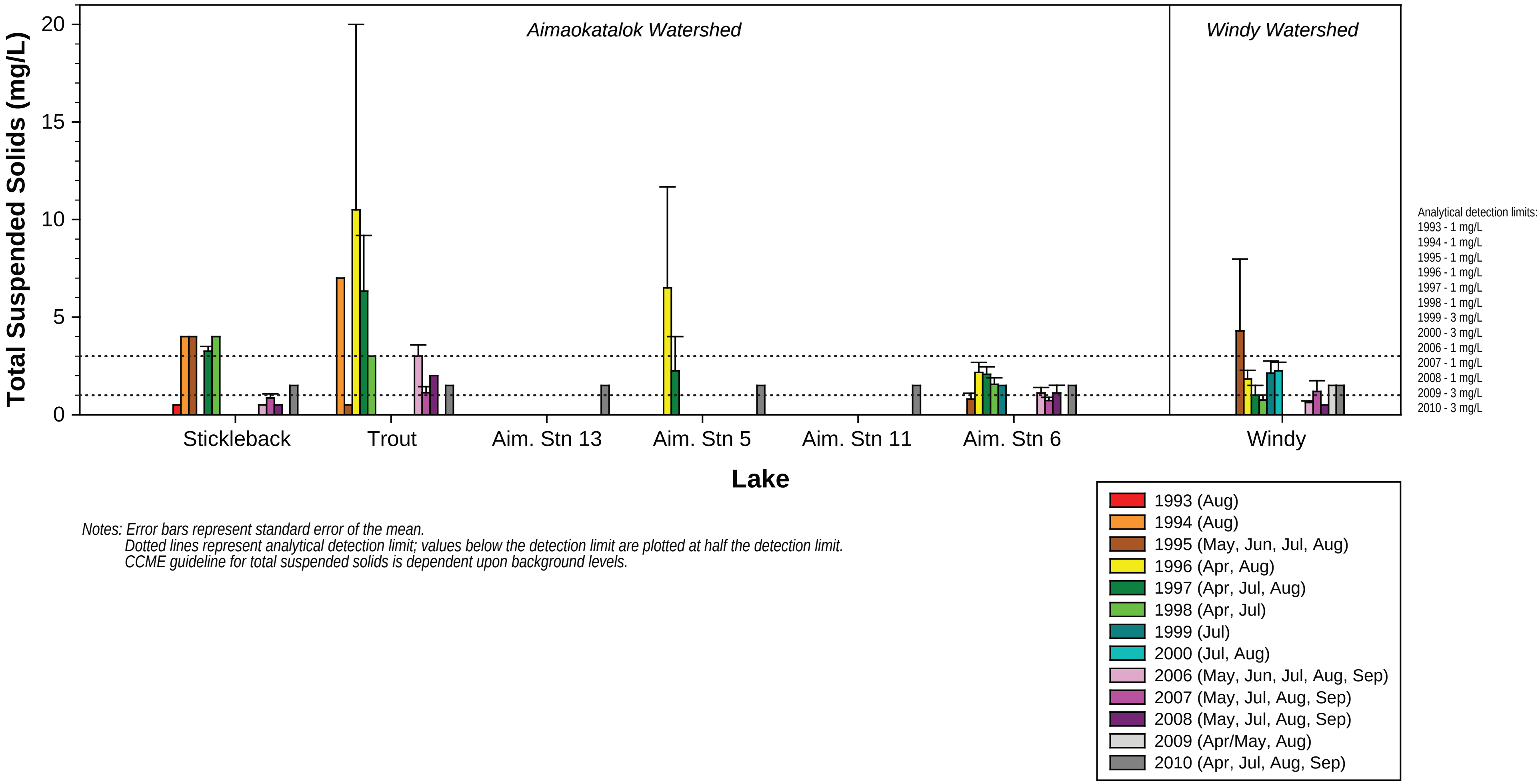


Notes: Error bars represent standard error of the mean.
Dotted lines represent analytical detection limit; values below the detection limit are plotted at half the detection limit.
CCME guideline for total suspended solids is dependent upon background levels.

