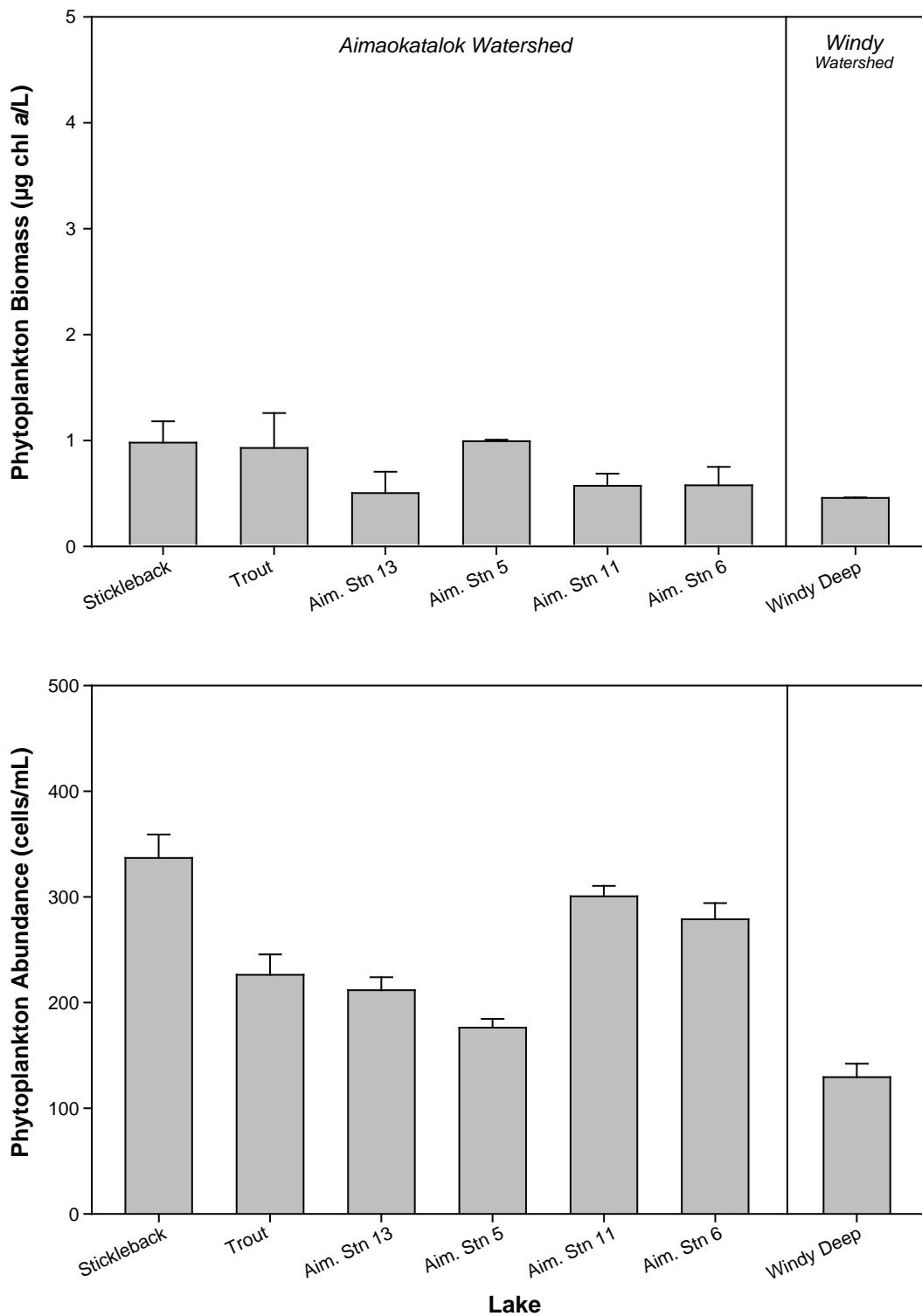
Lakes in the study area contained a diverse assemblage of phytoplankton taxa during August (Figure 3.6-2). Diatoms and chrysophytes were generally the most abundant taxa, making up a combined 61% to 90% of the phytoplankton assemblages in study lakes. The exception to this was Windy deep, where the phytoplankton was composed of 61% diatoms but less than 1% chrysophytes. The abundance of other taxonomic groups, including chlorophytes, cyanophytes and dinoflagellates, varied between lakes (Figure 3.6-2).

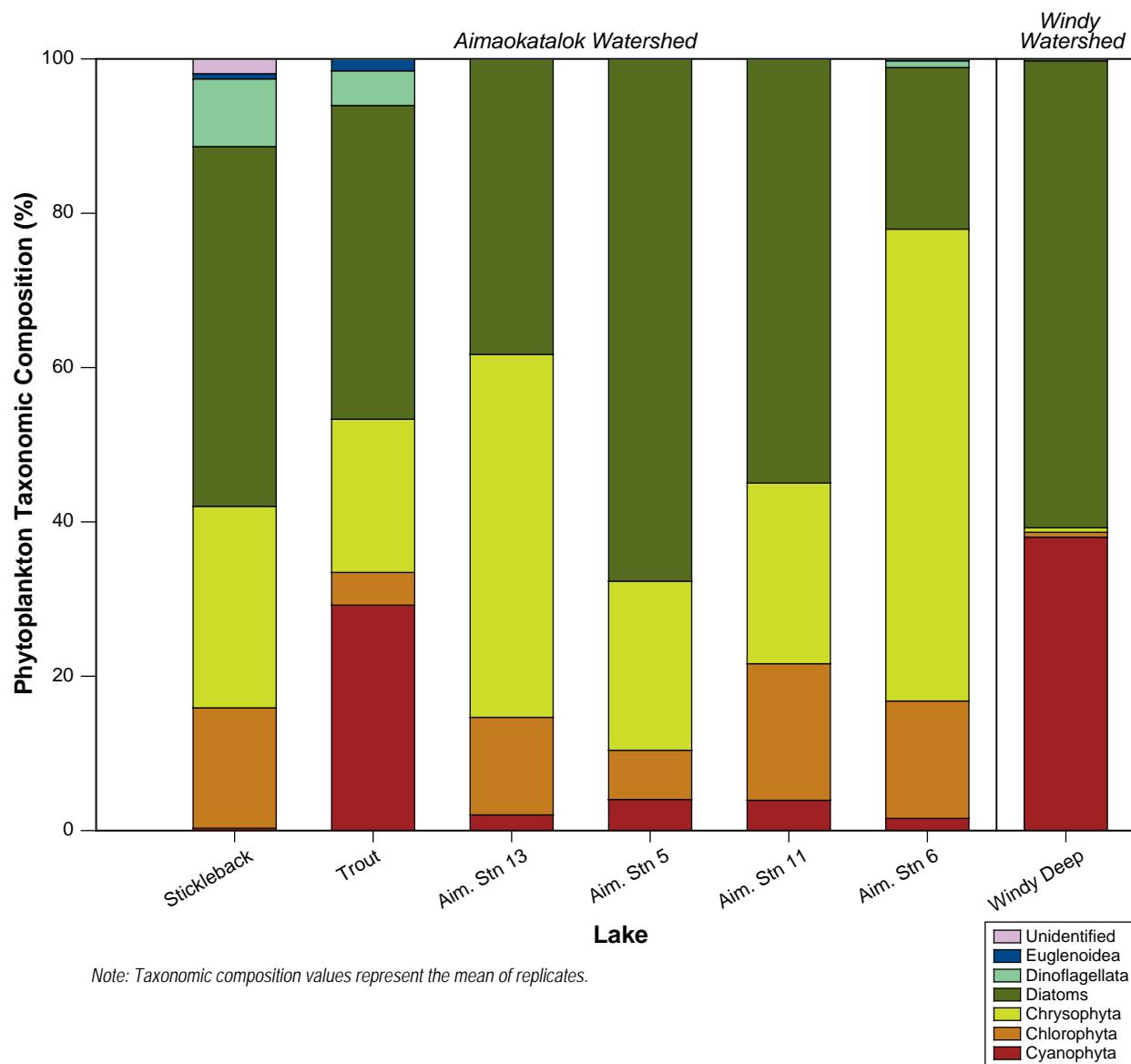
Cyanophytes (also known as blue-green algae or cyanobacteria) accounted for 29% and 38% of the phytoplankton assemblages in Trout Lake and Windy Lake, respectively, compared to a maximum of 4% at the other lake sampling sites. *Anabaena flos-aquae* and *Anabaena plantonica* were the most abundant species of blue-green algae in Trout Lake. *Aphanizomenon flos-aquae* was the dominant species in Windy Lake. The phytoplankton community in Windy Lake was distinctive both because of the relatively high contribution of cyanobacteria and the very low abundance of chrysophytes compared to other lakes (Figure 3.6-2).

