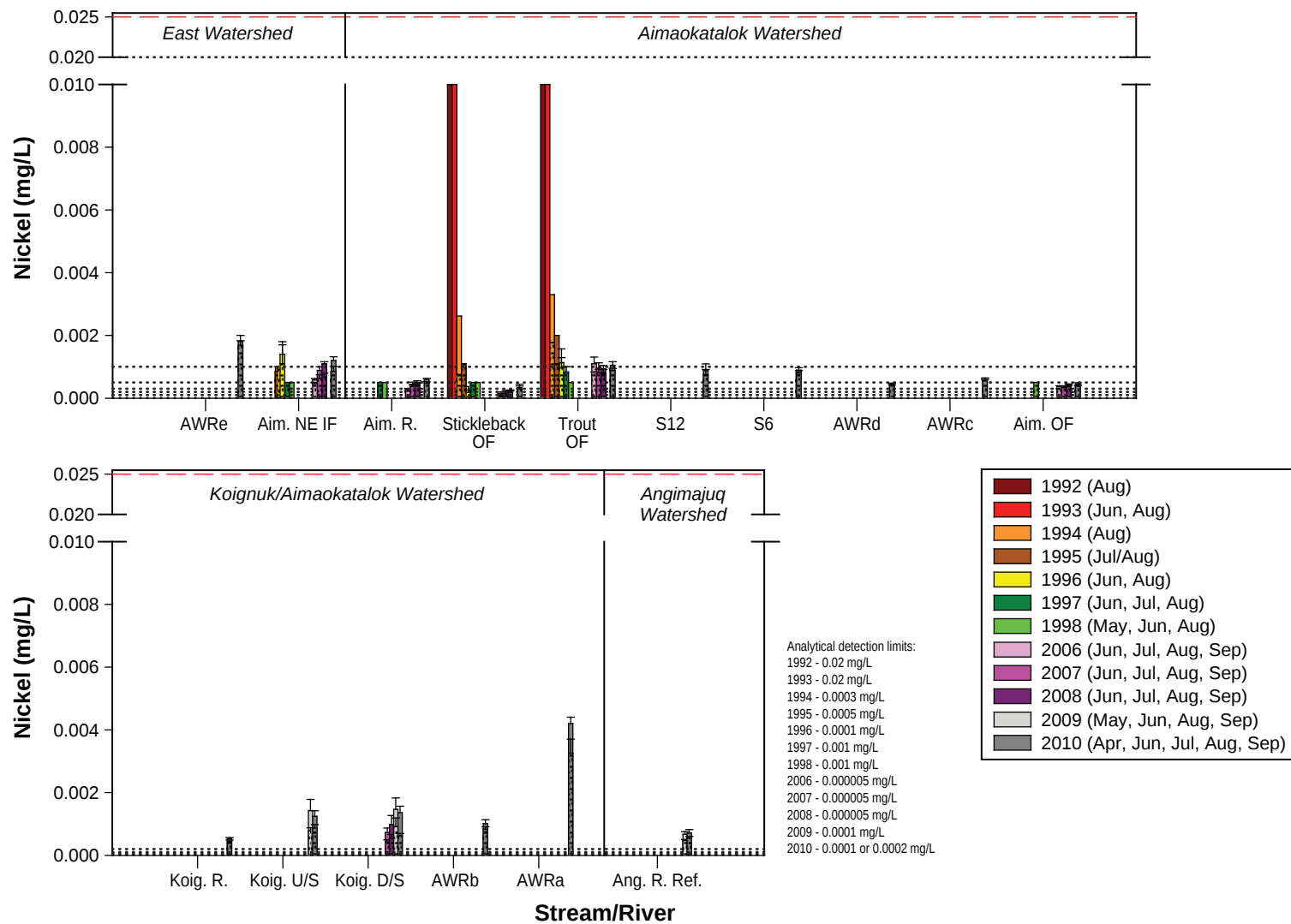
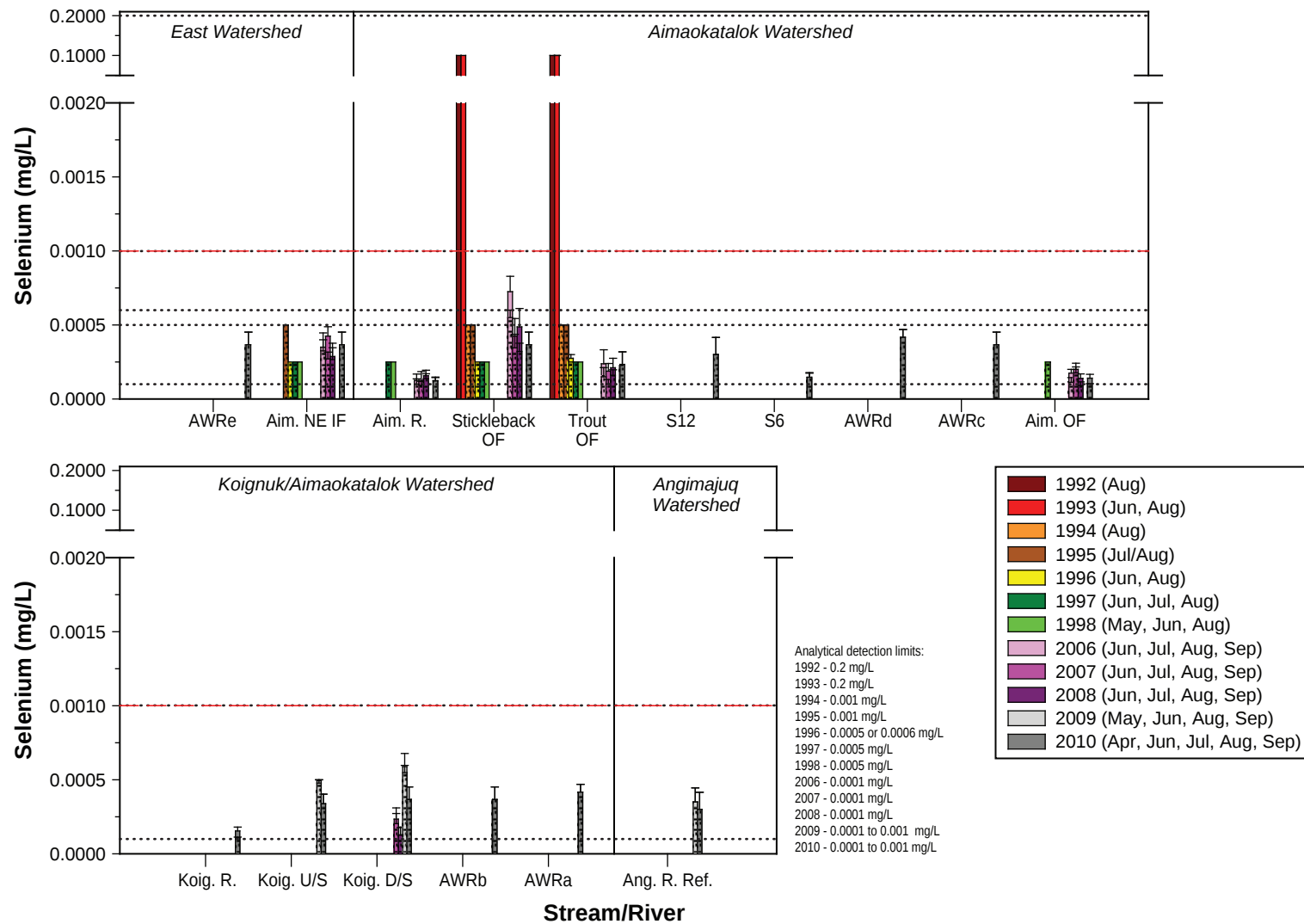
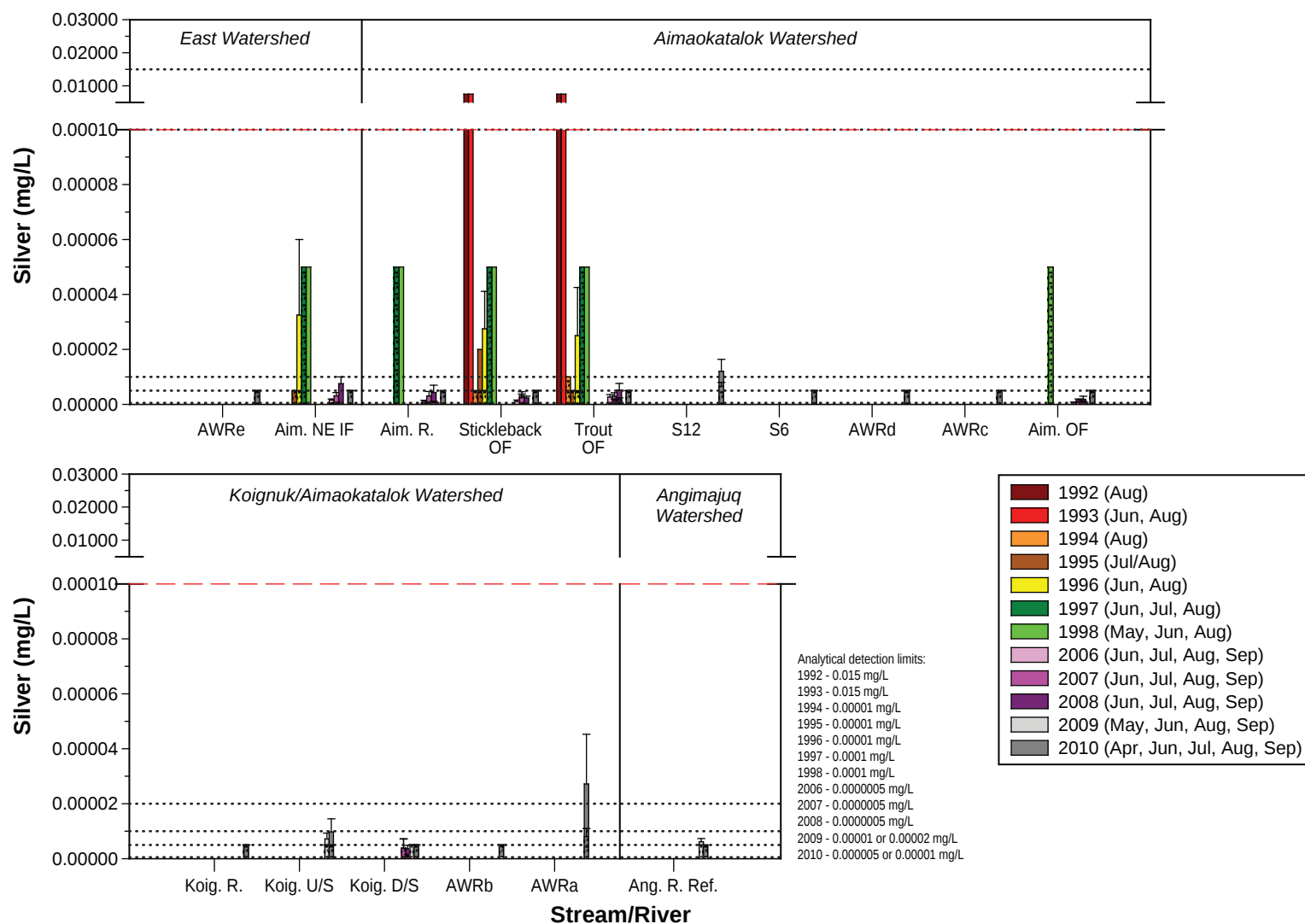