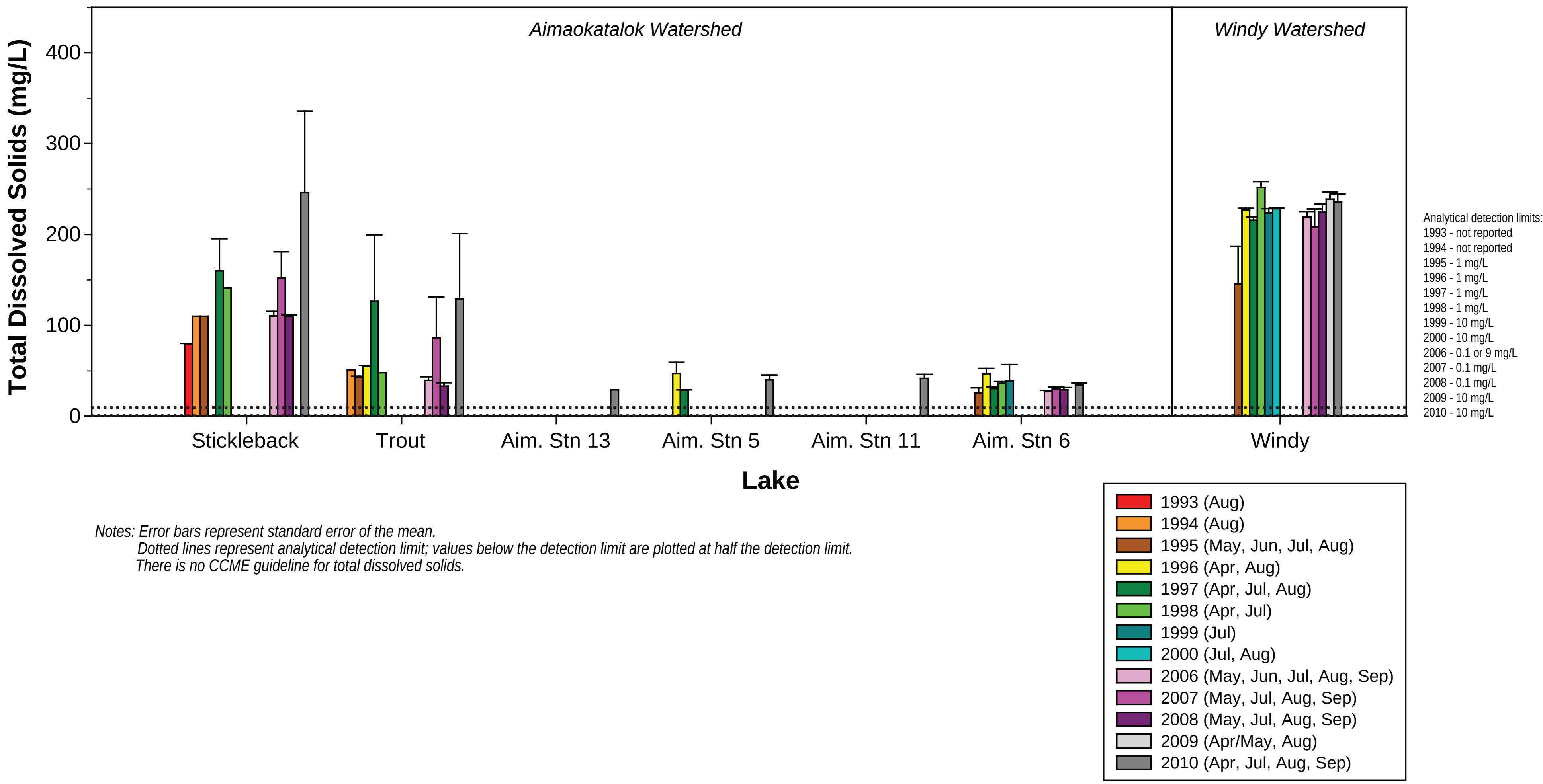
Figure 3.2-2d

NEWMONT NORTH AMERICA

Average Annual Total Suspended Solids Concentration in Lakes, Hope Bay Belt Project, 1993-2010

Figure 3.2-2d

Rescan Engineers & Scientists



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.
There is no CCME guideline for total dissolved solids.

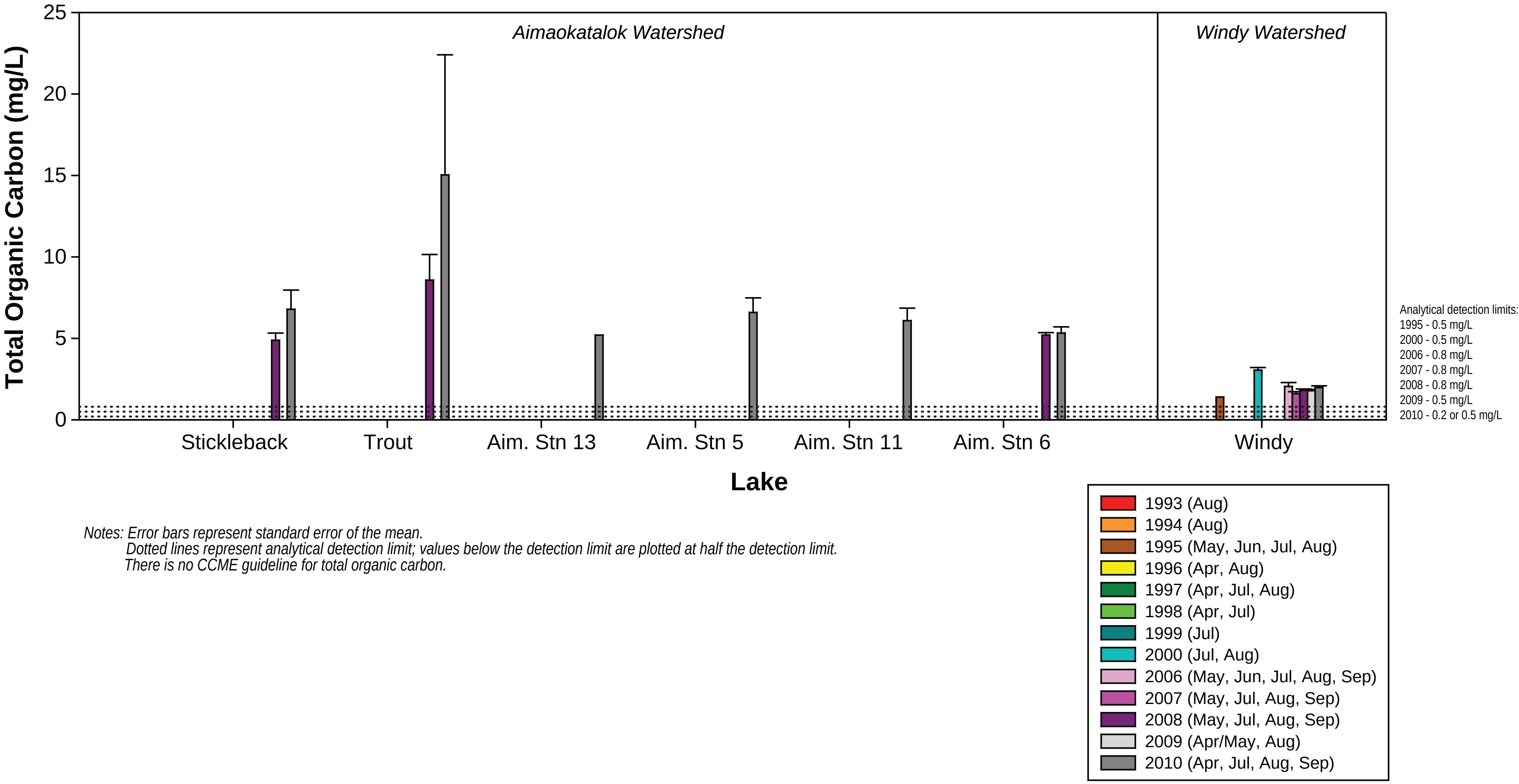
Figure 3.2-2e

NEWMONT NORTH AMERICA

Average Annual Total Dissolved Solids Concentration in Lakes, Hope Bay Belt Project, 1993-2010

Figure 3.2-2e

Rescan Engineers & Scientists



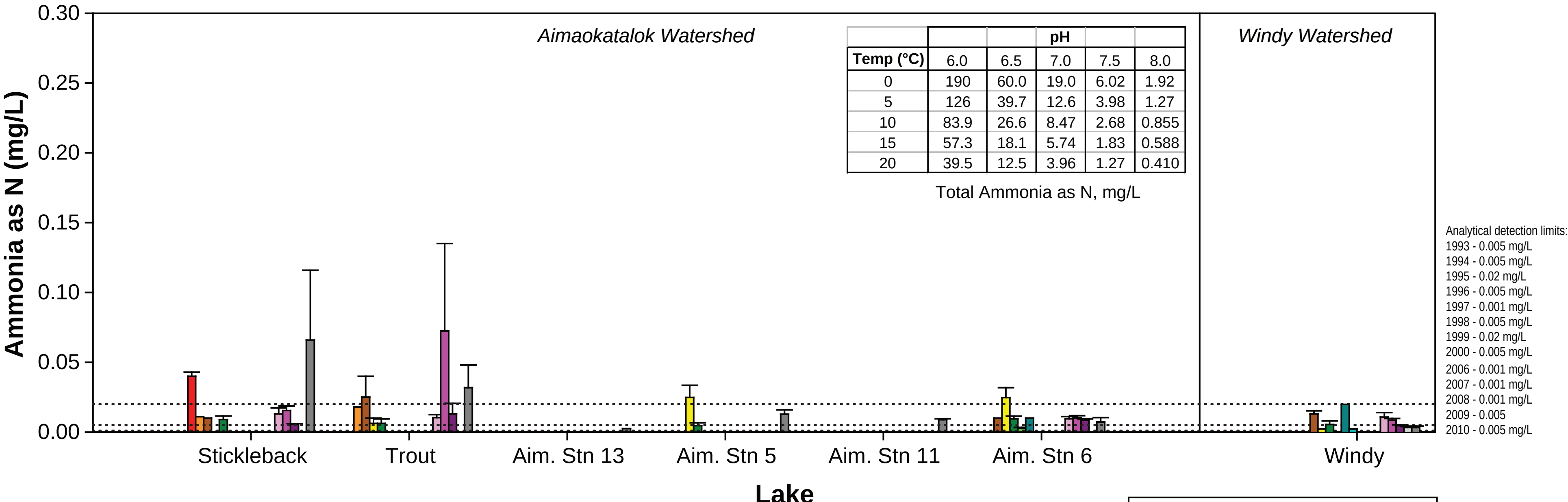
Notes: Error bars represent standard error of the mean.
Dotted lines represent analytical detection limit; values below the detection limit are plotted at half the detection limit.
There is no CCME guideline for total organic carbon.