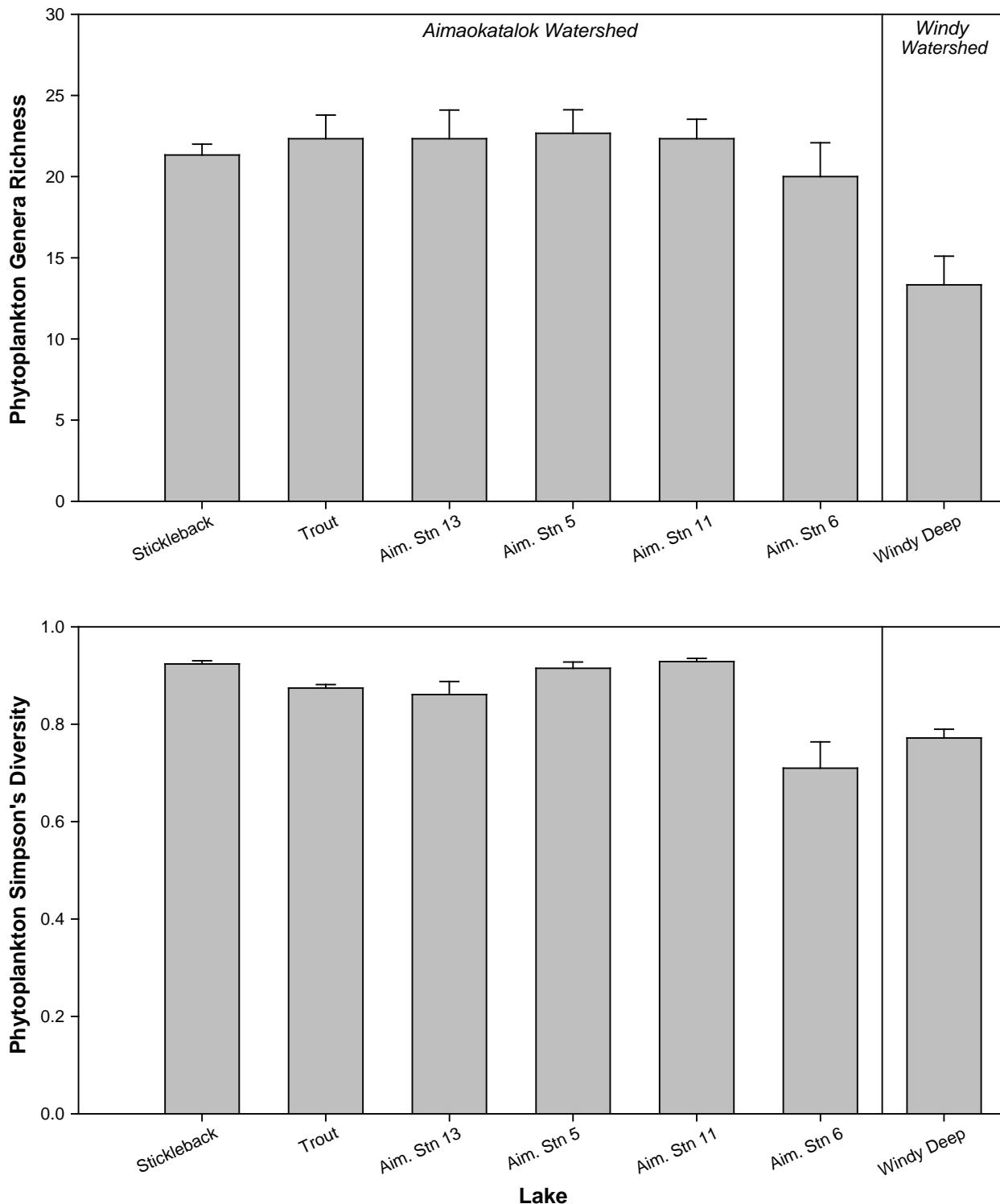
The phytoplankton assemblages in Stickleback and Trout lakes contained larger proportions of dinoflagellates compared to other lake sites, averaging 8.8% and 4.5%, respectively, compared to less than 1.4% at the other sites (Figure 3.6-2).

3.6.4 Richness and Diversity

Phytoplankton genera richness averaged 21 genera/sample in the lakes during August 2010 (Figure 3.6-3). Lakes within the Aimaokatalok Watershed had slightly greater richness (averaging 20 to 23 genera/sample) than Windy Lake (averaging 13 genera/sample).







Note: Error bars represent standard error of the mean.

During August, the diversity was lowest at Aim. Stn 6 (0.71) and highest at Aim. Stn 11 (0.93; Figure 3.6-3). Aimaokatalok Watershed tended to have greater diversity than Windy Lake.

3.6.5 Annual Variation

Only historical sampling locations that were also sampled in 2010 were included in the comparisons of annual phytoplankton biomass and abundance data shown in Figures 3.6-4 and 3.6-5. Note that historical sampling locations and methodology may not correspond exactly with 2010 locations and methodology, and this may contribute to variability observed between years (see Table 2.14-5 and Figures 2.14-3a to 2.14-3c for historical sampling locations and methodologies). Winter phytoplankton data were not included in the annual averages as winter samples were collected only in 2009 and 2010.

Phytoplankton biomass data have been collected since 1996 at some of the lakes that were sampled in 2010. Considering the annual differences in sample collection location, sampling date, and sampling methodology (e.g., discrete samples vs. depth-integrated samples), historical data generally showed similar biomasses. The exception being the spike in biomass at Trout Lake in 2006, which was five times higher than biomasses recorded in the six other years (Figure 3.6-4).

Phytoplankton abundance data have been collected since 1994 at some of the lakes that were sampled in 2010. Annual data were highly variable (Figure 3.6-5).

3.7 PERIPHYTON

Periphyton plates were installed in streams and rivers in early August and retrieved in early September 2010. Appendix 3.7-1 provides periphyton biomass data, and Appendix 3.7-2 provides periphyton density and taxonomy data.

3.7.1 Biomass

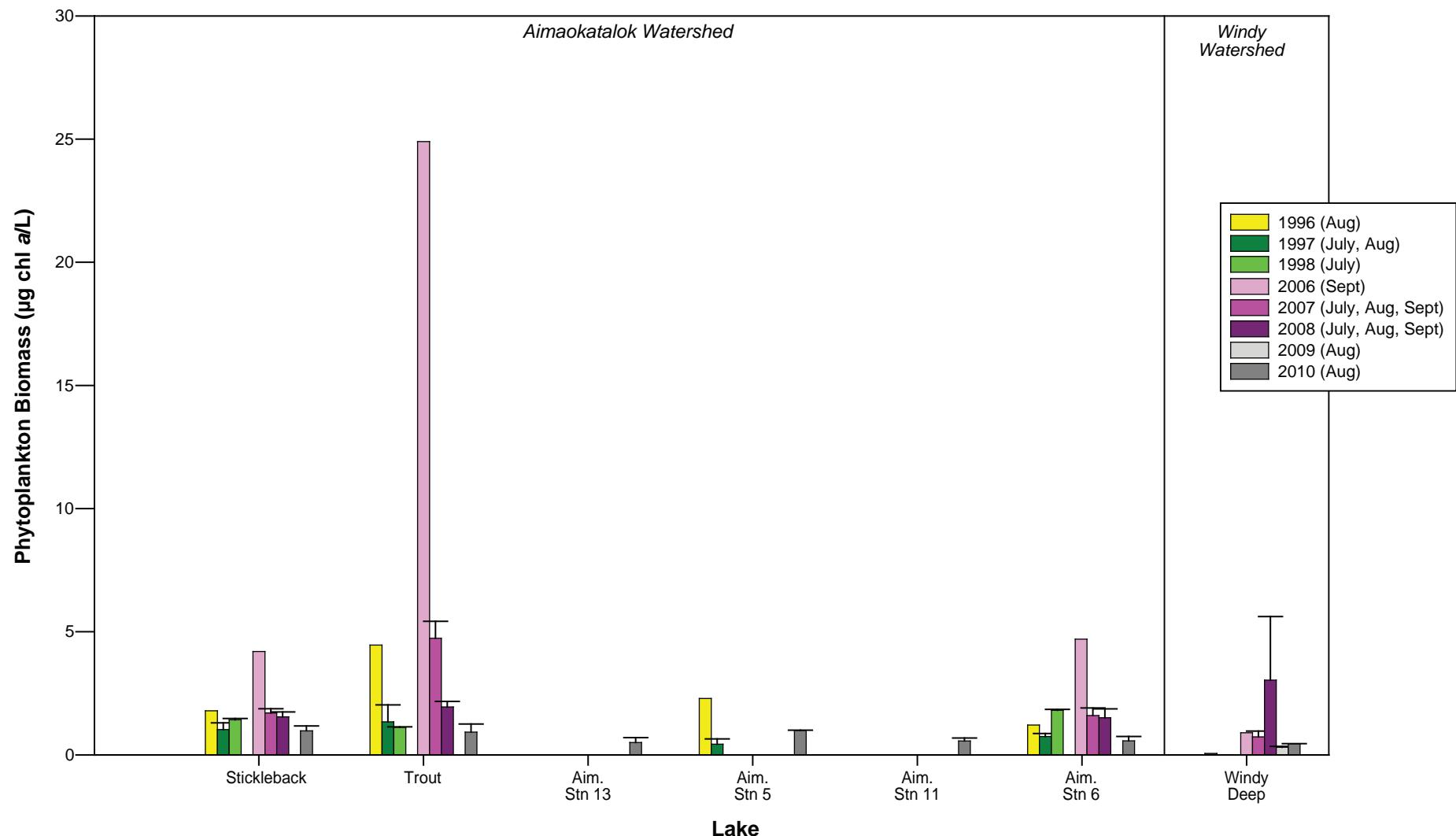
Average periphyton biomass (as chlorophyll *a*) ranged from 0.01 $\mu\text{g chl } a/\text{cm}^2$ at Koig. D/S to 0.44 $\mu\text{g chl } a/\text{cm}^2$ at Aim. OF (Figure 3.7-1). The average periphyton biomass for all of the sampled streams and rivers was 0.18 $\mu\text{g chl } a/\text{cm}^2$. There were no clear spatial patterns in periphyton biomass between watersheds (Figure 3.7-1).