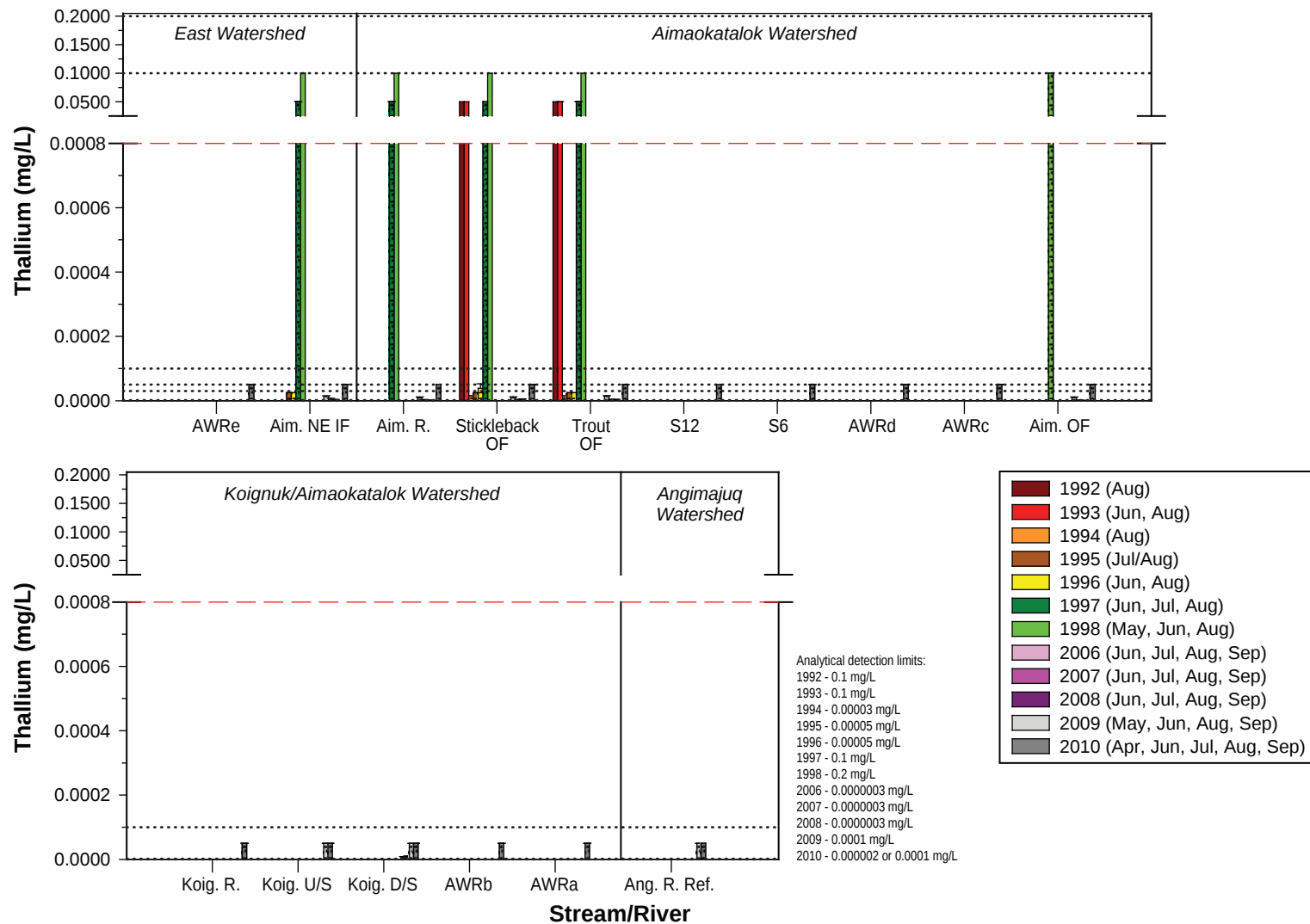
Notes: Error bars represent standard error of the mean.

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

Red dashed line represents CCME guideline (0.0001 mg/L).

Solid columns represent total silver and superimposed dotted columns represent dissolved silver.

* Indicates average total silver concentrations that are both above the detection limit and higher than the CCME guideline.



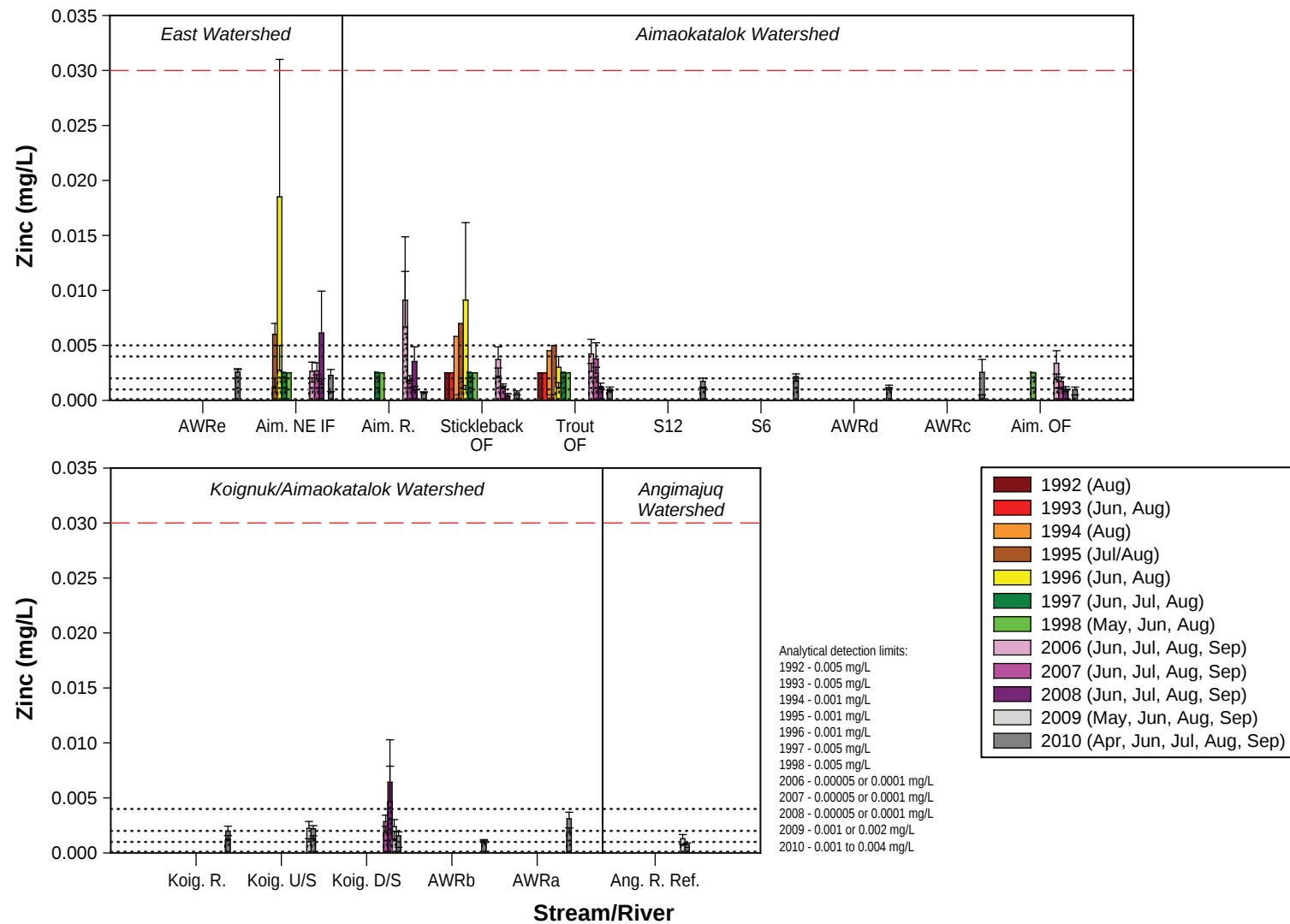
Notes: Error bars represent standard error of the mean.

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

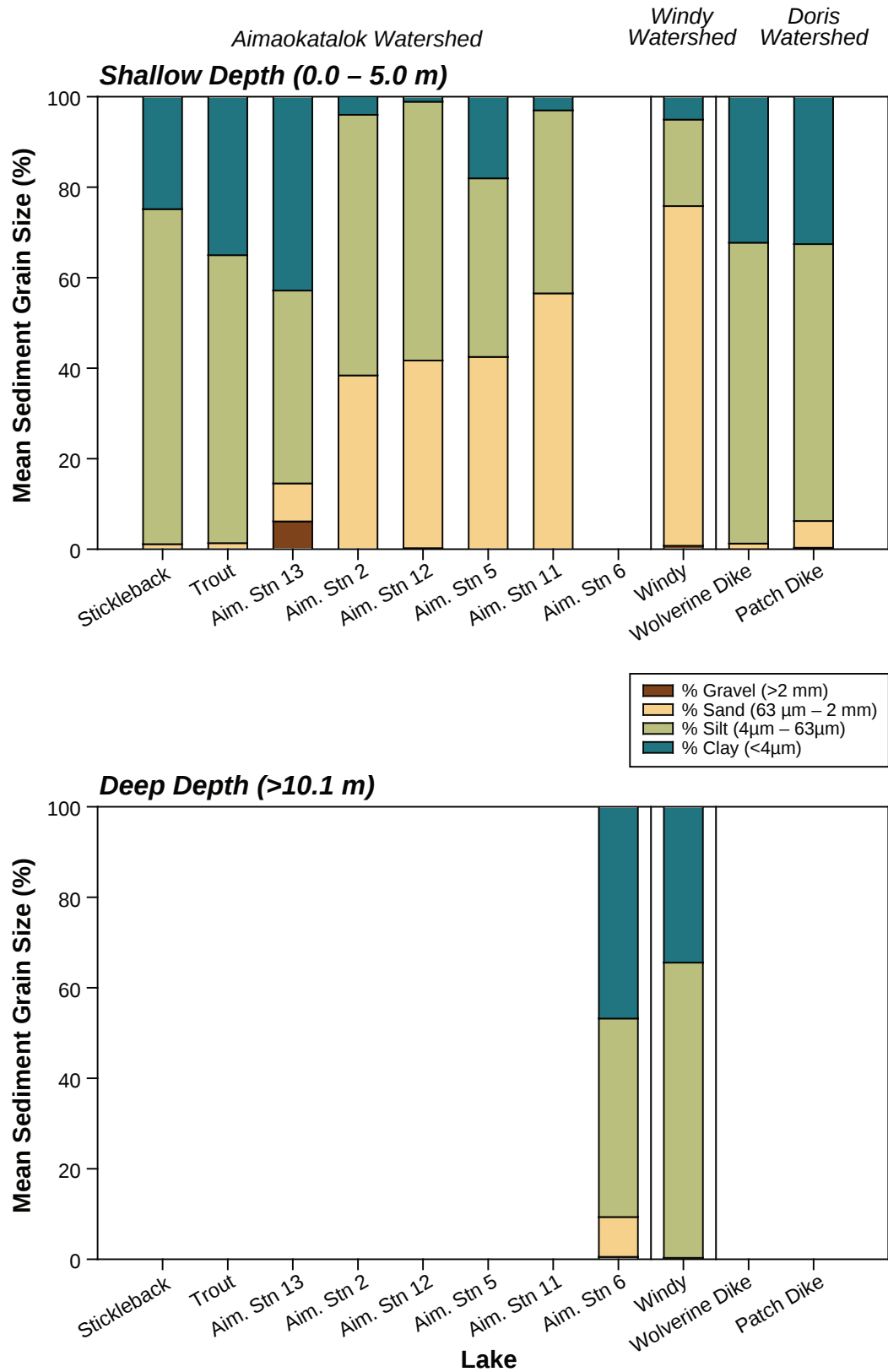
Red dashed line represents CCME guideline (0.0008 mg/L).

Solid columns represent total thallium and superimposed dotted columns represent dissolved thallium.

* Indicates average total thallium concentrations that are both above the detection limit and higher than the CCME guideline.