Figure 3.2-2f

NEWMONT NORTH AMERICA

Average Annual Total Organic Carbon Concentration in Lakes, Hope Bay Belt Project, 1993-2010

Rescan Engineers & Scientists



	pH				
Temp (°C)	6.0	6.5	7.0	7.5	8.0
0	190	60.0	19.0	6.02	1.92
5	126	39.7	12.6	3.98	1.27
10	83.9	26.6	8.47	2.68	0.855
15	57.3	18.1	5.74	1.83	0.588
20	39.5	12.5	3.96	1.27	0.410

Total Ammonia as N, mg/L

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.
Inset table shows temperature- and pH-dependent CCME guideline.
** Indicates average ammonia concentrations that are both above the detection limit and higher than the CCME guideline.*

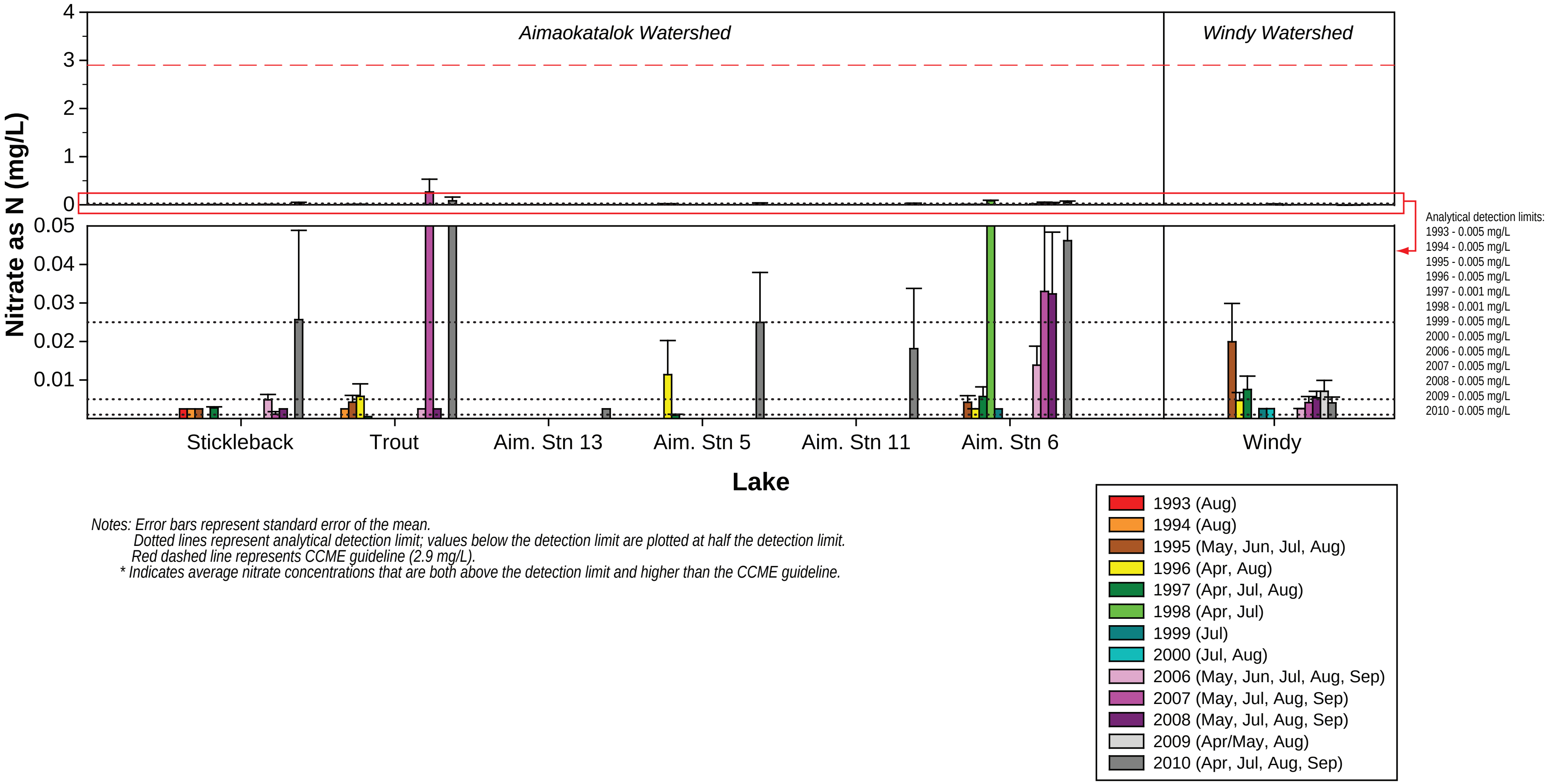
Figure 3.2-2g

Average Annual Ammonia Concentration in Lakes, Hope Bay Belt Project, 1993-2010

Figure 3.2-2g

NEWMONT NORTH AMERICA

Rescan Engineers & Scientists



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 (2.9 mg/L).
** Indicates average nitrate concentrations that are both above the detection limit and higher than the CCME guideline.*