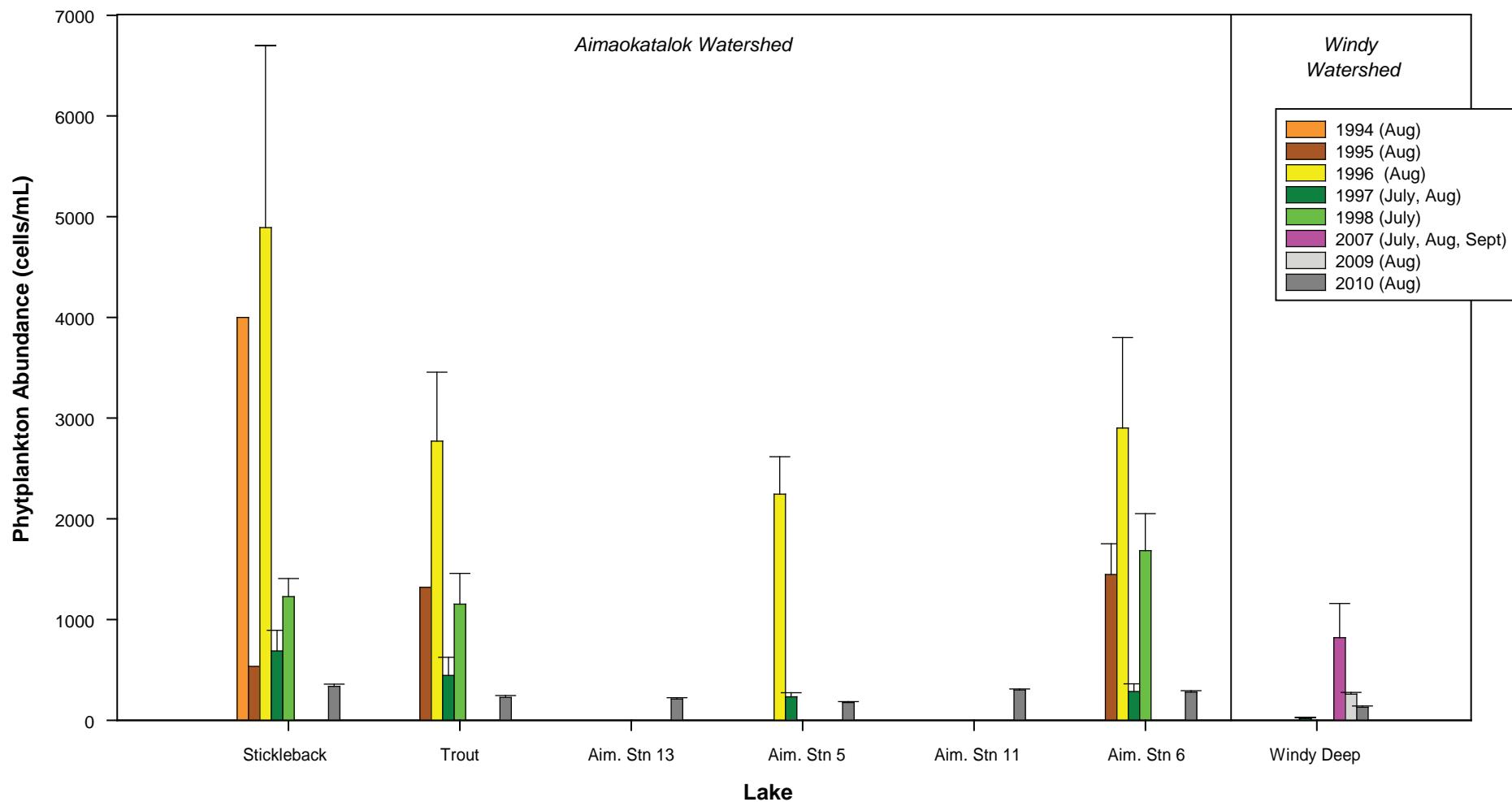
3.7.2 Density

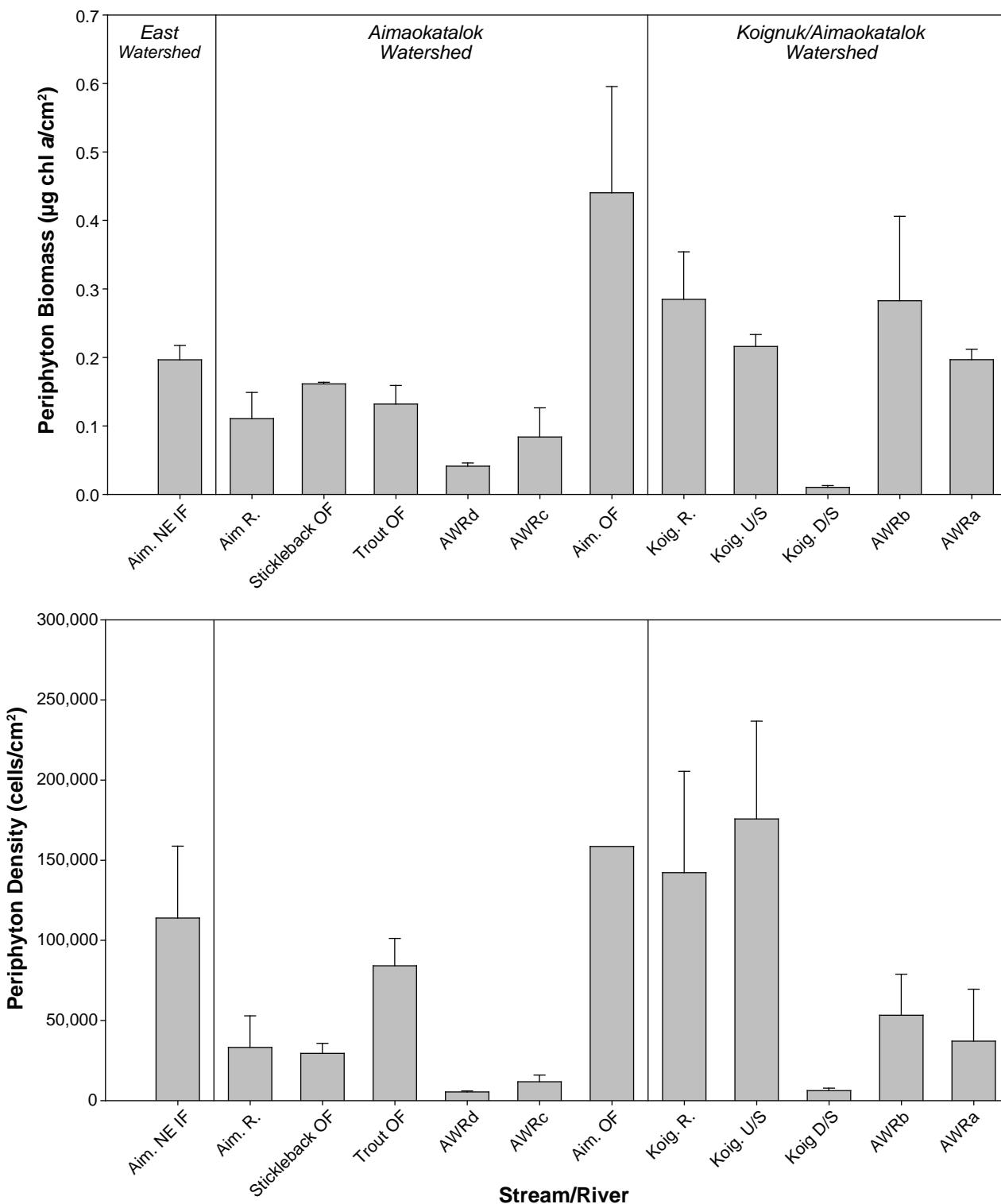
Average periphyton density ranged from approximately 5,400 cells/ cm^2 at AWRd to 176,000 cells/ cm^2 at Koig. U/S (Figure 3.7-1). Periphyton density and biomass generally showed similar patterns (e.g., with low biomass sites having low periphyton density, and sites with high biomass having high density). Overall, periphyton density averaged 65,100 cells/ cm^2 across all sites, and there were no apparent differences between watersheds (Figure 3.7-1).

3.7.3 Taxonomic Composition

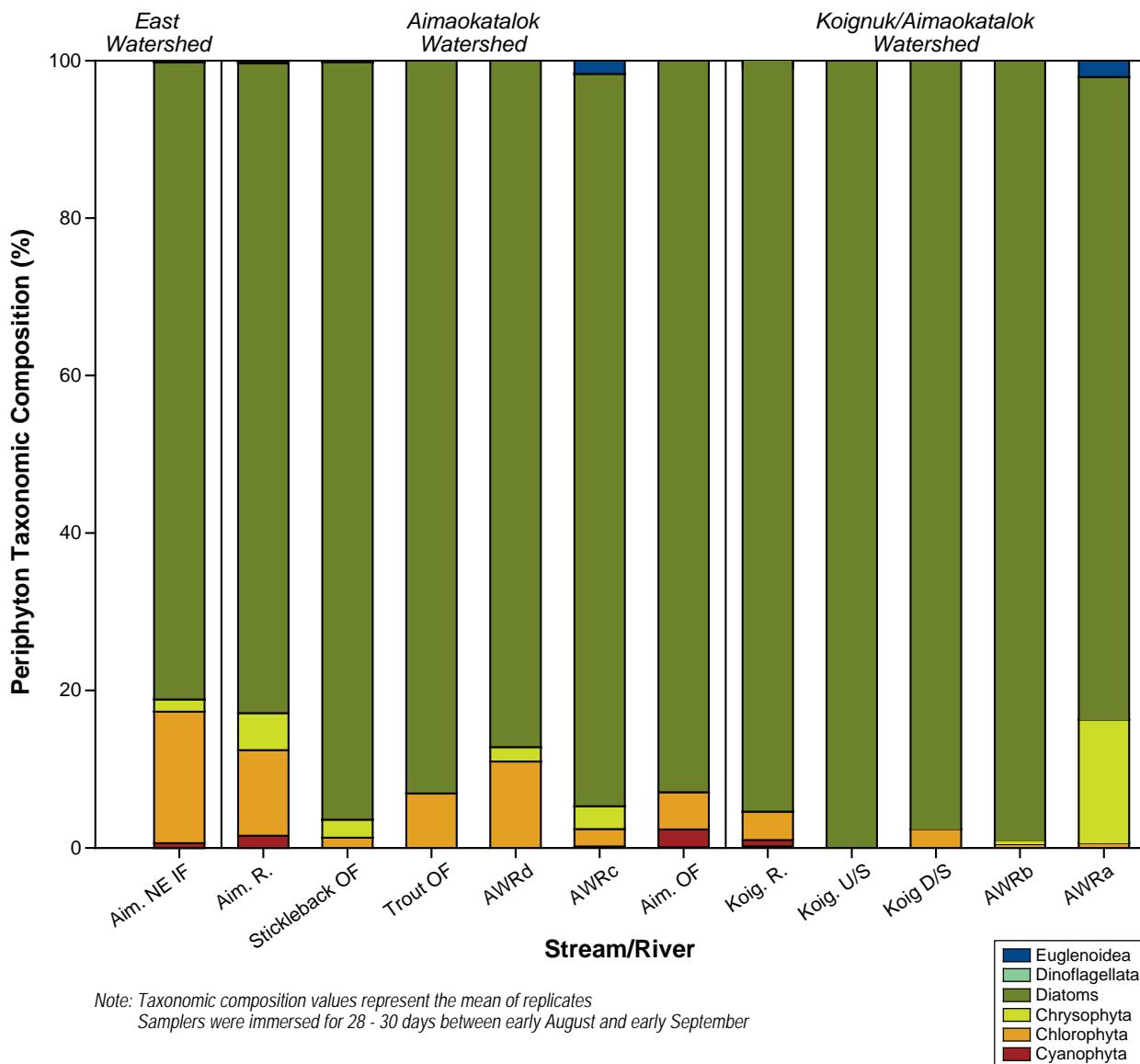
Periphyton assemblages were almost exclusively composed of diatoms, which made up at least 81% of the periphyton community in all sampled streams and rivers (Figure 3.7-2). The periphyton community at Koig. U/S was entirely composed of diatoms (100%). The diatoms *Achnanthes minutissima* and *Diatoma tenuie* were among the most common species of diatoms found in stream and river periphyton communities. *Achnanthes minutissima* is a small, adnate diatom that is common in riffle habitats and often dominates high flow regimes.