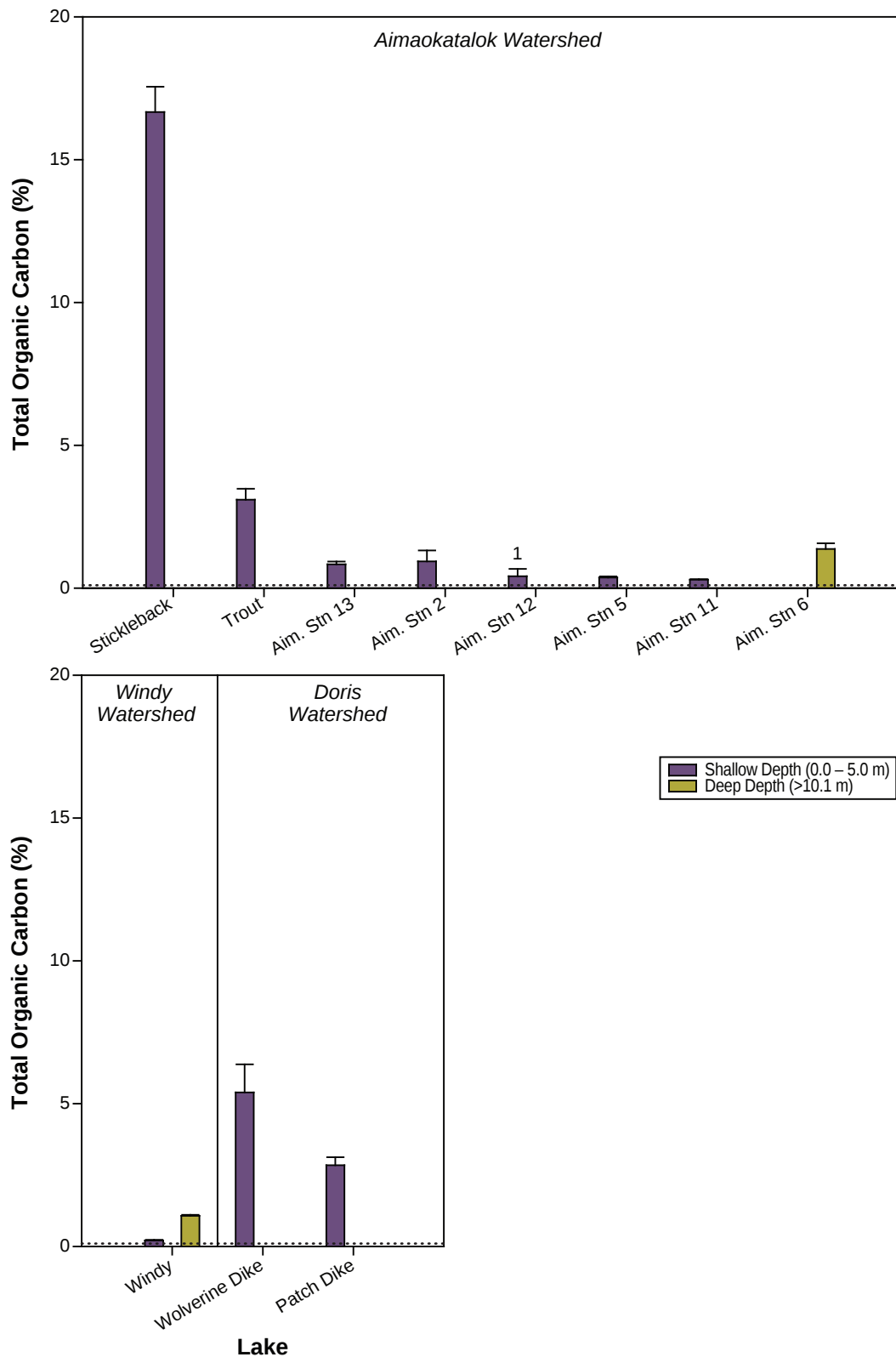


Notes: Error bars represent standard error of the mean.
 Dotted lines represent analytical detection limit; values below the detection limit are plotted at half the detection limit.
 Red dashed line represents CCME guideline (0.03 mg/L).
 Solid columns represent total zinc and superimposed dotted columns represent dissolved zinc.
 * Indicates average total zinc concentrations that are both above the detection limit and higher than the CCME guideline.



Note: Values represent the mean of replicates.

Figure 3.4-1



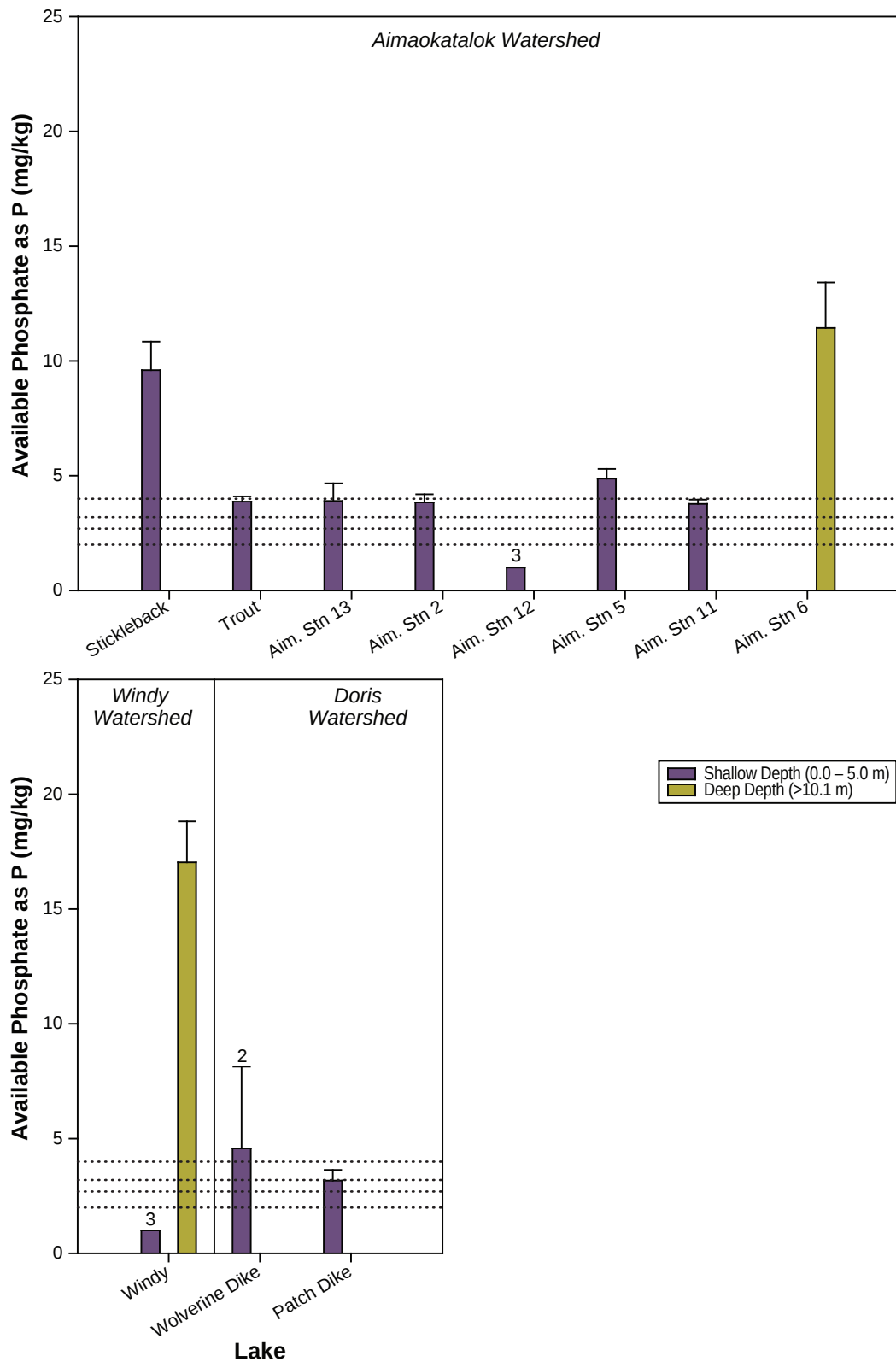
Notes: Error bars represent standard error of the mean of replicates.

Dotted line represents analytical detection limit (0.10 %); values below the detection limit are plotted at half the detection limit.

Numbers above the bars indicate number of replicates with concentrations below the analytical detection limit; absence of a number indicates all replicates were above the detection limit.

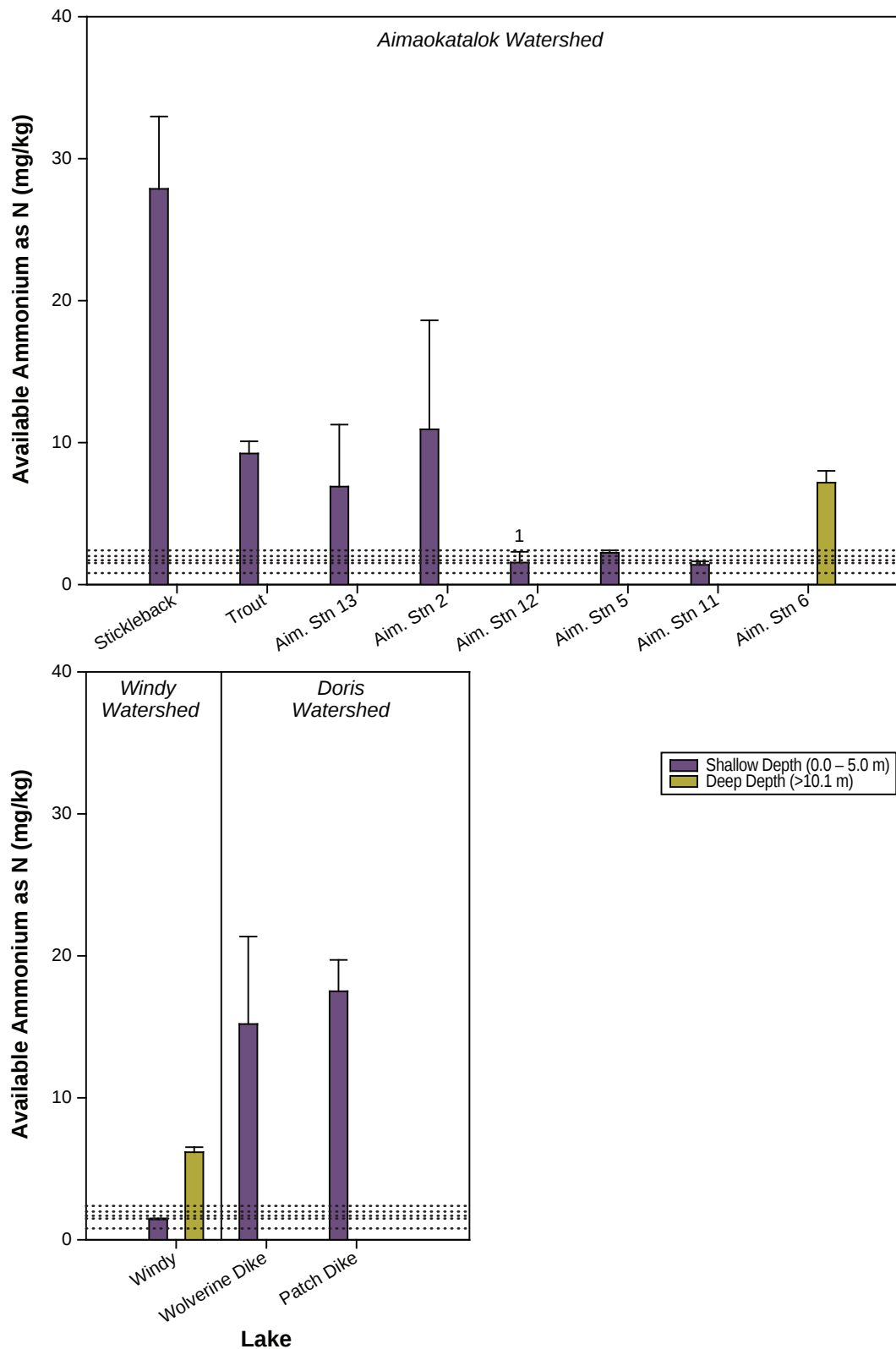
There is no CCME guideline for total organic carbon.