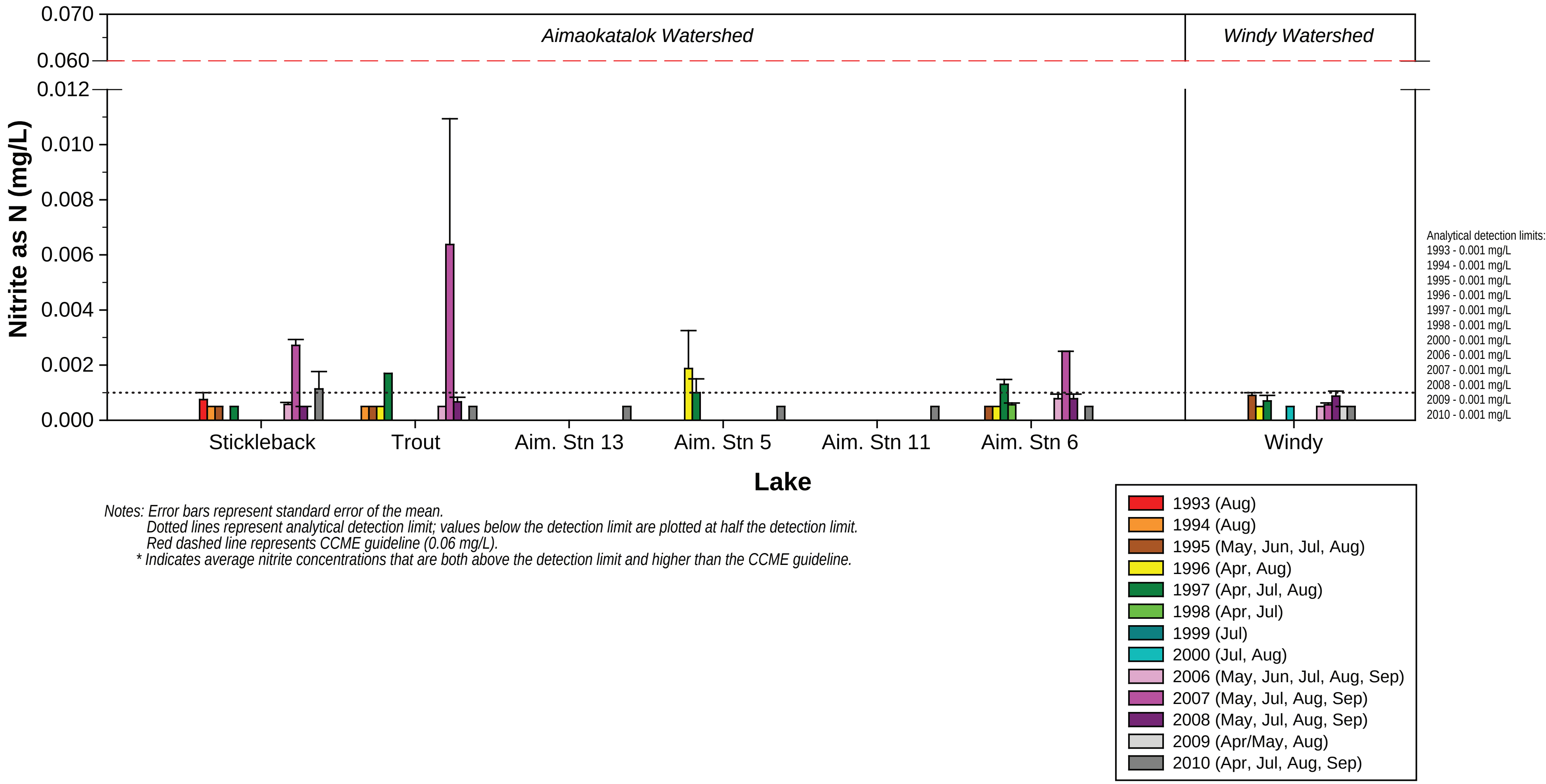
Figure 3.2-2h

NEWMONT NORTH AMERICA

Average Annual Nitrate Concentration in Lakes, Hope Bay Belt Project, 1993-2010

Figure 3.2-2h

Rescan Engineers & Scientists



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 (0.06 mg/L).
** Indicates average nitrite concentrations that are both above the detection limit and higher than the CCME guideline.*

NEWMONT NORTH AMERICA

Average Annual Nitrite Concentration in Lakes, Hope Bay Belt Project, 1993-2010

Figure 3.2-2i

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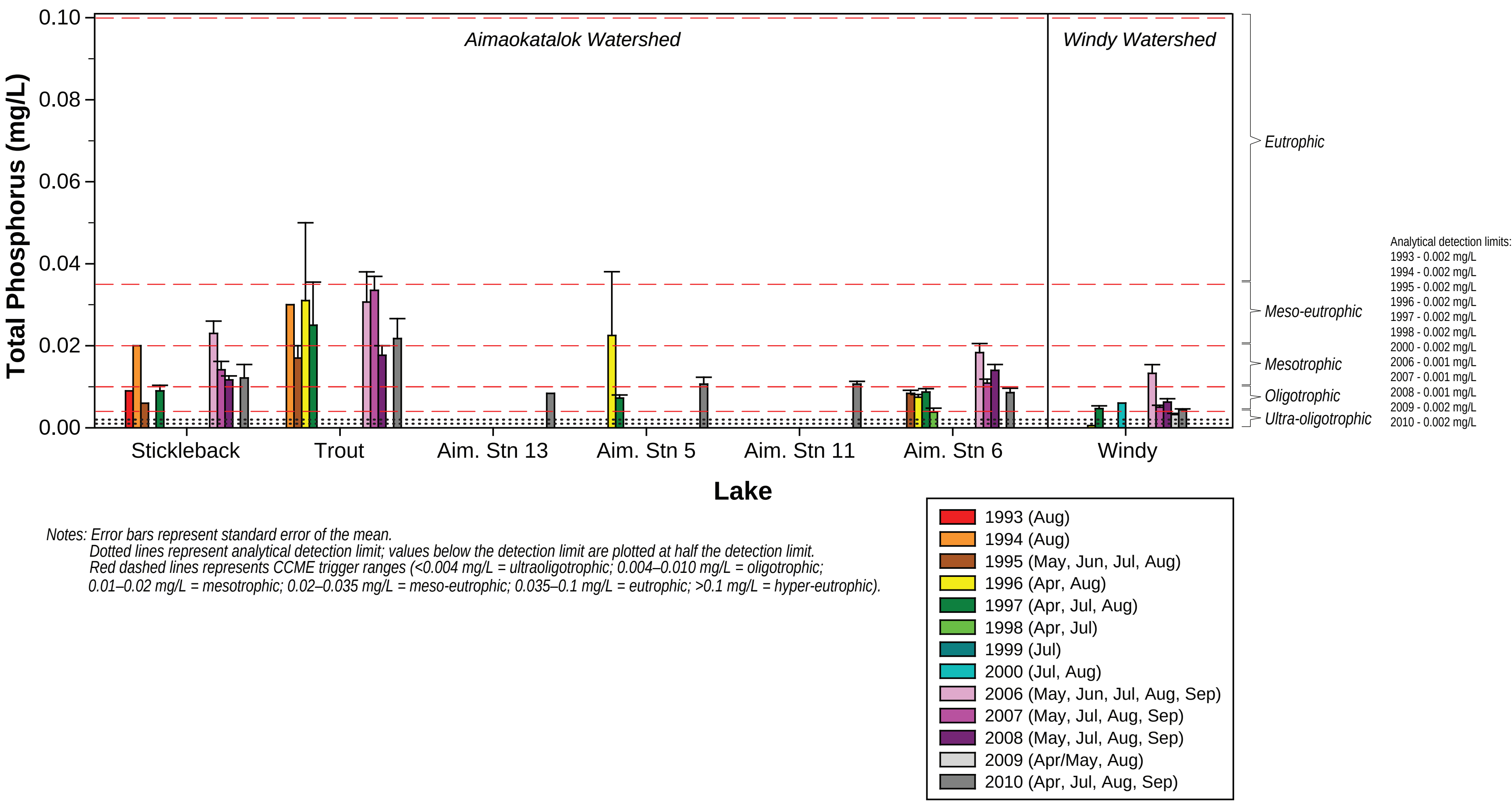