Note: Error bars represent standard error of the mean
 Samplers were immersed for 28 - 30 days between early August and early September



Chlorophytes were the second most common periphyton group in most streams and rivers, making up between 0% (Koig. U/S) and 16.7% (Aim. NE IF) of the composition by density. Chrysophytes, cyanophytes, and euglenoids generally made minor contributions to the periphyton assemblages.

3.7.4 Richness and Diversity

Periphyton genera richness ranged from 10 genera/sample at both Trout OF and Koig D/S to 18 genera/sample at both Aim. R and Aim. OF (Figure 3.7-3). Overall, the periphyton communities were quite diverse and relatively similar among sites, with diversity ranging from 0.63 to 0.88 at most sites, and averaging 0.77 (Simpson's diversity index). Trout OF was the exception to this, as diversity at this site (0.47) was relatively low compared to the other sites. This low diversity is likely a reflection of both the low genera richness as well as the low genera evenness at Trout OF, as the genus *Achnanthes* made up more than 60% of the periphyton community composition at this site.

3.7.5 Annual Variation

Only historical sampling locations corresponding to streams and rivers sampled in 2010 were included in the comparison of annual periphyton biomass and density shown in Figures 3.7-4 and 3.7-5. Note that historical sampling locations may not correspond exactly with those sampled in 2010 and this may contribute to variability in periphyton biomass and density between years. Prior to 1997, periphyton was collected by scraping rocks in streams and rivers, whereas from 1997 onward, Plexiglas® plates were installed in streams and rivers for approximately one month to allow for colonization by periphyton. As well, the timing of plate installation has varied between years. These differences in methodology and timing of sampling may also contribute to differences in periphyton biomass and density between years (see Table 2.14-6 and Figures 2.14-3a to 2.14-3c for historical sampling locations and methodologies).

Historical annual periphyton biomass data were highly variable within sites over time as well as between sites for any given year (Figure 3.7-4). Periphyton biomass was particularly high in 1997 and 1998 ranging from 9.5 to 371 µg chl a/cm² at Aim. NE IF, Aim. R, Stickleback OF, and Trout OF. Periphyton biomass levels in 2009 and 2010 have remained below 0.5 µg chl a/cm² at all sampling sites.

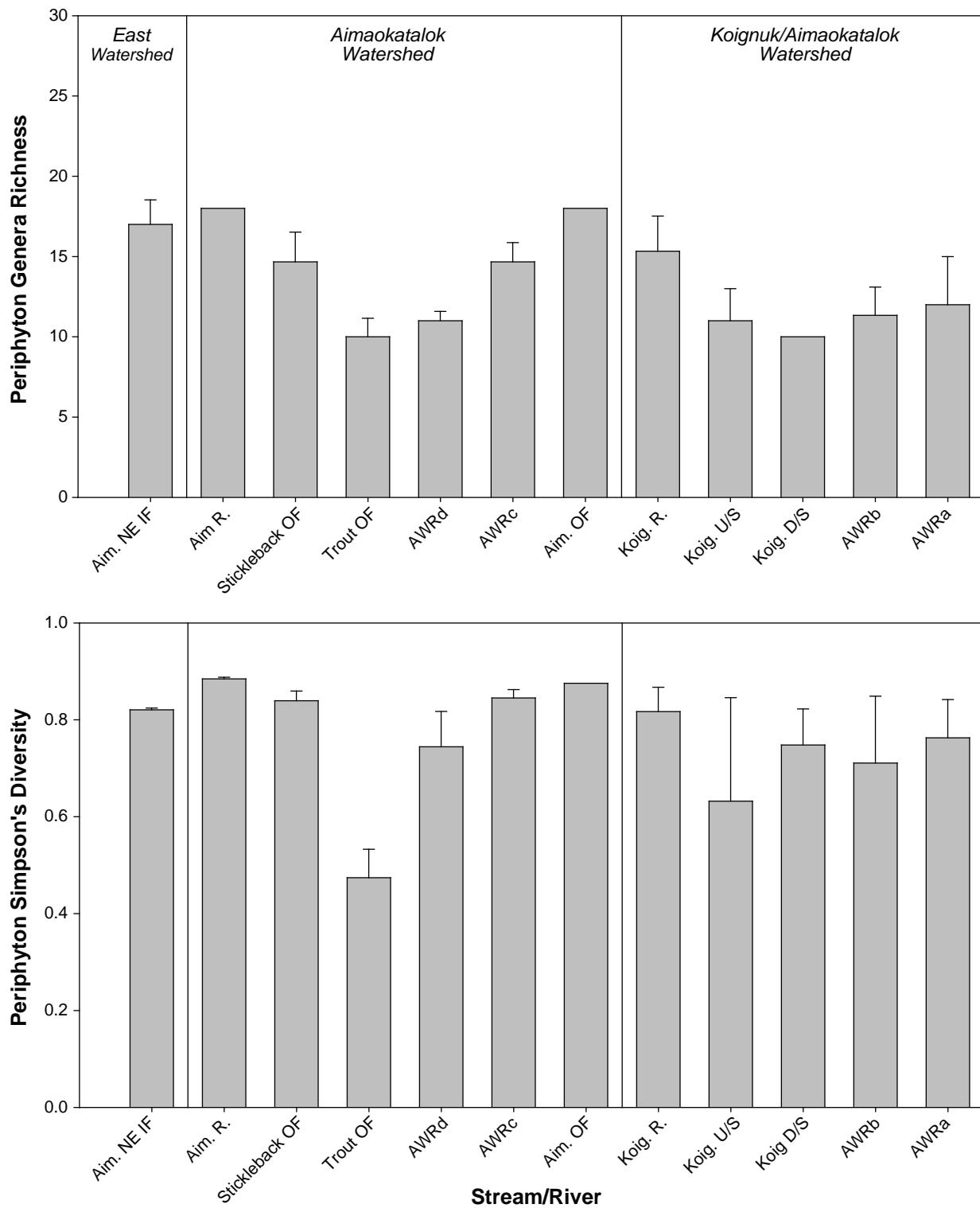
Historical annual periphyton density was also highly variable within and between sites (Figure 3.7-5). Some of the highest periphyton densities were reported in 1995 when samples were collected by scraping periphyton from the surface of rocks. There were no obvious spatial or temporal trends in periphyton density, possibly because of the high variability in the historical dataset (Figure 3.7-5).

3.8 ZOOPLANKTON

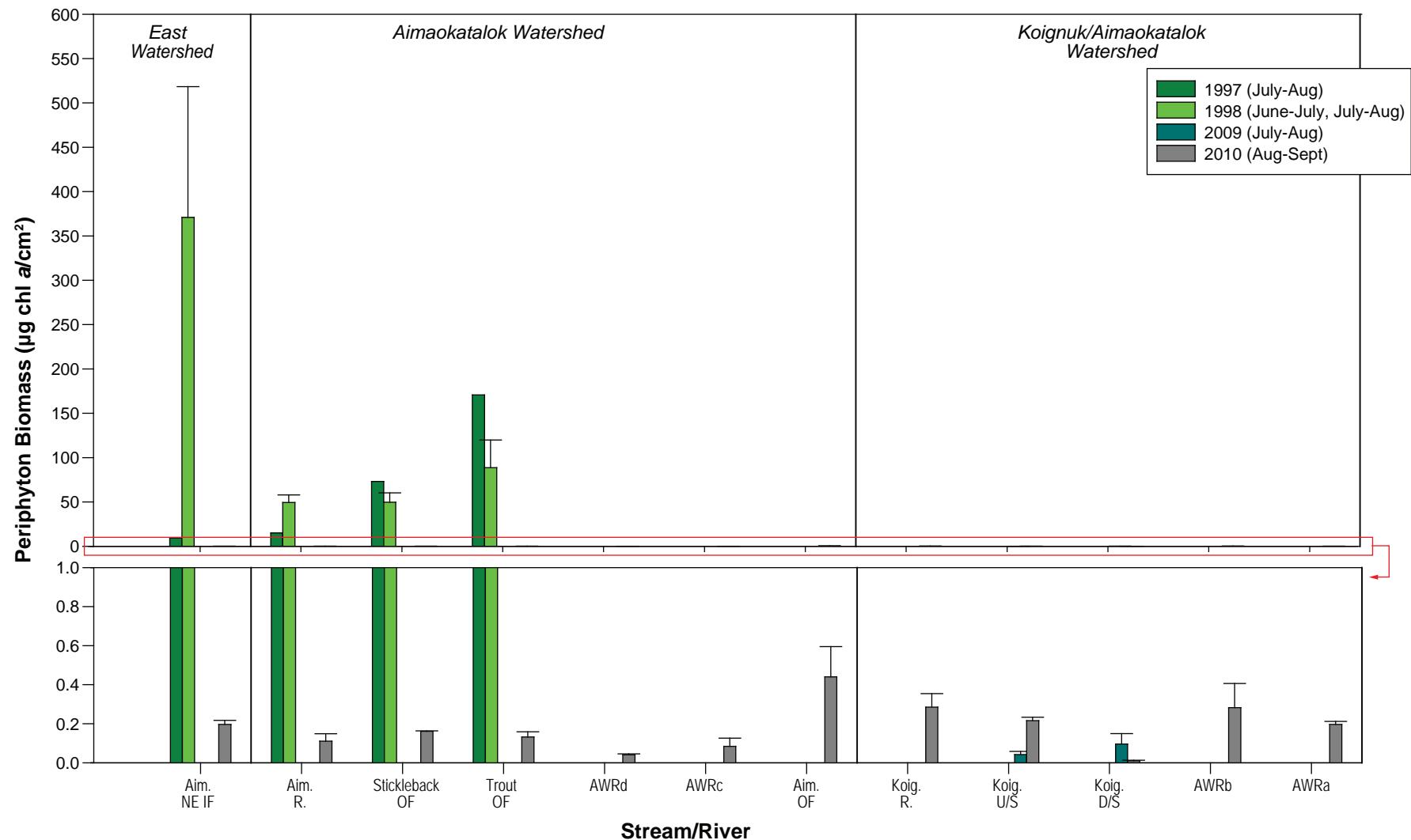
Zooplankton abundance and taxonomy samples were collected from lakes in August 2010. The raw zooplankton data are presented in Appendix 3.8-1.