Figure 3.4-2a



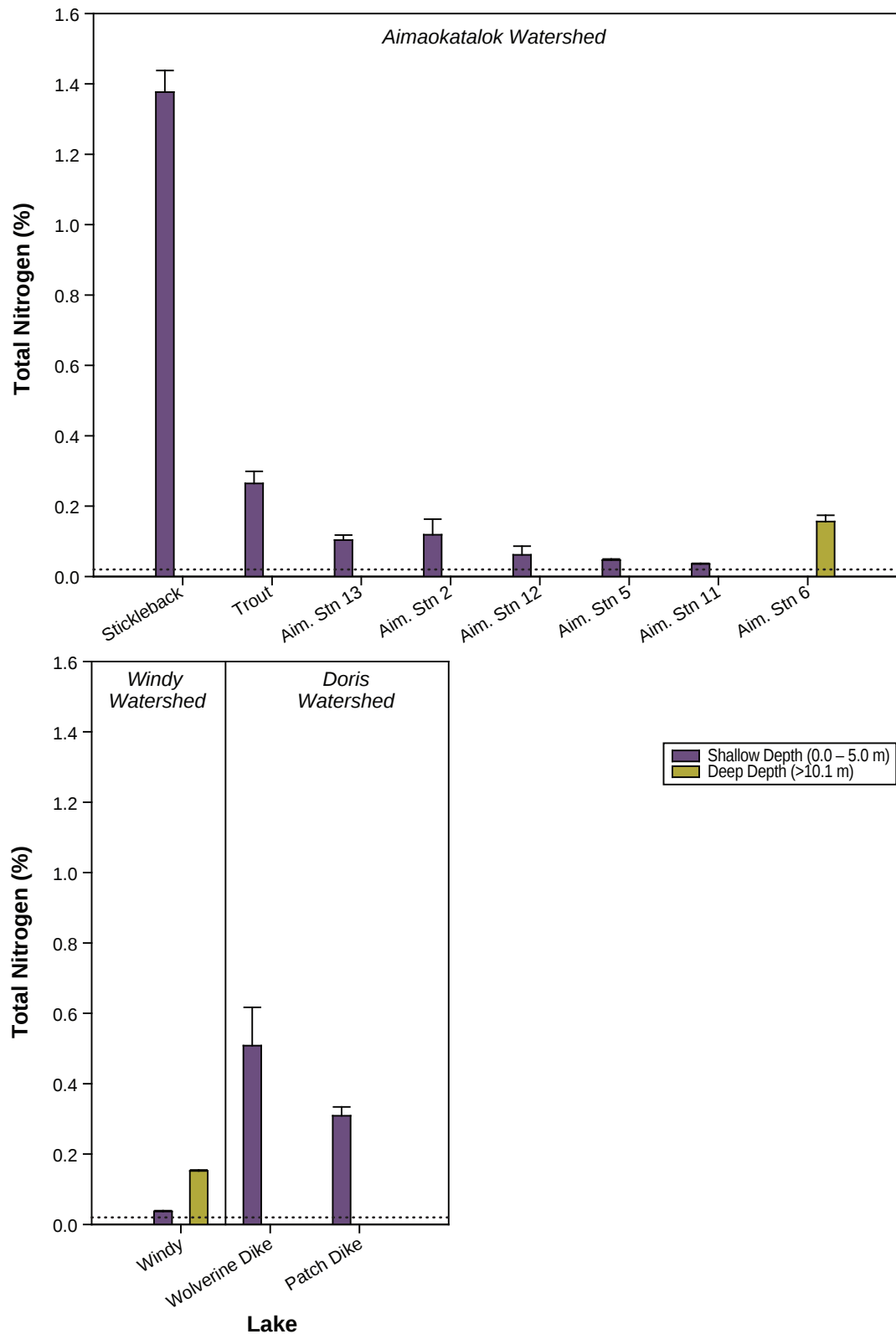
Notes: Error bars represent standard error of the mean of replicates.
 Dotted lines represent analytical detection limits (2.0, 2.7, 3.2, or 4.0 mg/kg);
 values below the detection limit are plotted at half the detection limit.
 Numbers above bars indicate number of replicates with concentrations below the analytical detection limit;
 absence of a number indicates all replicates were above the detection limit.
 There is no CCME guideline for available phosphate.

Figure 3.4-2b



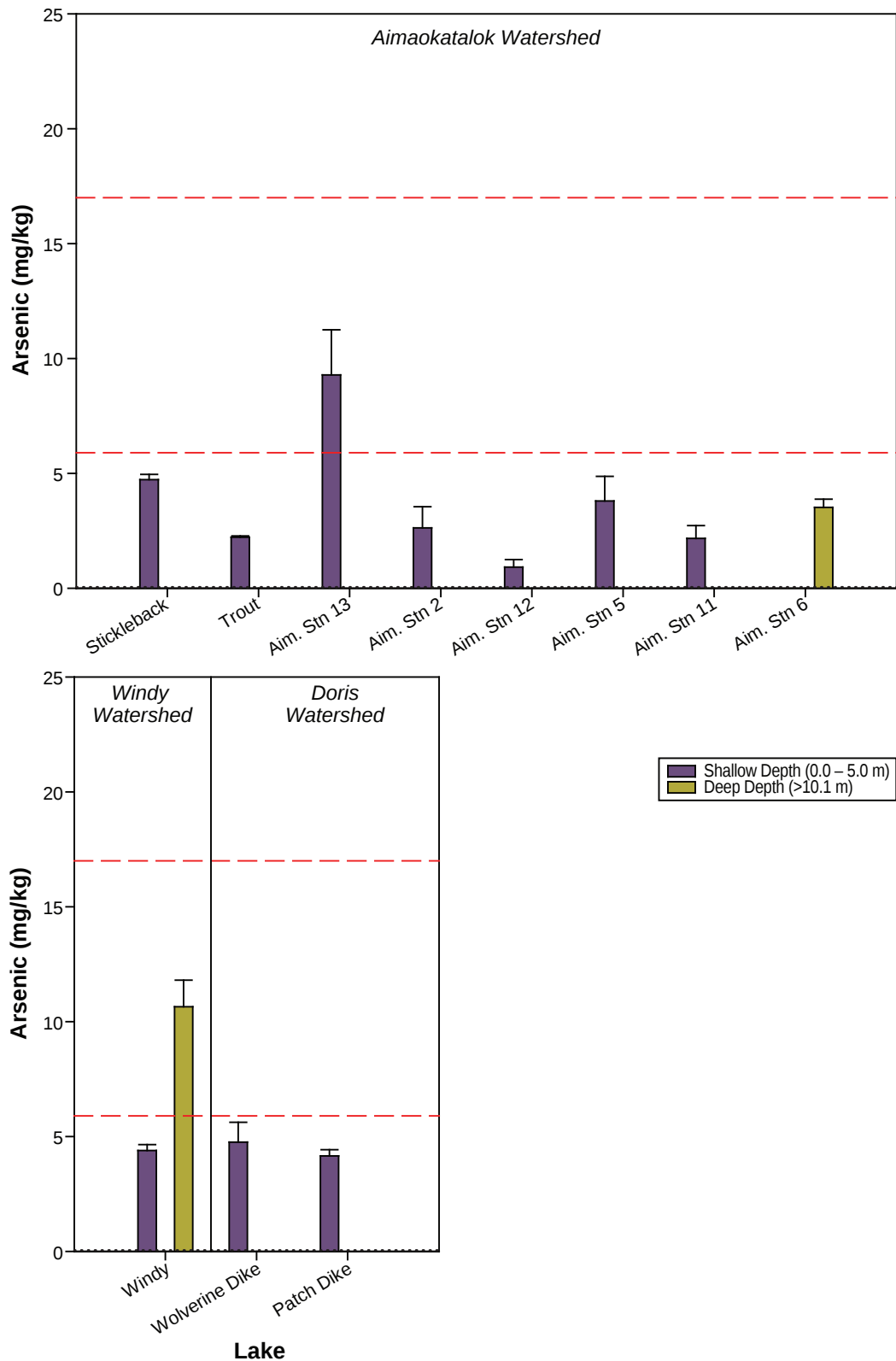
Notes: Error bars represent standard error of the mean of replicates.
 Dotted lines represent analytical detection limit (0.8, 1.5, 1.7, 2.0, or 2.4 mg/kg);
 values below the detection limit are plotted at half the detection limit.
 Numbers above bars indicate number of replicates with concentrations below the analytical detection limit;
 absence of a number indicates all replicates were above the detection limit.
 There is no CCME guideline for available ammonium.

Figure 3.4-2c



Notes: Error bars represent standard error of the mean of replicates.
Dotted line represents analytical detection limit (0.02 %); 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.
There is no CCME guideline for total nitrogen.

Figure 3.4-2d

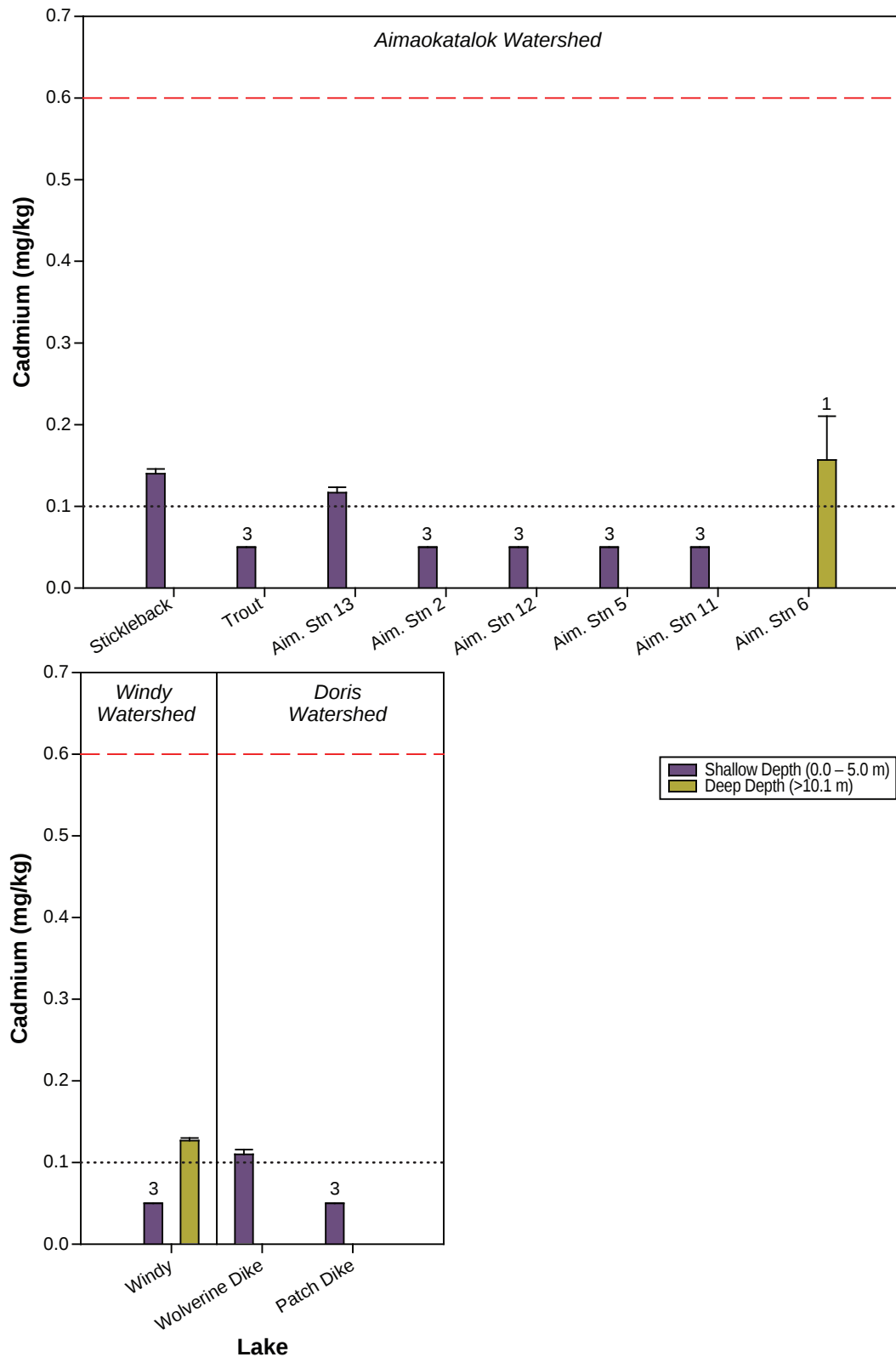


Notes: Error bars represent standard error of the mean of replicates.