Notes: Error bars represent standard error of the mean.
Dotted lines represent analytical detection limit; values below the detection limit are plotted at half the detection limit.
Red dashed lines represents CCME trigger ranges (<0.004 mg/L = ultraoligotrophic; 0.004–0.010 mg/L = oligotrophic; 0.01–0.02 mg/L = mesotrophic; 0.02–0.035 mg/L = meso-eutrophic; 0.035–0.1 mg/L = eutrophic; >0.1 mg/L = hyper-eutrophic).

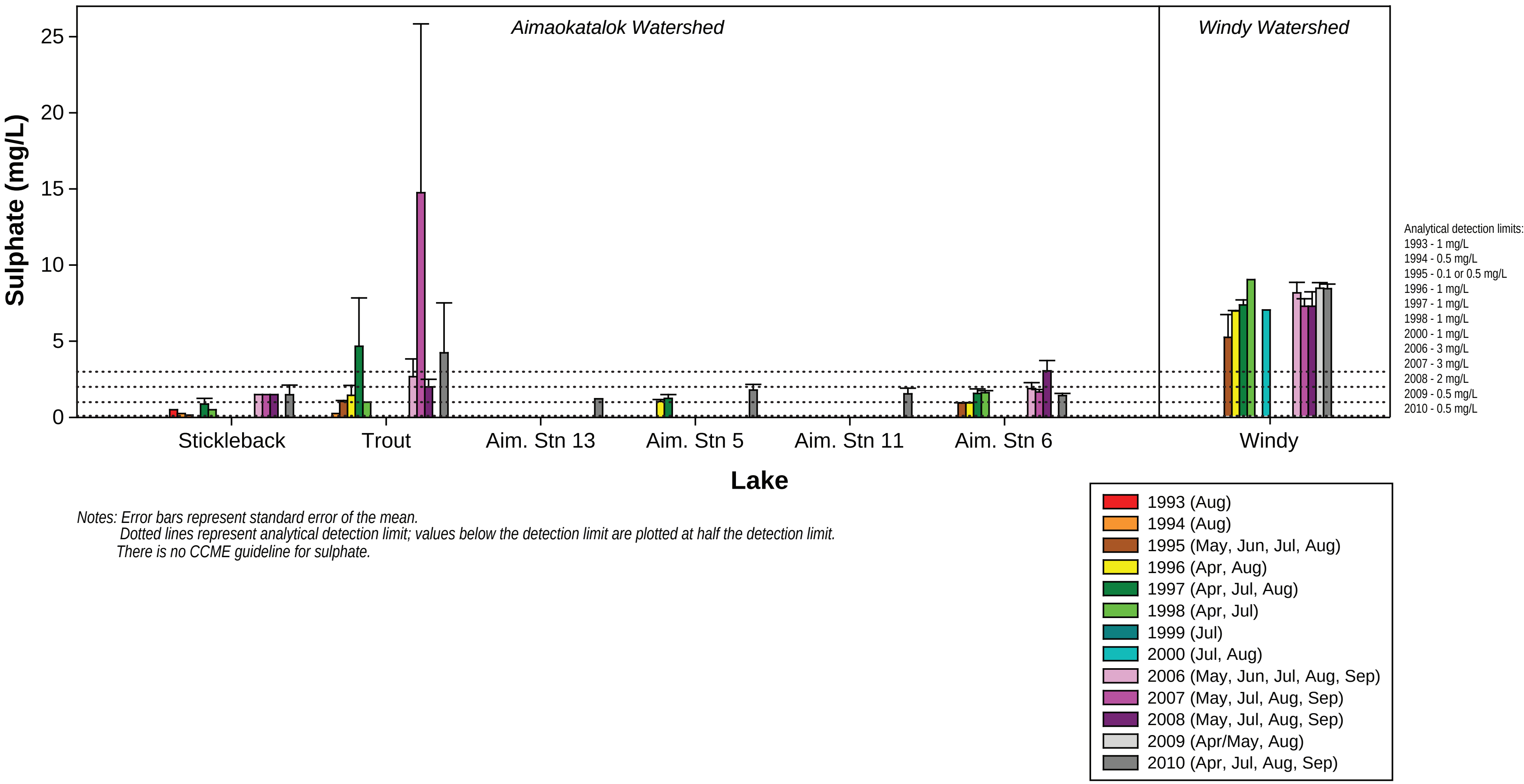
Figure 3.2-2j

NEWMONT NORTH AMERICA

Average Annual Total Phosphorus Concentration in Lakes, Hope Bay Belt Project, 1993-2010

Figure 3.2-2j

Rescan Engineers & Scientists



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.
There is no CCME guideline for sulphate.