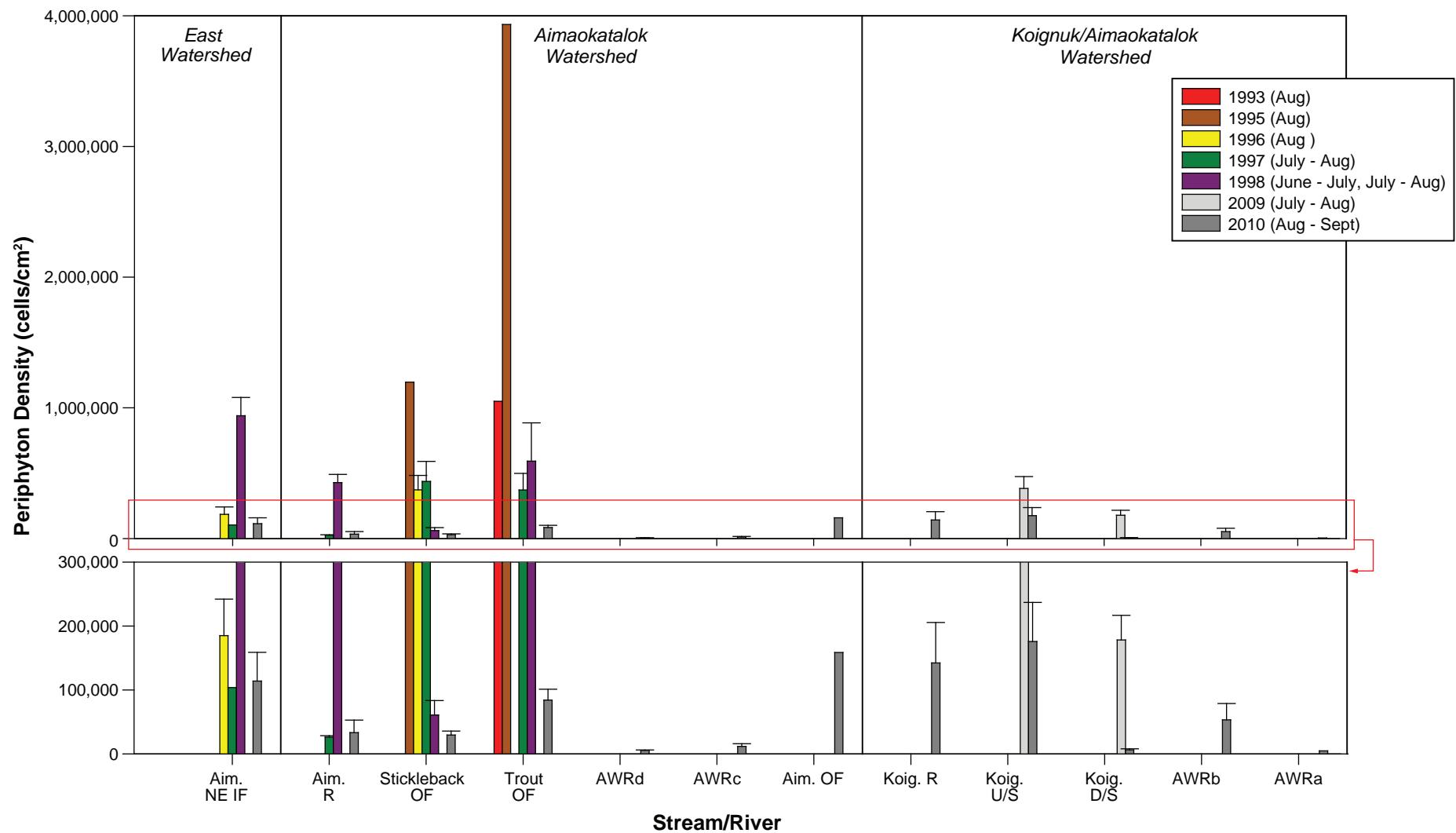
3.8.1 Abundance

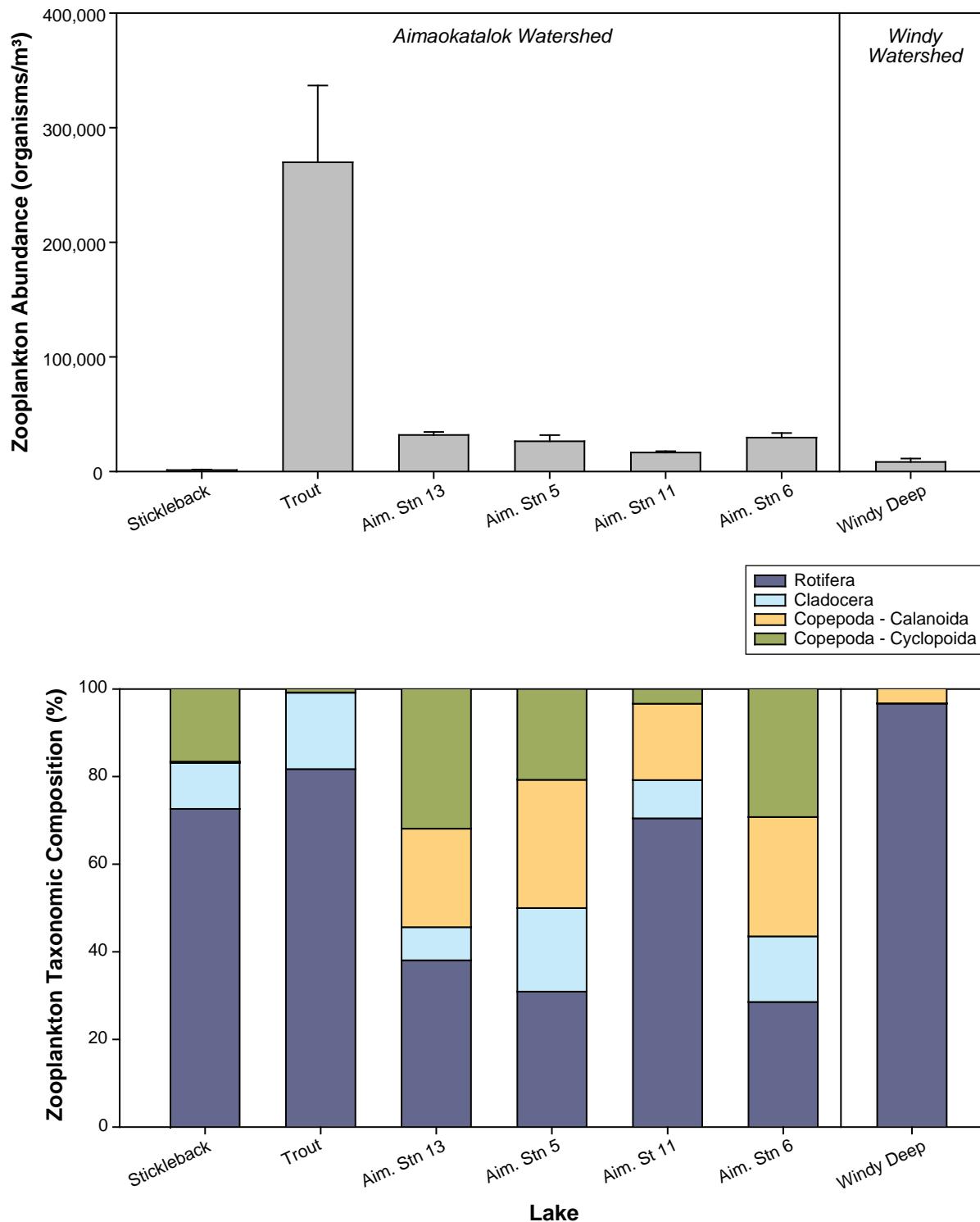
Zooplankton abundances were below 32,000 organisms/m³ in all lakes, except Trout Lake where zooplankton abundance averaged 270,000 organisms/m³ (Figure 3.8-1). The lowest abundances were found in Stickleback and Windy Lake sites, which averaged 1,250 and 8,330 organisms/m³ respectively. Zooplankton abundances at the other sites averaged between 26,000 and 32,000 organisms/m³. There were no clear differences in zooplankton abundances between watersheds (Figure 3.8-1).