Dotted line represents analytical detection limit (0.05 mg/kg); values below the detection limit are plotted at half the detection limit.

Dashed lines represent the CCME interim sediment quality guideline (5.9 mg/kg) and probable effects level (17 mg/kg).

Figure 3.4-2e



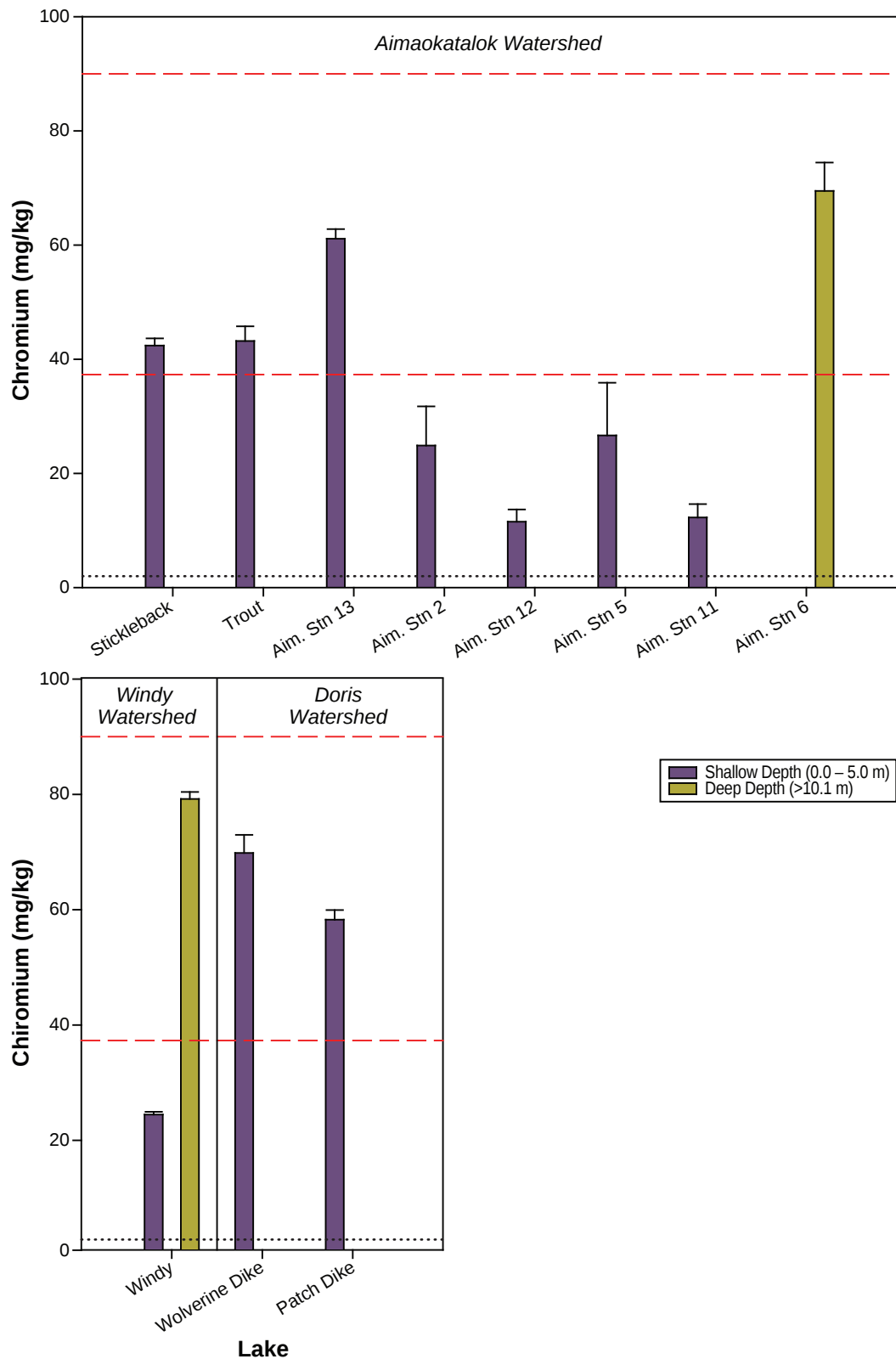
Notes: Error bars represent standard error of the mean of replicates.

Dotted line represents analytical detection limit (0.1 mg/kg); 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 (0.6 mg/kg); the CCME probable effects level (3.5 mg/kg) is not shown.

Figure 3.4-2f



Notes: Error bars represent standard error of the mean of replicates.

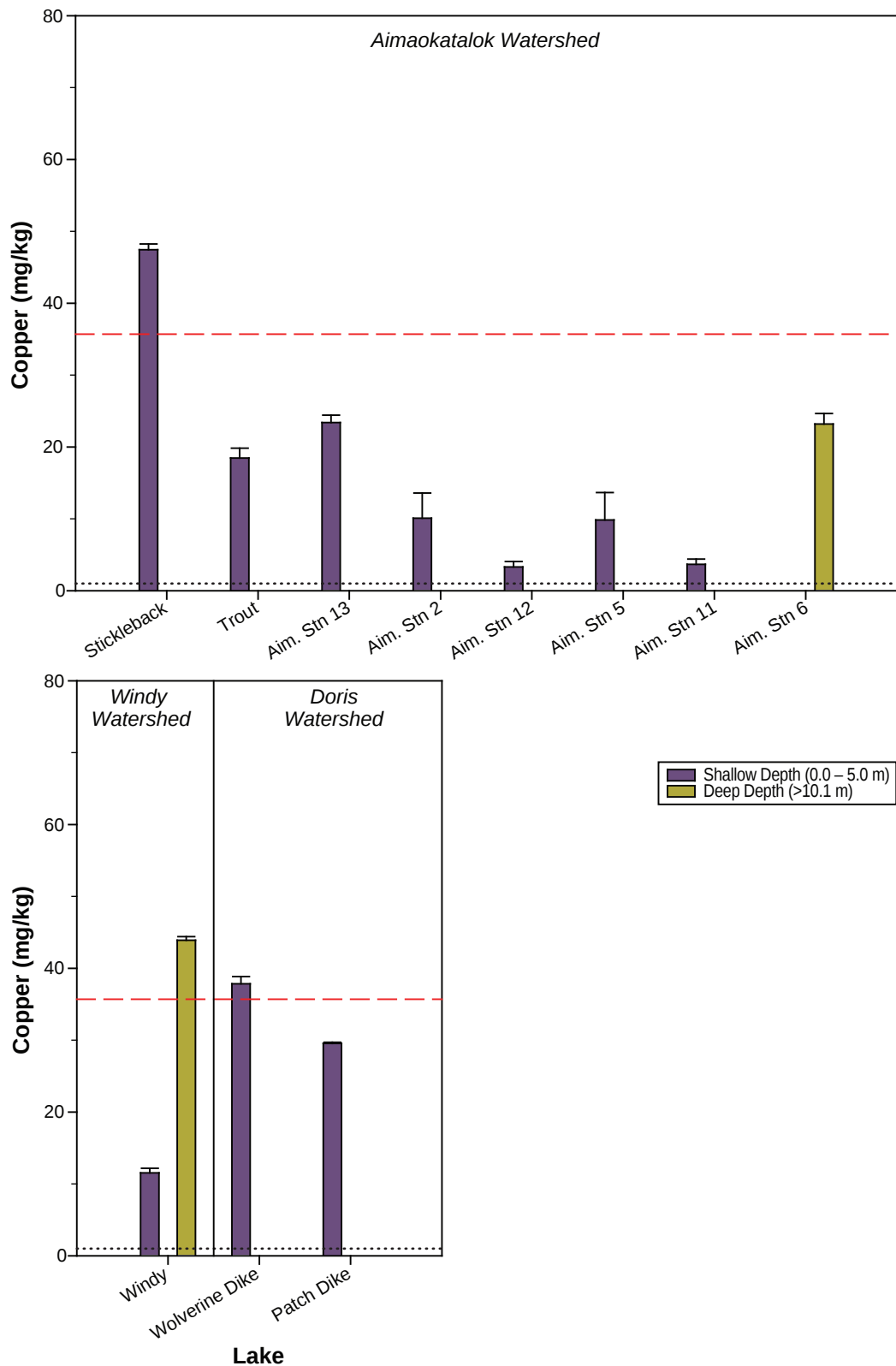
Dotted line represents analytical detection limit (2.0 mg/kg); values below the detection limit are plotted at half the detection limit.

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).

Figure 3.4-2g



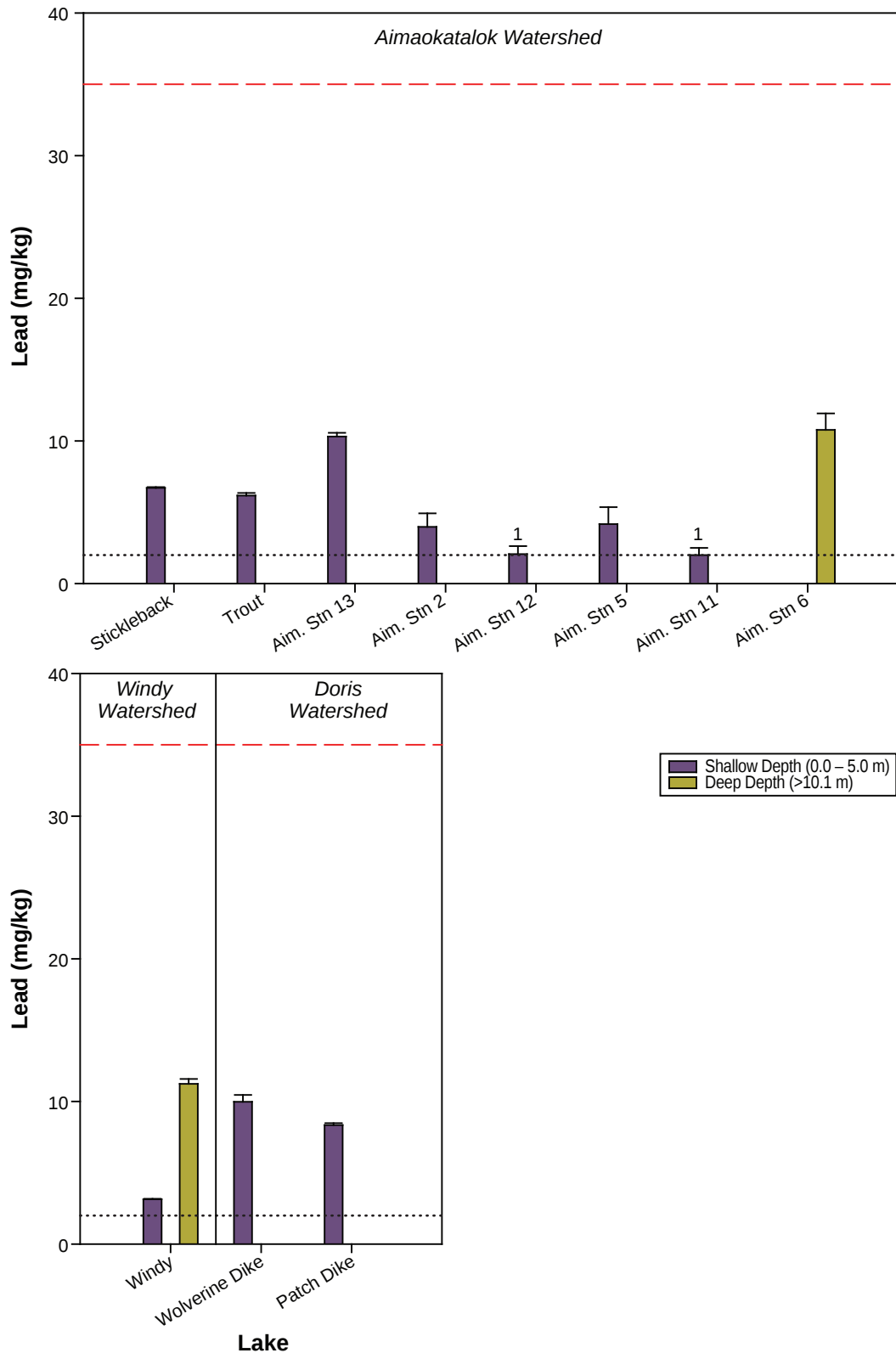
Notes: Error bars represent standard error of the mean of replicates.