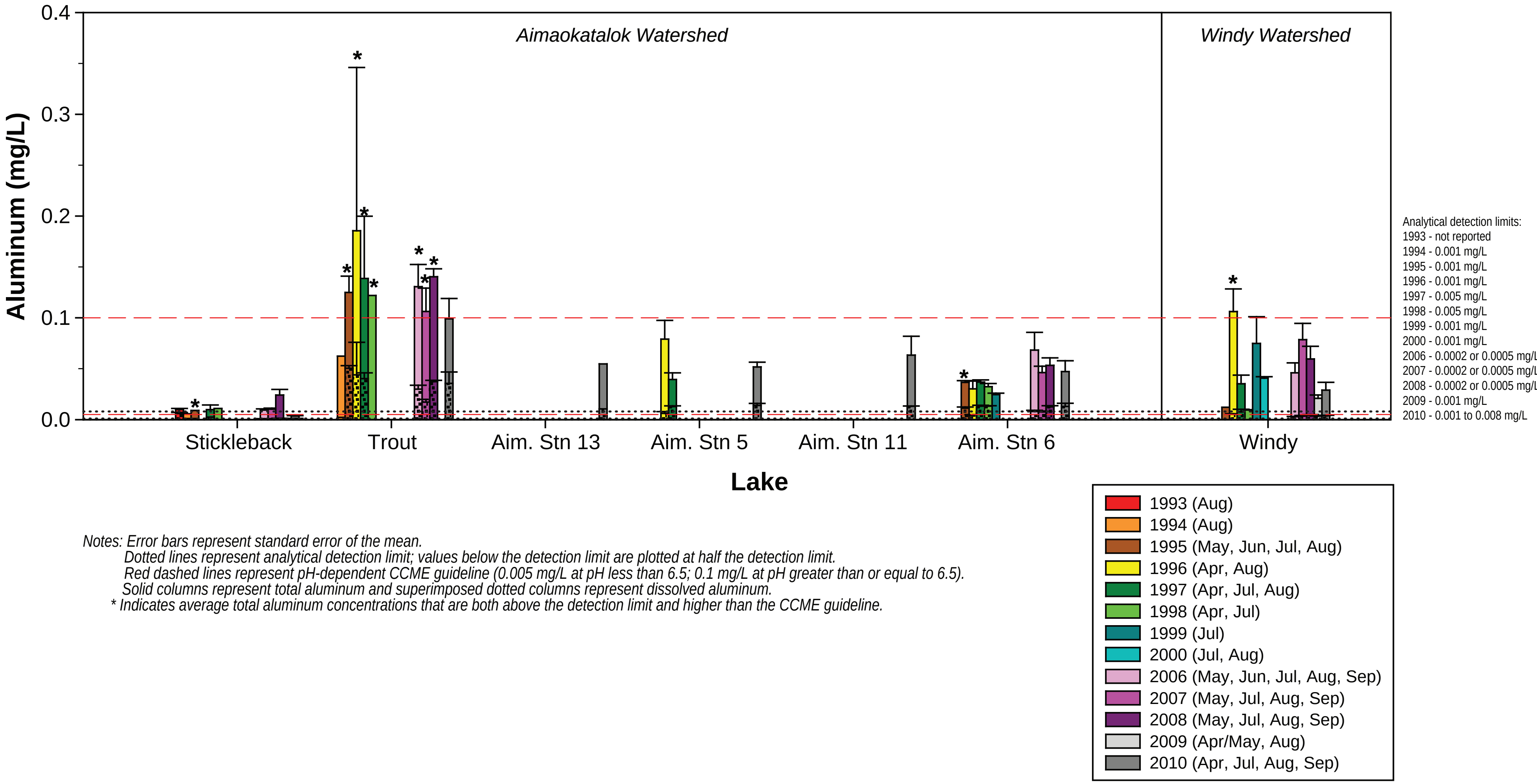
Figure 3.2-2k

NEWMONT NORTH AMERICA

Average Annual Sulphate Concentration in Lakes, Hope Bay Belt Project, 1993-2010

Figure 3.2-2k

Rescan Engineers & Scientists



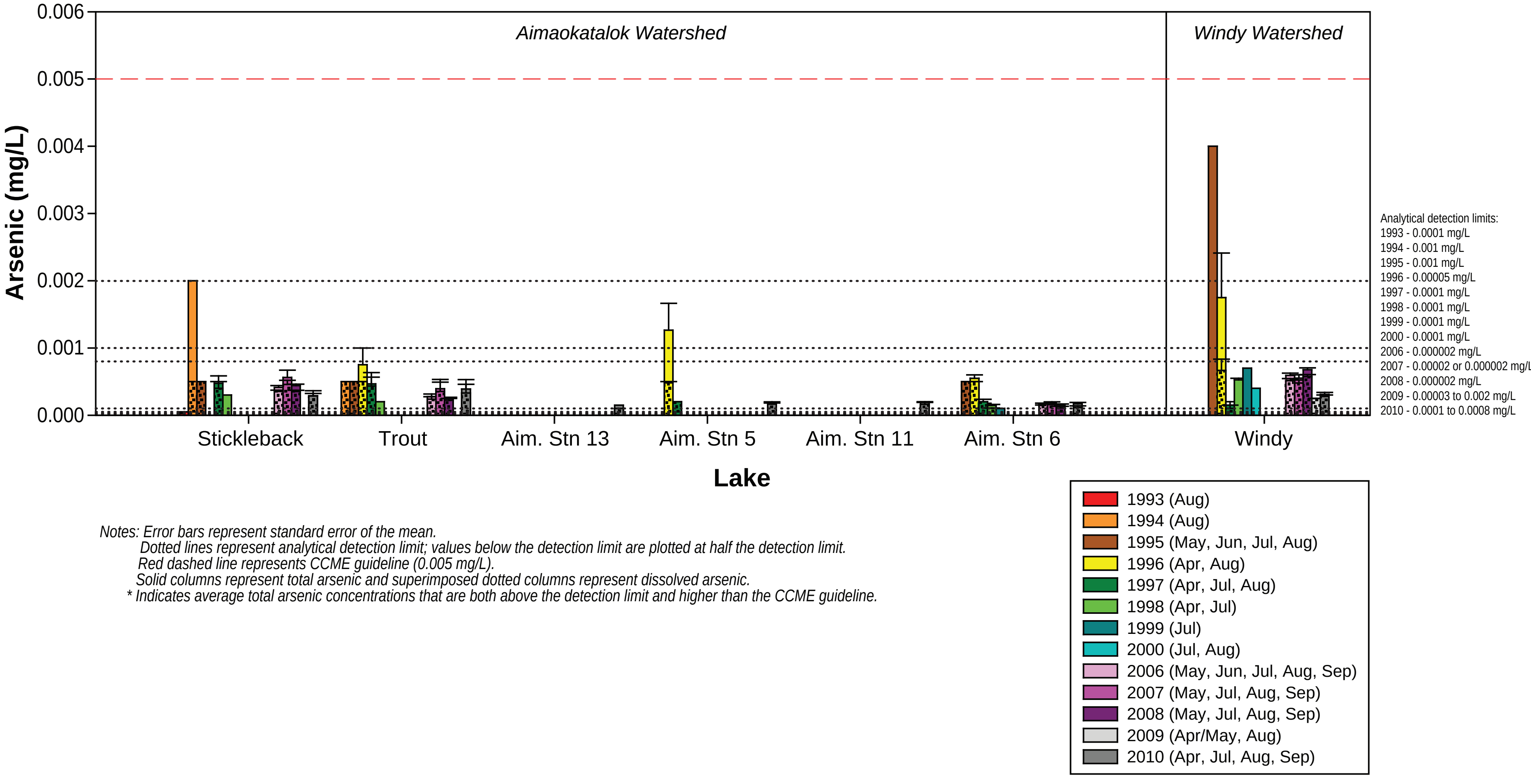
Notes: Error bars represent standard error of the mean.
Dotted lines represent analytical detection limit; values below the detection limit are plotted at half the detection limit.
Red dashed lines represent pH-dependent CCME guideline (0.005 mg/L at pH less than 6.5; 0.1 mg/L at pH greater than or equal to 6.5).
Solid columns represent total aluminum and superimposed dotted columns represent dissolved aluminum.
** Indicates average total aluminum concentrations that are both above the detection limit and higher than the CCME guideline.*