Note: Error bars represent the stand error of the mean
 Samplers were immersed for 28 - 30 days between early August and early September







3.8.2 Taxonomic Composition

Lake zooplankton assemblages were largely composed of rotifers, cladocerans, and calanoid and cyclopoid copepods (Figure 3.8-1). Aim. Stn 13, Aim. Stn 5, and Aim. Stn 6 were similar in composition, having approximately even proportions of rotifers, and calanoid and cyclopoid copepods, with fewer cladocerans. The zooplankton assemblages at Stickleback, Trout, Aim. Stn 11, and Windy lakes were composed mainly of rotifers, which made up between 70 and 97% of the zooplankton community. The rotifer *Kellicottia longispina* was particularly abundant in Trout Lake, which had the highest total zooplankton abundance. This rotifer accounted for 61% of all zooplankton individuals collected in the study lakes. Compared to other lakes, Trout Lake contained relatively small proportions of copepods (<1%), and Windy Deep had low proportions of cladocerans and cyclopoid copepods (<1%) (Figure 3.8-1).

3.8.3 Richness and Diversity

Average zooplankton genera richness varied between lakes, and ranged from 4 genera/sample at Windy Lake Deep, to 13 genera/sample at Trout Lake. The genera richness of the remaining sites ranged between 8.3 and 9.3 genera/sample (Figure 3.8-2).

The Simpson's diversity index for zooplankton was also variable, ranging from 0.22 at Windy Deep to 0.70 at Aim. Stn 5 (Figure 3.8-2). The site with the lowest Simpson's diversity, Windy Deep, also had very low evenness, with only two genera making up more than 96% of the community. There were no clear differences in diversity between watersheds.

3.8.4 Annual Variation

Only historical sampling locations that were also sampled in 2010 were included in the comparison of annual zooplankton abundance shown in Figure 3.8-3. Note that historical sampling locations and methods may not correspond exactly with those sampled in 2010, and this may contribute to the large variability observed between years (see Table 2.14-7 and Figures 2.14-4a to 2.14-4c for historical sampling locations and methodologies).

Zooplankton abundances were highly variable among years, and no consistent annual trends were apparent. The very high zooplankton abundance at Stickleback Lake in 1993 may be partly attributable to the smaller zooplankton net mesh size used in 1993 (63 μm compared to 118 μm from 1995 to 2010). 2010 zooplankton abundances at Aim. Stn 5, and Windy Deep were generally similar to previous years. Trout Lake zooplankton abundance was high in 2010 relative to previous years (Figure 3.8-3).

3.9 LAKE BENTHOS

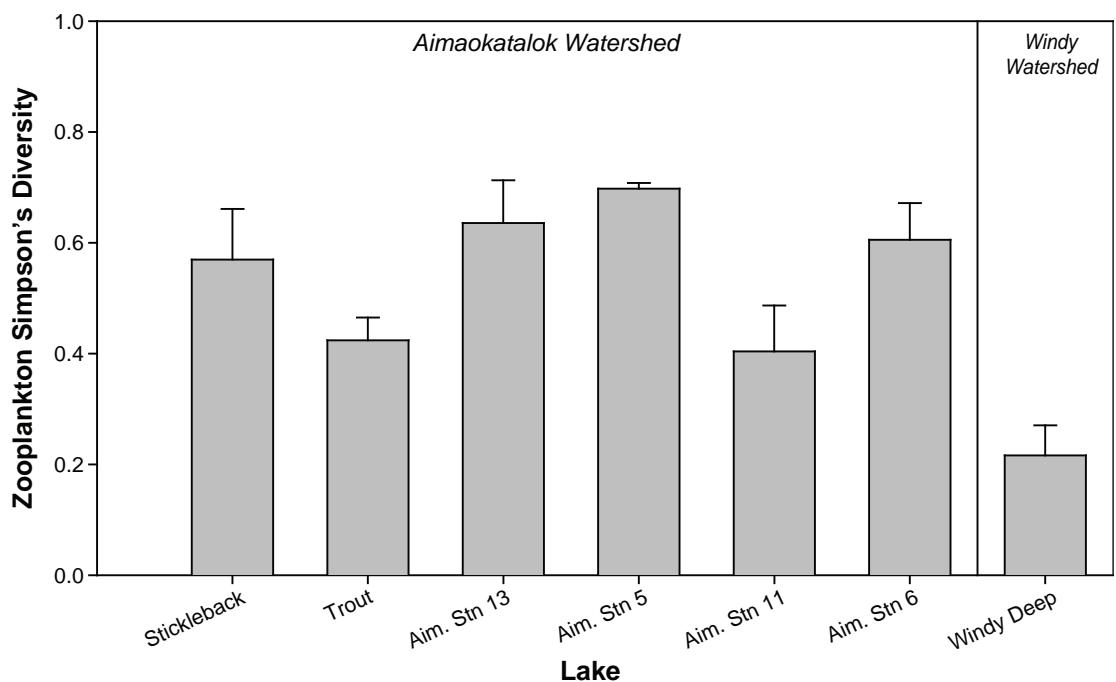
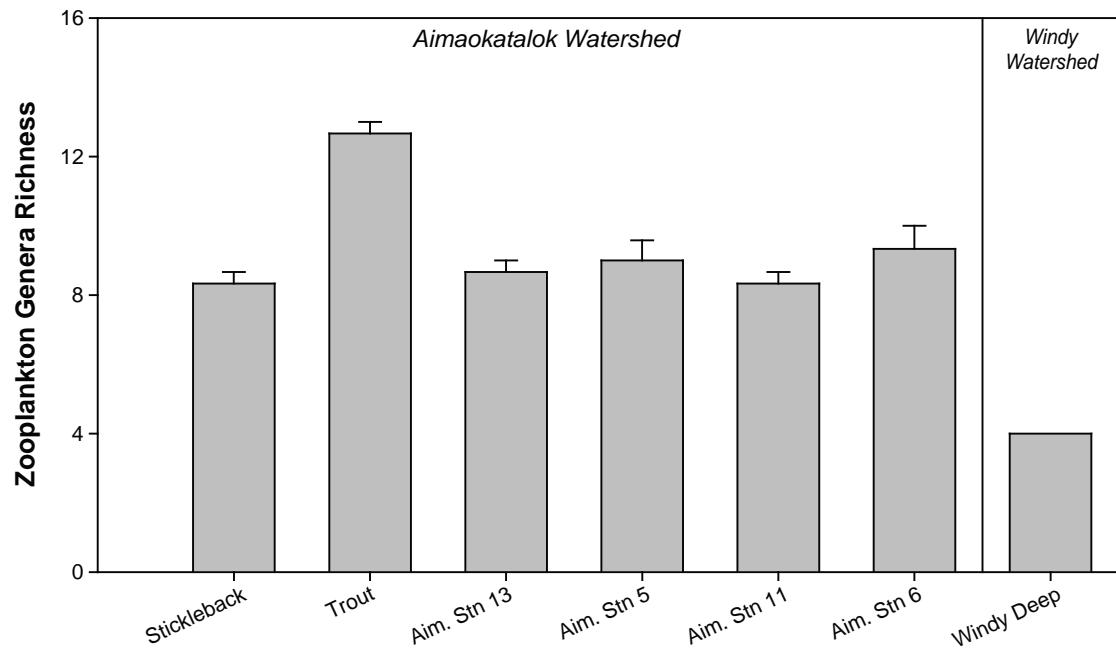
Benthos density and taxonomy samples were collected from lakes in August 2010. Raw benthos data are provided in Appendix 3.9-1.

3.9.1 Density

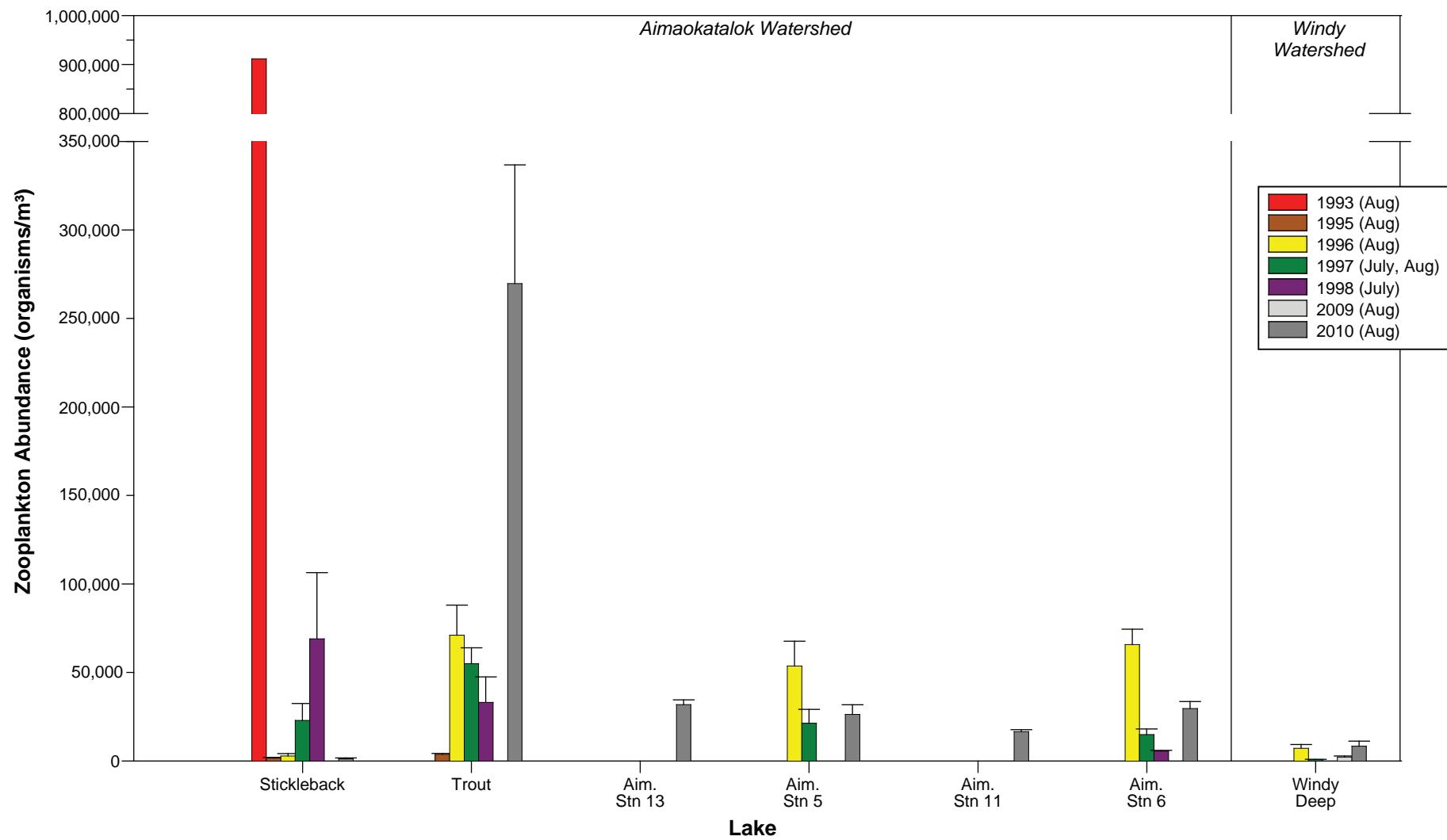
Average benthos density varied between lakes, ranging from 77 organisms/ m^2 in Windy Lake (deep depth) to 35,500 organisms/ m^2 in Trout Lake (shallow depth; Figure 3.9-1; Appendix 3.9-1). Benthos densities at Trout and Stickleback lakes were much higher than other lakes, averaging of 31,600 organisms/ m^2 , while all other lakes had average densities below 8,000 organisms/ m^2 (Figure 3.9-1).