Dotted line represents analytical detection limit (1.0 mg/kg); 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.



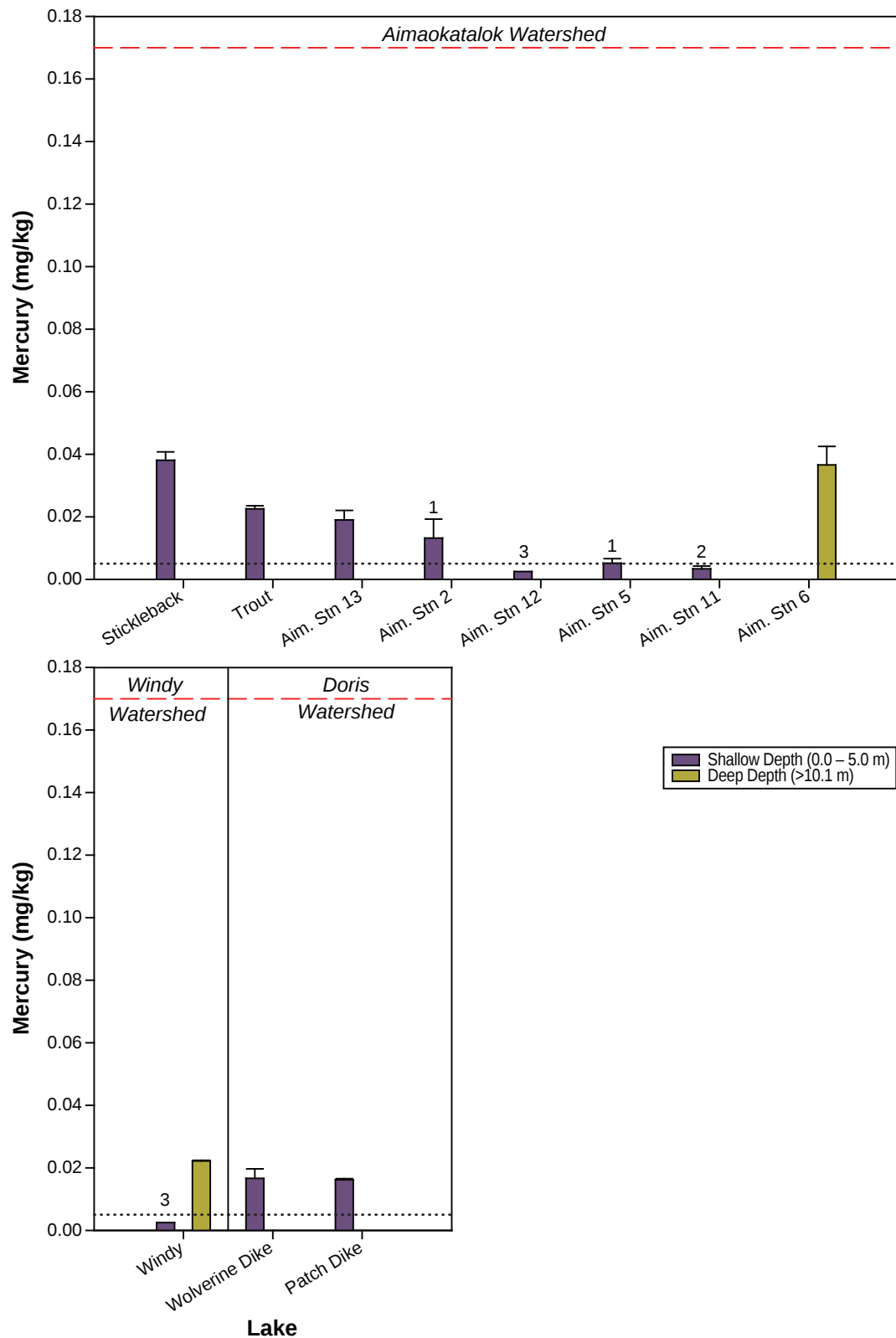
Notes: Error bars represent standard error of the mean of replicates.

Dotted line represents analytical detection limit (2.0 mg/kg); 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 mg/kg) is not shown.



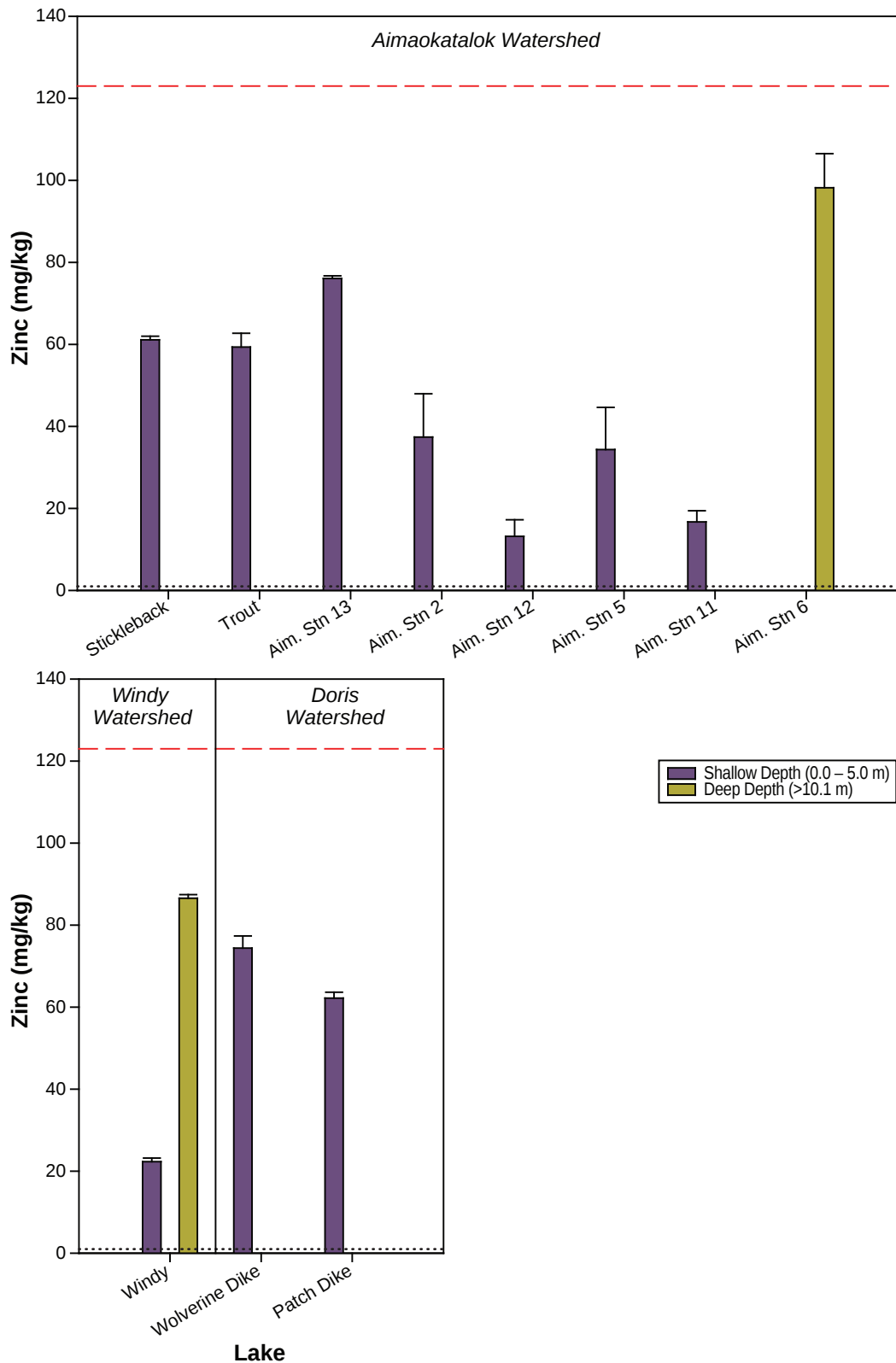
Notes: Error bars represent standard error of the mean of replicates.

Dotted line represents analytical detection limit (0.005 mg/kg); 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.



Notes: Error bars represent standard error of the mean of replicates.

Dotted line represents analytical detection limit (1.0 mg/kg); 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 (123 mg/kg); the CCME probable effects level (315 mg/kg) is not shown.

3.4.2 Spatial Variation

There were few clear trends in parameter concentrations among sites. Within the shallow depth zone category, Stickleback Lake sediments contained the highest concentrations of TOC (Figure 3.4-2a), available ammonium (Figure 3.4-2c), and total nitrogen (Figure 3.2-2d) compared to other lake sites. No obvious watershed-wide patterns were observed.

3.4.3 Comparison with CCME Guidelines

All sediment samples collected were compared to both ISQG and PEL CCME sediment quality guidelines for the protection of aquatic life. Table 3.4-1 presents the percentage of lake sediment samples in which metal concentrations were higher than CCME guidelines, and Table 3.4-2 provides the factor by which average 2010 sediment metal concentrations were higher than CCME guidelines.

Lake sediments were naturally elevated in arsenic, chromium, and copper, and concentrations of these metals were often higher than CCME ISQGs. Chromium concentrations in sediments were higher than the ISQG for chromium (37.3 mg/kg) in at least one replicate at nearly all lake sites sampled, with the exception of Aim. Stn 12, Aim. Stn 11, and Windy Shallow. Average copper concentrations were higher than the ISQG for copper (35.7 mg/kg) in all sediment samples collected from Stickleback and Wolverine lakes. Average arsenic concentrations were higher than the ISQG for arsenic (5.9 mg/kg) in sediments collected from Aim. Stn 13 and Windy Deep, and in one third of Wolverine Lake replicates. Although concentrations of arsenic, chromium, and copper in lake sediments frequently exceeded CCME ISQGs, concentrations of these metals were always below the CCME PELs.

3.4.4 Annual Variation

Only historical sampling locations that were also sampled in 2010 were included in the comparison of annual sediment quality data shown in Figures 3.4-3a to 3.4-3k. Note that historical sampling locations may not correspond exactly with those sampled in 2010, and this, in addition to methodological differences, may contribute to variability observed among years (see Table 2.14-3 and Figures 2.14-2a to 2.14-2c for historical sampling methodologies and locations).

Historical lake sediment quality data are available from 1996, 1997, 2007 and 2009, although not all parameters analyzed in 2010 were analyzed historically. Available phosphate, available ammonium, and total nitrogen were not sampled prior to 2009. For some sediment quality parameters, there was high variability between years, making within-site annual variability comparable in magnitude to between-site variability (e.g., TOC, arsenic, cadmium). Historical data show that lake sediment arsenic, chromium, and copper concentrations have frequently exceeded CCME guidelines (Figures 3.4-3a to 3.4-3k).