Figure 3.2-2l

NEWMONT NORTH AMERICA

Average Annual Aluminum Concentration in Lakes, Hope Bay Belt Project, 1993-2010

Rescan Engineers & Scientists



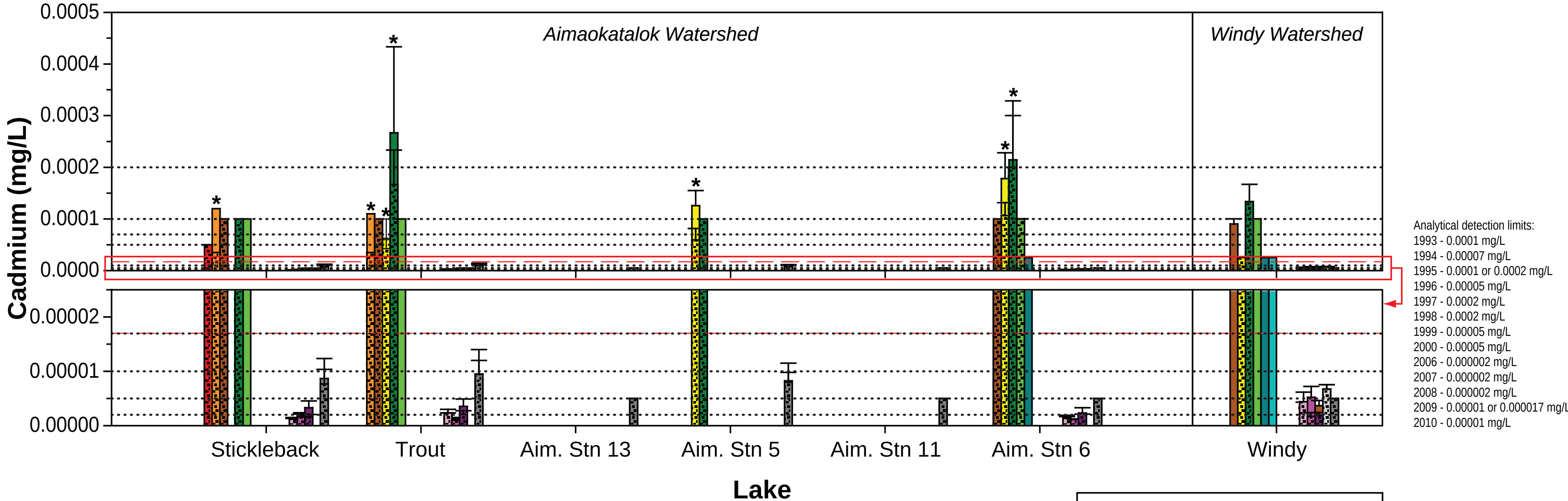
Notes: Error bars represent standard error of the mean.
Dotted lines represent analytical detection limit; values below the detection limit are plotted at half the detection limit.
Red dashed line represents CCME guideline (0.005 mg/L).
Solid columns represent total arsenic and superimposed dotted columns represent dissolved arsenic.
** Indicates average total arsenic concentrations that are both above the detection limit and higher than the CCME guideline.*

Figure 3.2-2m

NEWMONT NORTH AMERICA

Average Annual Arsenic Concentration in Lakes, Hope Bay Belt Project, 1993-2010

Rescan Engineers & Scientists



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 (0.000017 mg/L). The equation for correcting this guideline for hardness is: $10^{\{0.86[\log(hardness)]-3.2\}}/1000$.
Solid columns represent total cadmium and superimposed dotted columns represent dissolved cadmium.
** Indicates average total cadmium concentrations that are both above the detection limit and higher than the hardness-corrected CCME guideline.*