3.9.2 Taxonomic Composition

Figure 3.9-2 presents the taxonomic composition of the lake benthos communities surveyed. Benthic communities in the study lakes were composed largely of dipterans, or true flies as they are commonly known (between 26 and 91% of individuals found at each site). Pelecypods (bivalves), oligochaetes (segmented worms), and ostracods (seed shrimp) also made important contributions to the benthic assemblages at some sites.



Note: Error bars represent standard error of the mean.



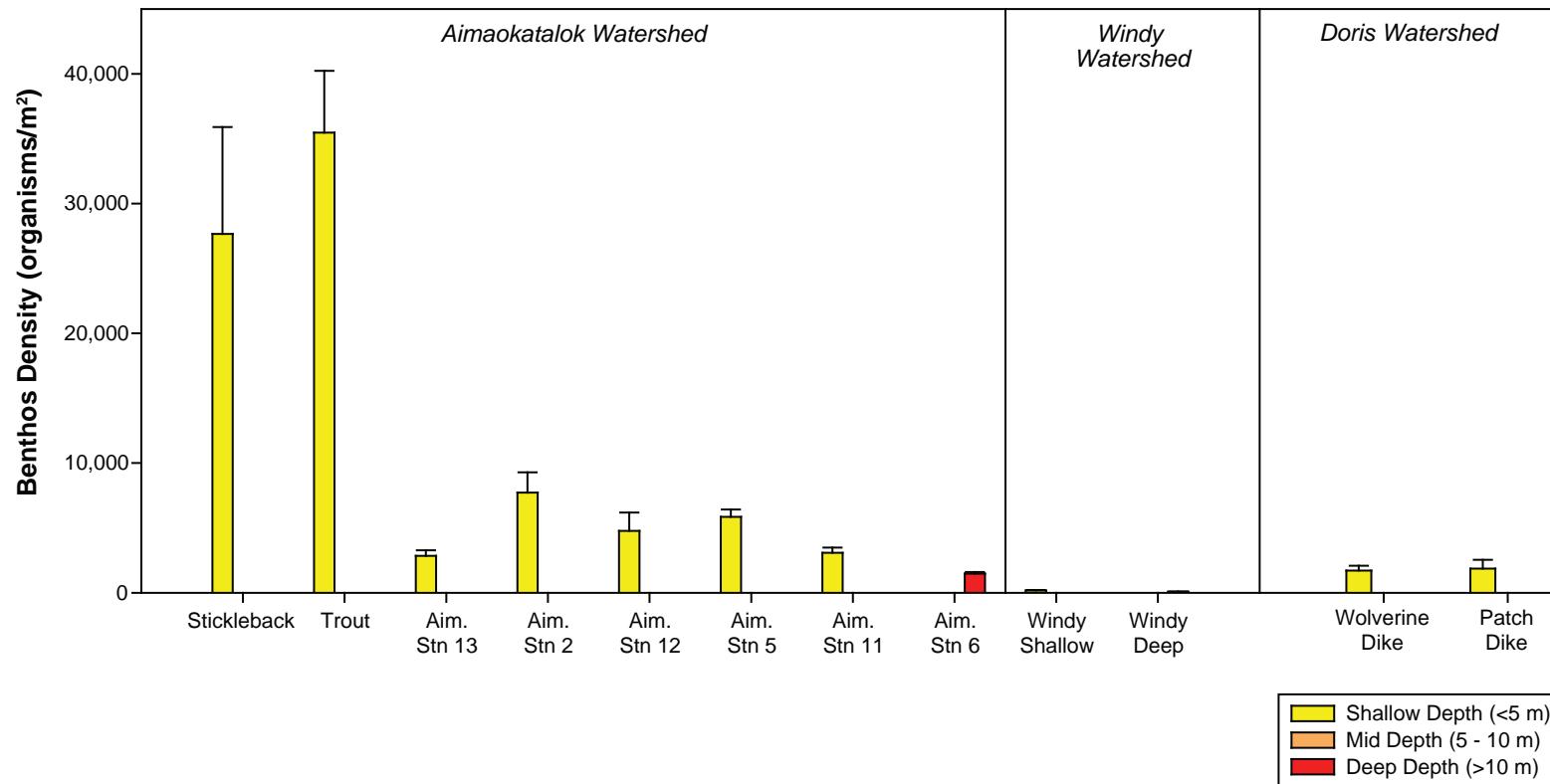


Figure 3.9-1

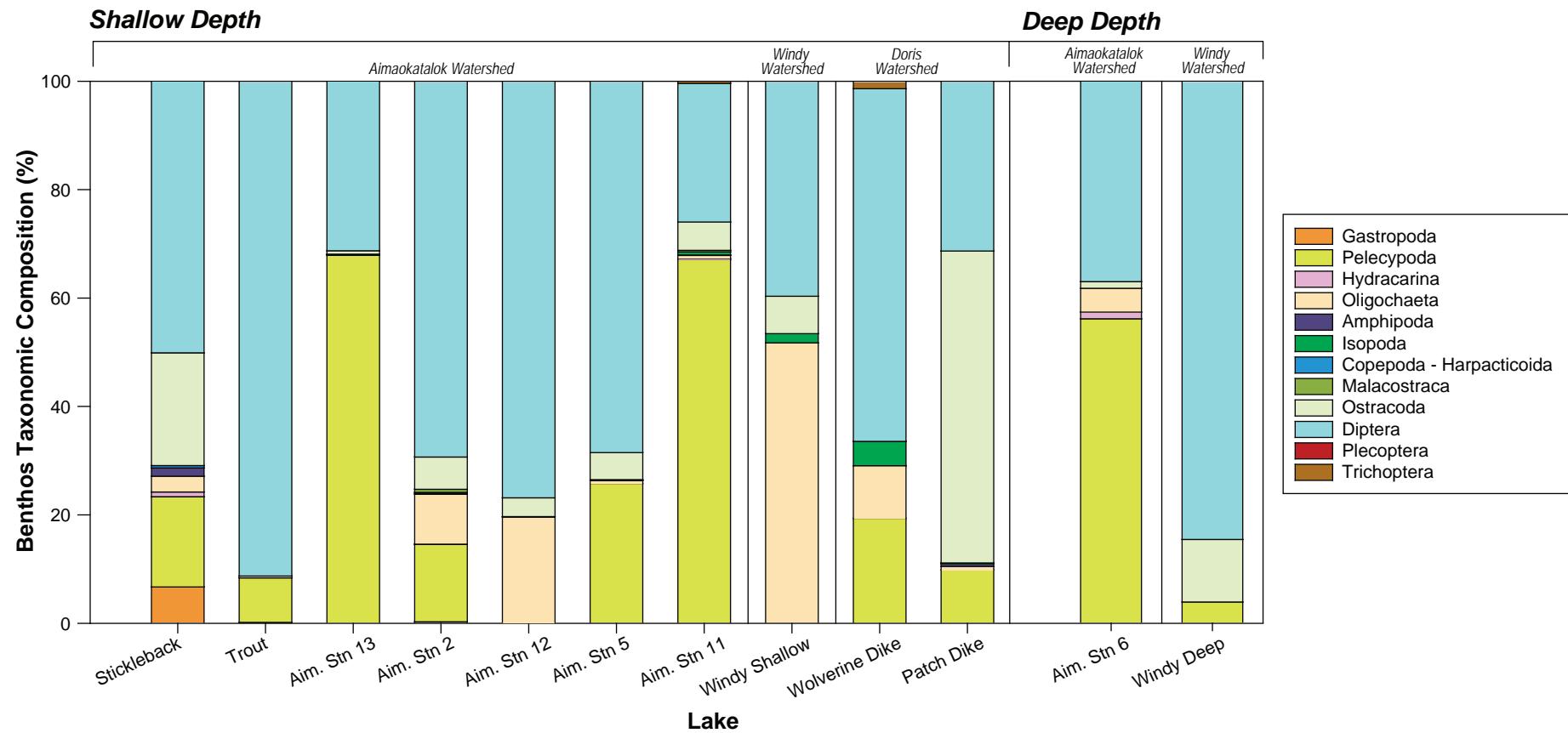


Figure 3.9-2

Dipterans made up over 60% of the total benthos community in Trout, Aim. Stn 2, Aim. Stn 12, Aim. Stn 5, and Wolverine Dike (Figure 3.9-2). The proportions of pelecypods, oligochaetes, and ostracods varied between sites. Pelecypods made up the largest proportion of the benthos community at Aim. Stn 13 (68%), Aim. Stn 11 (67%), and Aim. Stn 6 (56%). Oligochaetes made up a substantial component of the benthos assemblage at Aim. Stn 12 (20%) and Windy Shallow (52%). Ostracods made up 21% of the benthos community at Stickleback, and 58% (Figure 3.9-2).