3.5 STREAM AND RIVER SEDIMENT QUALITY

Stream and river sediment samples were collected in August 2010 (see Table 2.1-5 for locations and dates of sample collection). All sediment samples collected were compared to CCME sediment quality guidelines for the protection of aquatic life: the interim sediment quality guidelines (ISQGs) and the probable effects levels (PELs; CCME 2002). The more conservative ISQGs are levels below which adverse biological effects are rarely observed, whereas the higher PELs correspond to concentrations above which negative effects frequently occur. All raw 2010 sediment quality data are presented in Appendix 3.5-1. Some historical sediment quality data are available for some streams and rivers in the study area (Figures 2.14-2a to 2.14-2c; Table 2.14-4).

Table 3.4-1. Lake Sediment Quality, Percent of Samples in which Concentrations are Higher than CCME Guidelines, Hope Bay Belt Project, 2010

Lake	Total Number of Samples Collected	CCME Guideline value ^a (mg/kg):	Percent of Samples Higher than ISQG ^b Guidelines							Percent of Samples Higher than PEL ^c Guidelines						
			Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Copper (Cu)	Lead (Pb)	Mercury (Hg)	Zinc (Zn)	Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Copper (Cu)	Lead (Pb)	Mercury (Hg)	Zinc (Zn)
			5.9	0.6	37.3	35.7	35	0.17	123	17	3.5	90	197	91.3	0.486	315
Aimaakatalok																
Stickleback	3		-	-	100	100	-	-	-	-	-	-	-	-	-	-
Trout	3		-	-	100	-	-	-	-	-	-	-	-	-	-	-
Aim. Stn 13	3		100	-	100	-	-	-	-	-	-	-	-	-	-	-
Aim. Stn 2	3		-	-	33.3	-	-	-	-	-	-	-	-	-	-	-
Aim. Stn12	3		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aim. Stn 5	3		-	-	33.3	-	-	-	-	-	-	-	-	-	-	-
Aim. Stn 11	3		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aim. Stn 6	3		-	-	100	-	-	-	-	-	-	-	-	-	-	-
Windy																
Windy Shallow	3		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Windy Deep	3		100	-	100	100	-	-	-	-	-	-	-	-	-	-
Doris																
Wolverine Dike	3		33.3	-	100	100	-	-	-	-	-	-	-	-	-	-
Patch Dike	3		-	-	100	-	-	-	-	-	-	-	-	-	-	-

All values represent percentages of 2010 samples that are both higher than the CCME guidelines and above analytical detection limits.

a) Canadian sediment quality guidelines for the protection of aquatic life (CCME 2002)

b) ISQG = Interim sediment quality guideline

c) PEL = Probable effects level

Table 3.4-2. Lake Sediment Quality, Factor by which Average Concentrations are Higher than CCME Guidelines, Hope Bay Belt Project, 2010

Lake	Total Number of Samples Collected	CCME Guideline Value ^a : (mg/kg):	Factor by which Samples are Higher than ISQG ^b Guidelines							Factor by which Samples are Higher than PEL ^c Guidelines						
			Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Copper (Cu)	Lead (Pb)	Mercury (Hg)	Zinc (Zn)	Arsenic (As)	Cadmium (Cd)	Chromium (Cr)	Copper (Cu)	Lead (Pb)	Mercury (Hg)	Zinc (Zn)
			5.9	0.6	37.3	35.7	35	0.17	123	17	3.5	90	197	91.3	0.486	315
Aimaakatalok																
Stickleback	3		-	-	1.13	1.33	-	-	-	-	-	-	-	-	-	-
Trout	3		-	-	1.16	-	-	-	-	-	-	-	-	-	-	-
Aim. Stn 13	3		1.57	-	1.64	-	-	-	-	-	-	-	-	-	-	-
Aim. Stn 2	3		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aim. Stn12	3		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aim. Stn 5	3		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aim. Stn 11	3		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Aim. Stn 6	3		-	-	1.86	-	-	-	-	-	-	-	-	-	-	-
Windy																
Windy Shallow	3		-	-	-	-	-	-	-	-	-	-	-	-	-	-
Windy Deep	3		1.81	-	2.12	1.23	-	-	-	-	-	-	-	-	-	-
Doris																
Wolverine Dike	3		-	-	1.87	1.06	-	-	-	-	-	-	-	-	-	-
Patch Dike	3		-	-	1.56	-	-	-	-	-	-	-	-	-	-	-

All values represent the factor by which 2010 lake averages are higher than CCME guidelines.

Even though a percentage of samples may be higher than a guideline amount, the calculated lake average may not be higher than a guideline amount.

a) Canadian sediment quality guidelines for the protection of aquatic life (CCME 2002)