Overall, there were no clear patterns in benthos composition between watersheds or sampling depths. Community composition also did not seem to be related to the total density of benthos organisms (Figure 3.9-2).

3.9.3 Richness and Diversity

Dipterans were typically the dominant taxonomic group in lake benthos samples (Figure 3.9-2). For this reason, benthic diversity (at the level of genus) was analyzed for both the whole community and the dipteran subset.

3.9.3.1 *Community Richness and Diversity*

Benthos genera richness in lakes ranged from 2 to 17 genera/sample and averaged 9 genera/sample (Figure 3.9-3). Average genera richness was lowest at Windy Deep (2 genera/sample) and Windy Shallow (4 genera/sample), the two sites with the lowest benthos densities. The highest genera richness (17 genera/sample) occurred in Stickleback Lake, one of the two lakes with the highest benthos density (Figure 3.9-3). Genera richness tended to decline with increasing depth in the lakes that samples were collected from different depth strata (Aimaokatalok and Windy).

Benthos Simpson's diversity was variable across lakes, ranging from 0.28 at Windy Deep to 0.86 at Aim. Stn 12. There were no apparent trends in benthos diversity between watersheds or sampling depths. Diversity also seemed to be unrelated to the total density of benthos organisms (Figure 3.9-2).

3.9.3.2 *Dipteran Richness and Diversity*

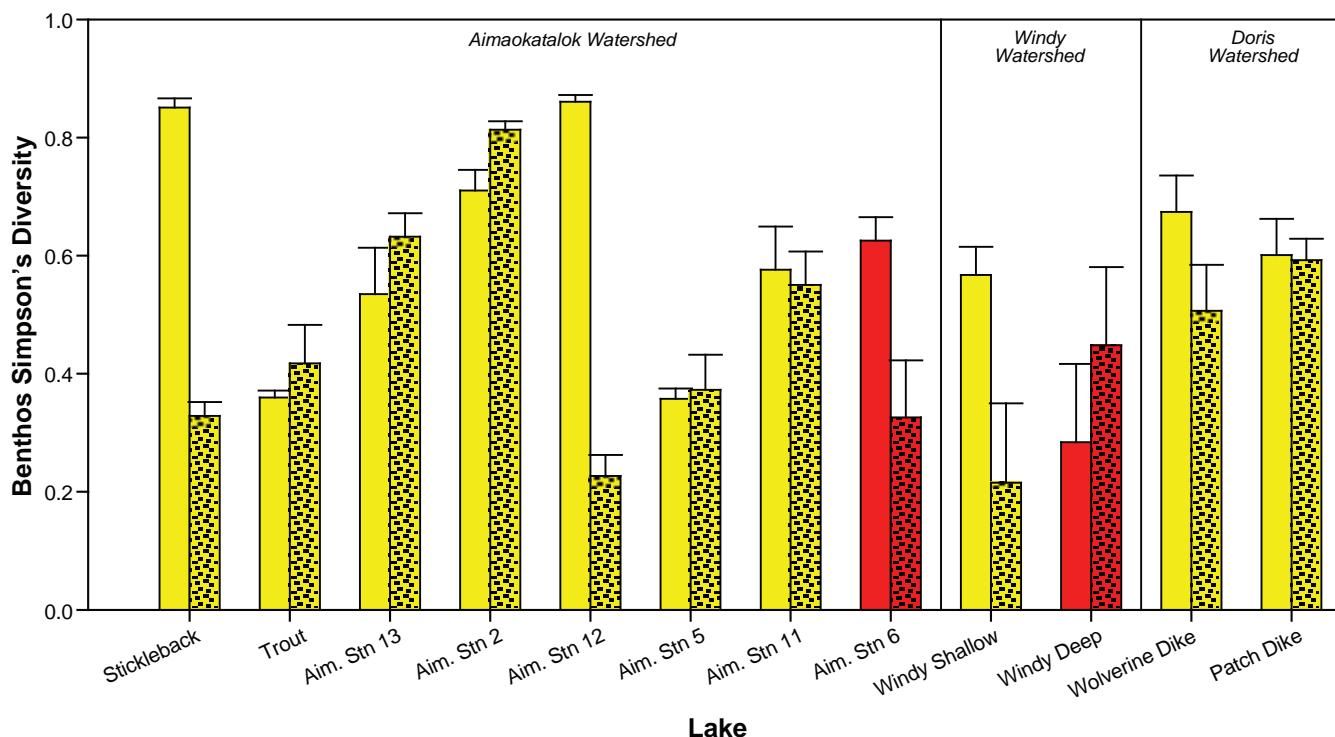
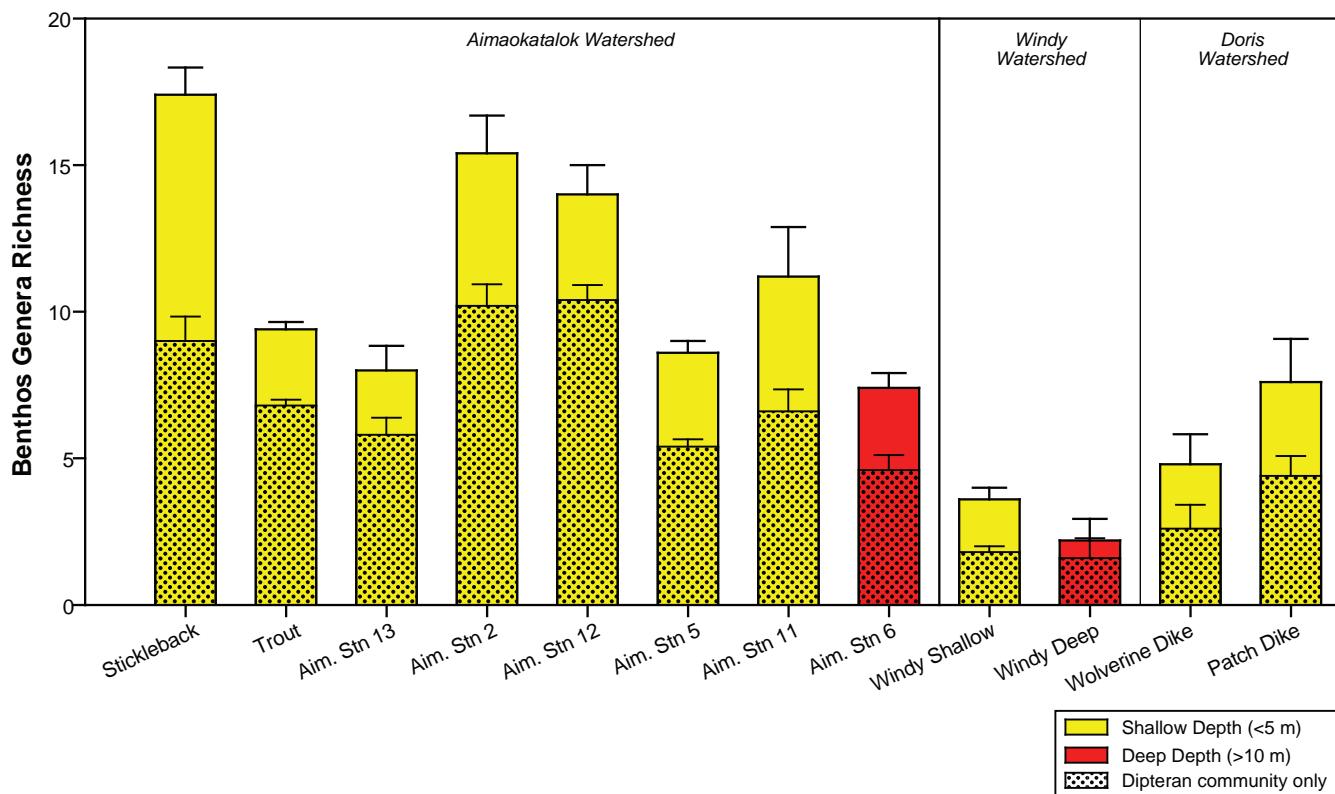
Mean dipteran genera richness averaged 6 genera/sample and ranged from 2 genera/sample at Windy Shallow and Windy Deep to 10 genera/sample at Aim. Stn 2 and Aim. Stn 12. Patterns in dipteran genera richness closely followed those observed for total community benthos genera richness.

Dipteran diversity ranged widely from 0.22 at Windy Shallow to 0.81 at Aim. Stn 2. There was no clear pattern between dipteran diversity and overall benthos diversity.

3.9.4 Annual Variation

Only historical sampling locations that were also sampled in 2010 were included in the annual comparison of benthos density shown in Figures 3.9-4a and b. Note that historical sampling locations and methods may not correspond exactly with those sampled in 2010, and this may contribute to the variability observed between years (see Table 2.14-8 and Figures 2.14-5a to 2.14-5c for historical sampling locations and methodologies).

Lake benthos samples have been collected at some of the 2010 sampling sites since 1994. Between 1994 and 2010, Stickleback Lake often had the highest benthos densities compared to other lakes, averaging 25,000 organisms/m² across years. Trout Lake and Wolverine Lake had sporadically elevated benthos densities during at least one year of sampling (Figures 3.9-4a and b). Aim. Stn 6, Windy Shallow, Windy Deep, and Patch lake sampling sites generally had low benthos densities over time (<2,500 organisms/m²; Figure 3.9-4a and b).



Note: Error bars represent standard error of the mean.

Superimposed bars represent the dipteran component of the benthos community.