b) ISQG = Interim sediment quality guideline

c) PEL = Probable effects level

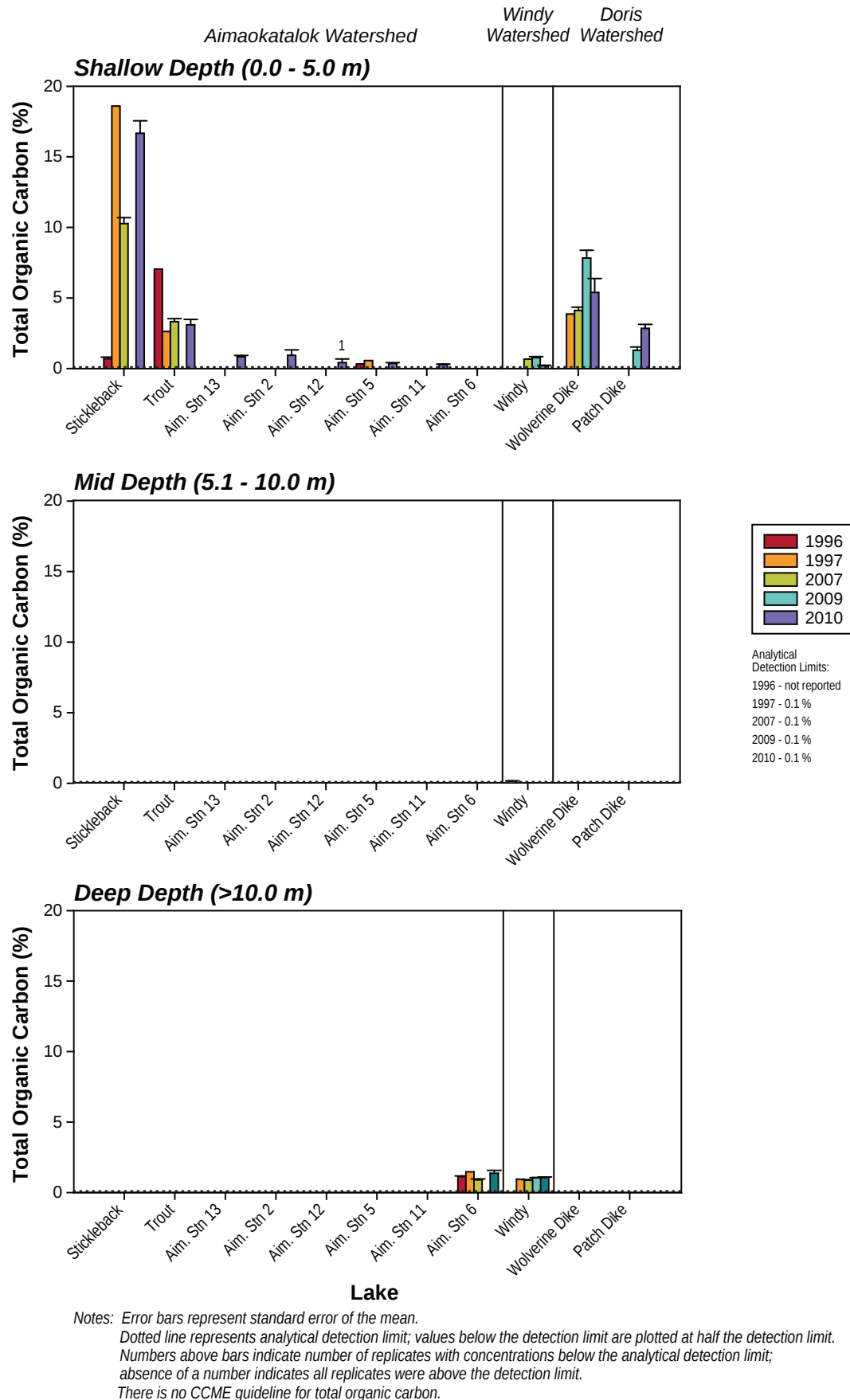


Figure 3.4-3a

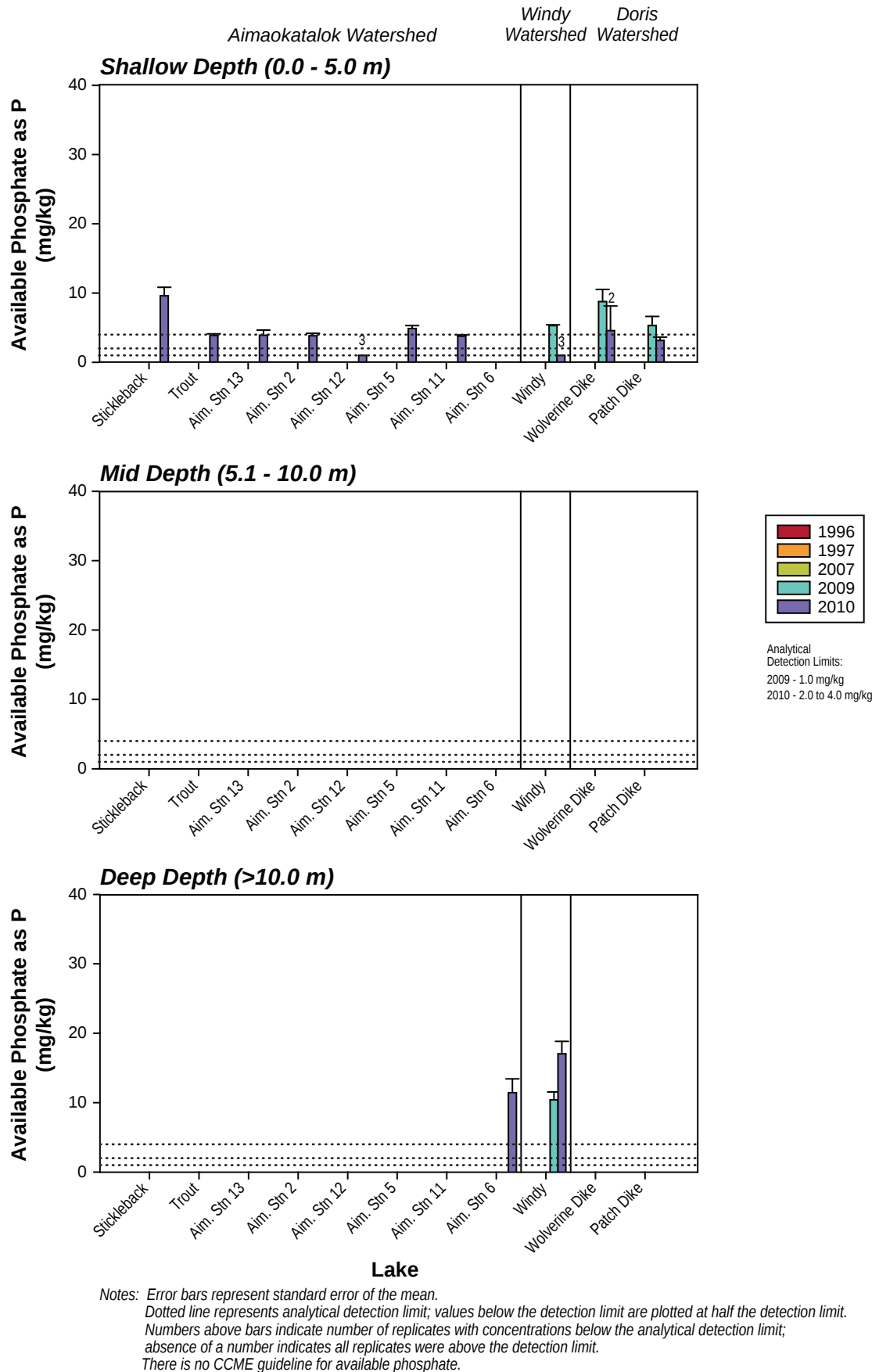


Figure 3.4-3b

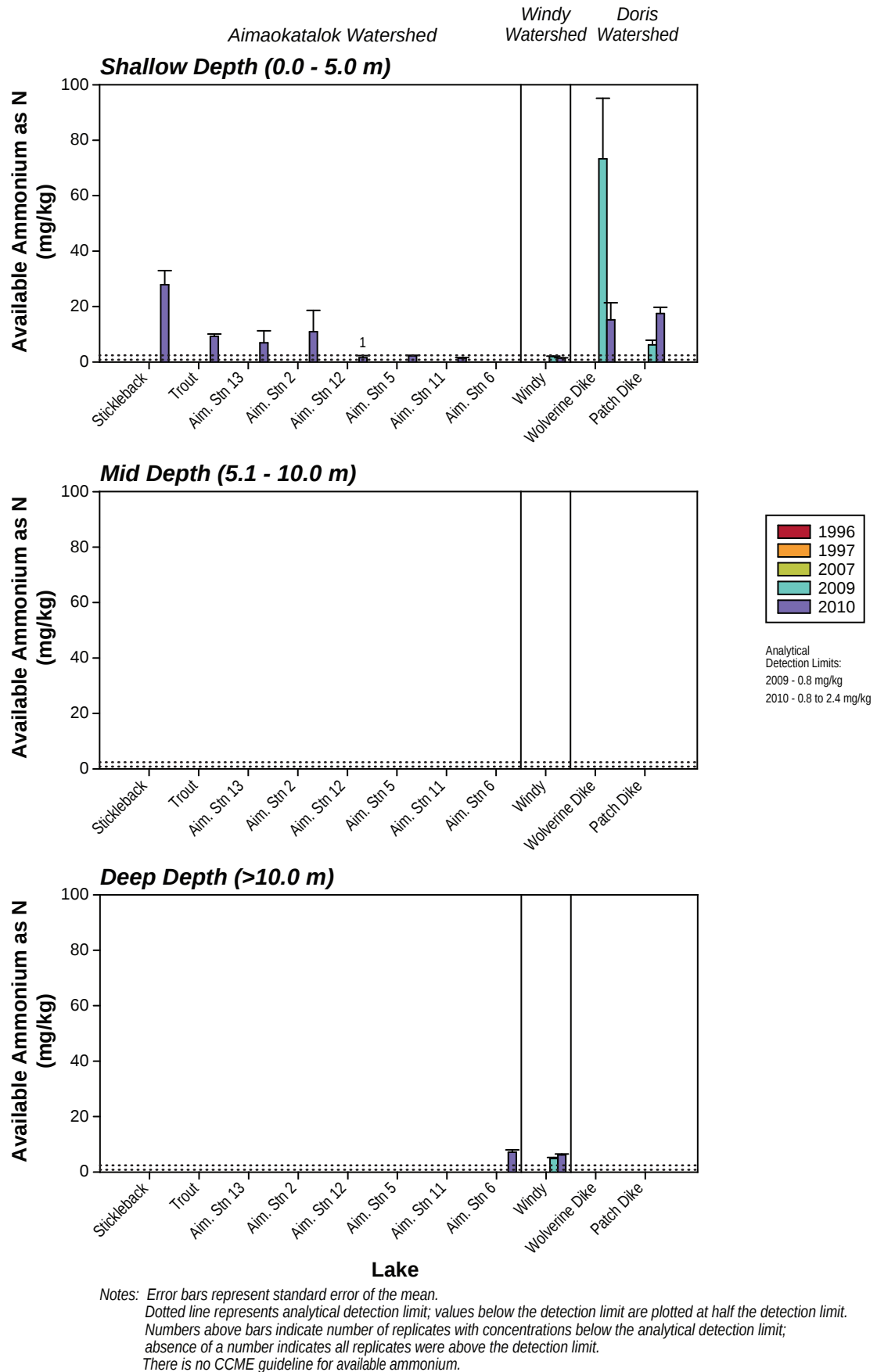


Figure 3.4-3c

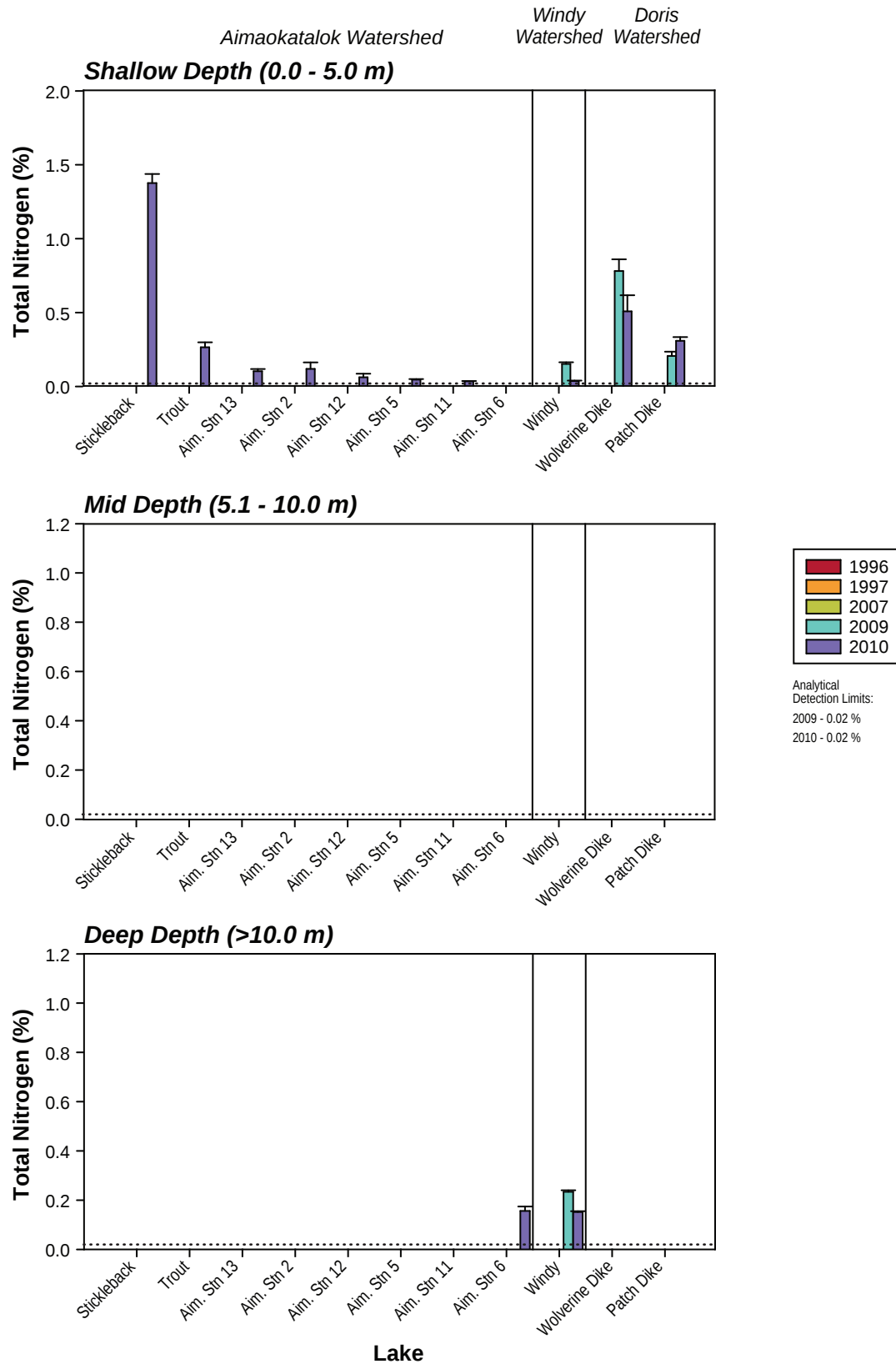


Figure 3.4-3d

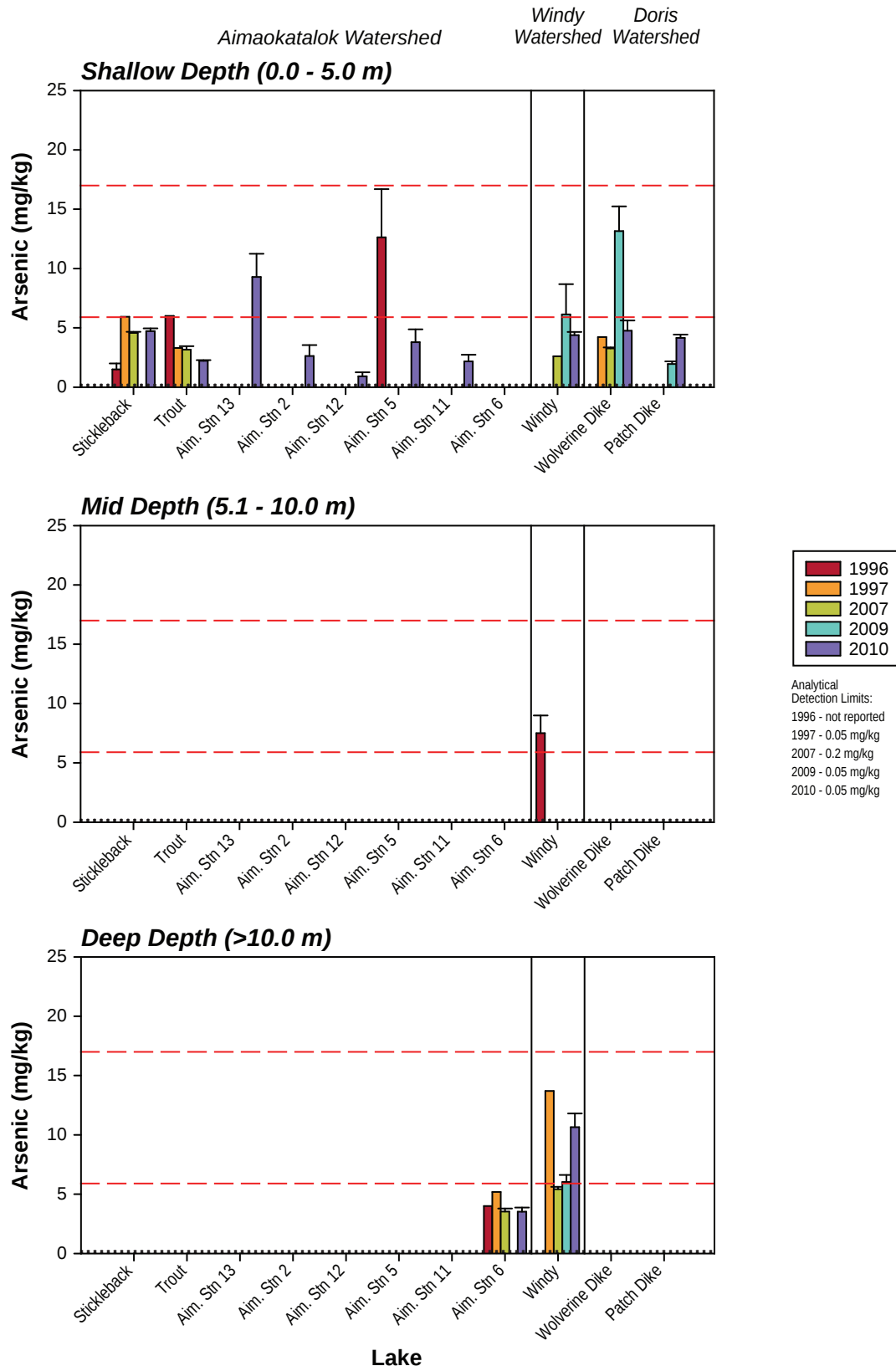


Figure 3.4-3e