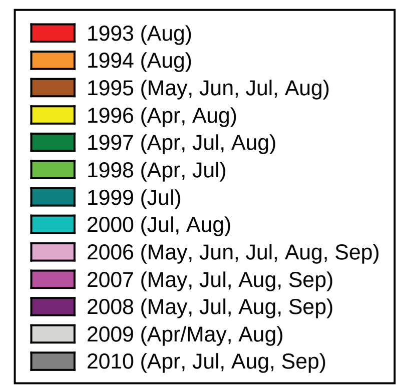


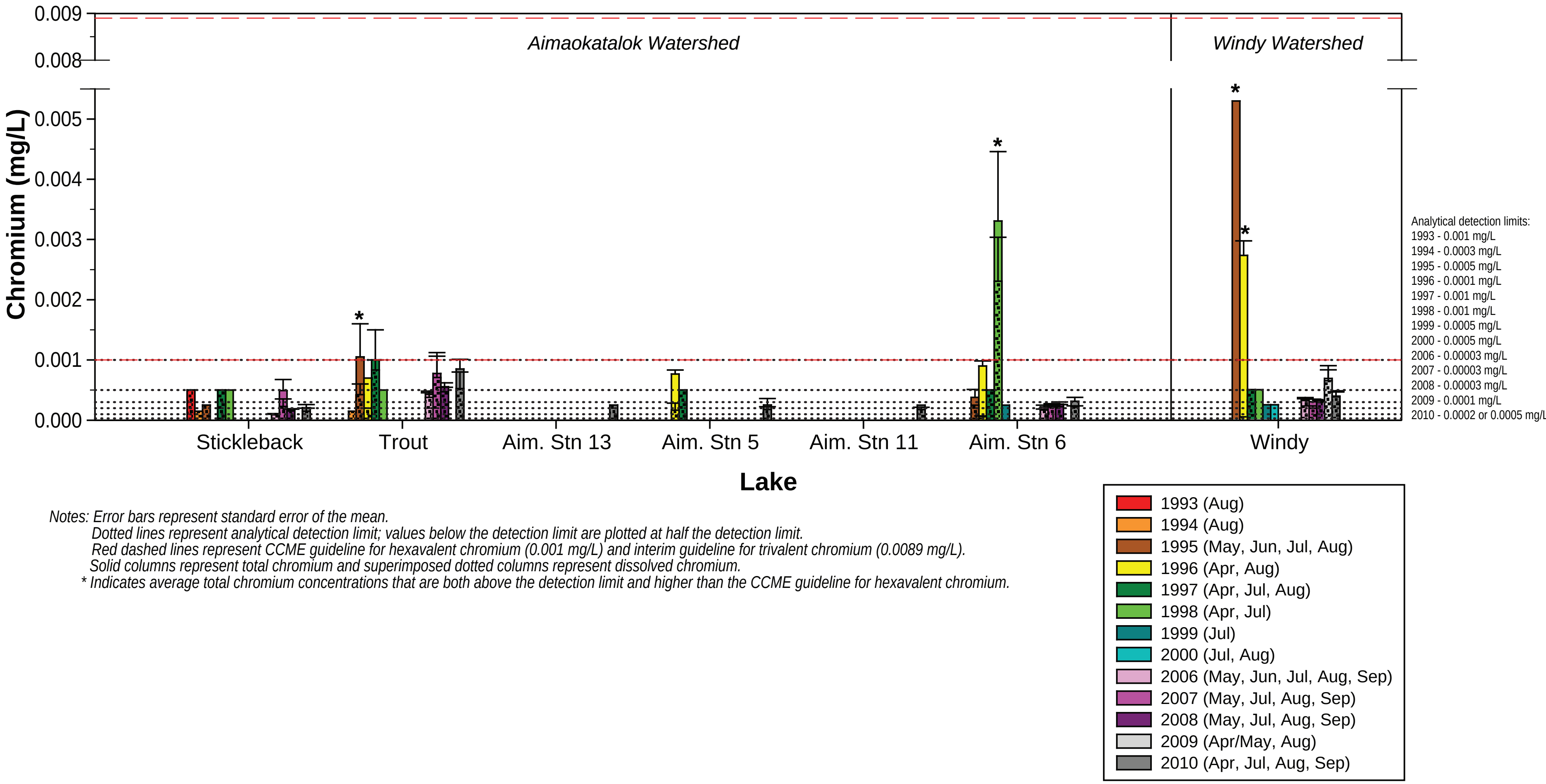
Figure 3.2-2n

NEWMONT NORTH AMERICA

Average Annual Cadmium Concentration in Lakes, Hope Bay Belt Project, 1993-2010

Figure 3.2-2n

Rescan Engineers & Scientists



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 lines represent CCME guideline for hexavalent chromium (0.001 mg/L) and interim guideline for trivalent chromium (0.0089 mg/L).
Solid columns represent total chromium and superimposed dotted columns represent dissolved chromium.
** Indicates average total chromium concentrations that are both above the detection limit and higher than the CCME guideline for hexavalent chromium.*

Figure 3.2-2o

NEWMONT NORTH AMERICA

Average Annual Chromium Concentration in Lakes, Hope Bay Belt Project, 1993-2010

Figure 3.2-2o

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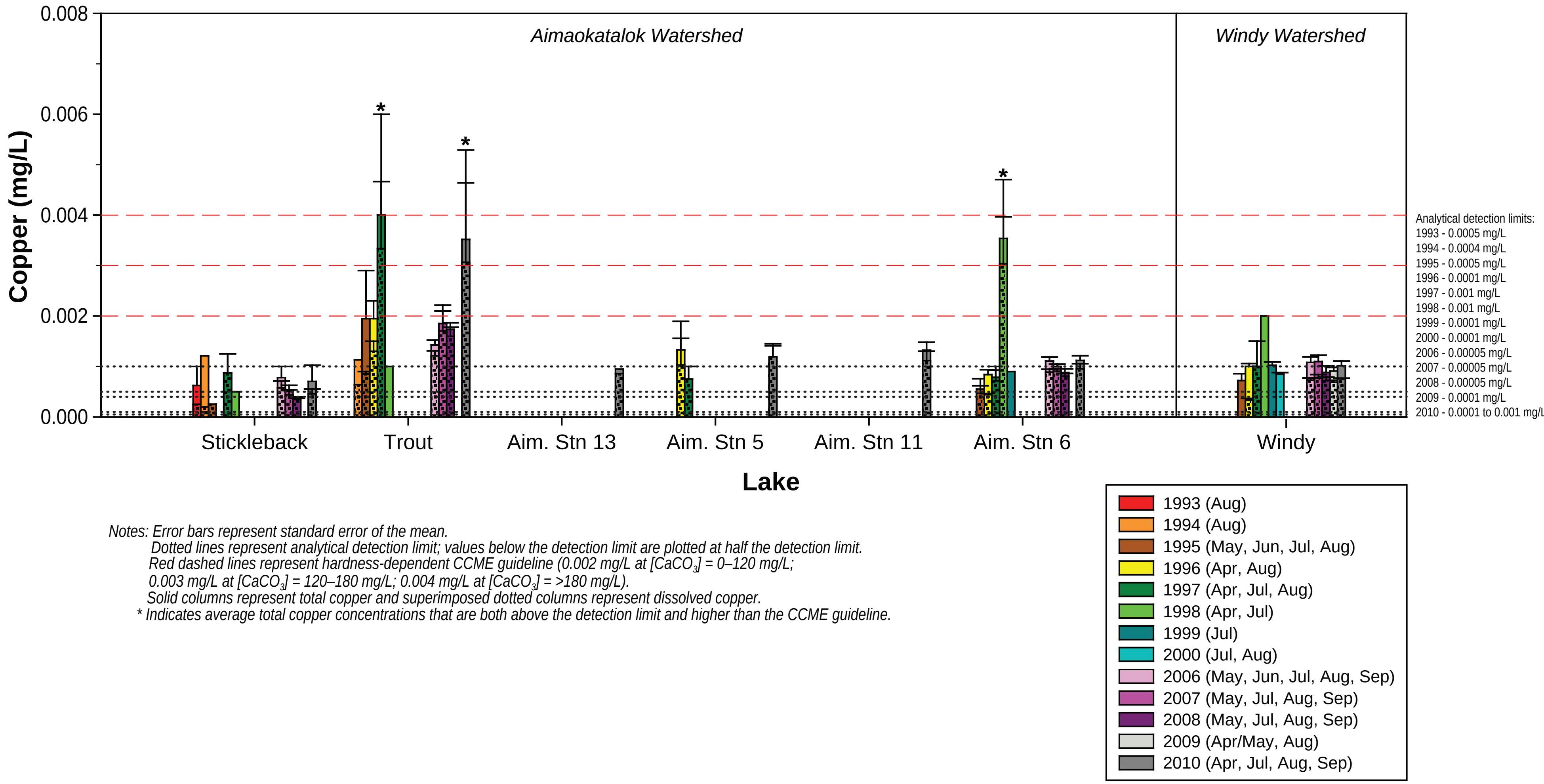


Notes: Error bars represent standard error of the mean.
Dotted lines represent analytical detection limit; values below the detection limit are plotted at half the detection limit.
Red dashed lines represent hardness-dependent CCME guideline (0.002 mg/L at [$CaCO_3$] = 0–120 mg/L; 0.003 mg/L at [$CaCO_3$] = 120–180 mg/L; 0.004 mg/L at [$CaCO_3$] = >180 mg/L).
Solid columns represent total copper and superimposed dotted columns represent dissolved copper.
** Indicates average total copper concentrations that are both above the detection limit and higher than the CCME guideline.*

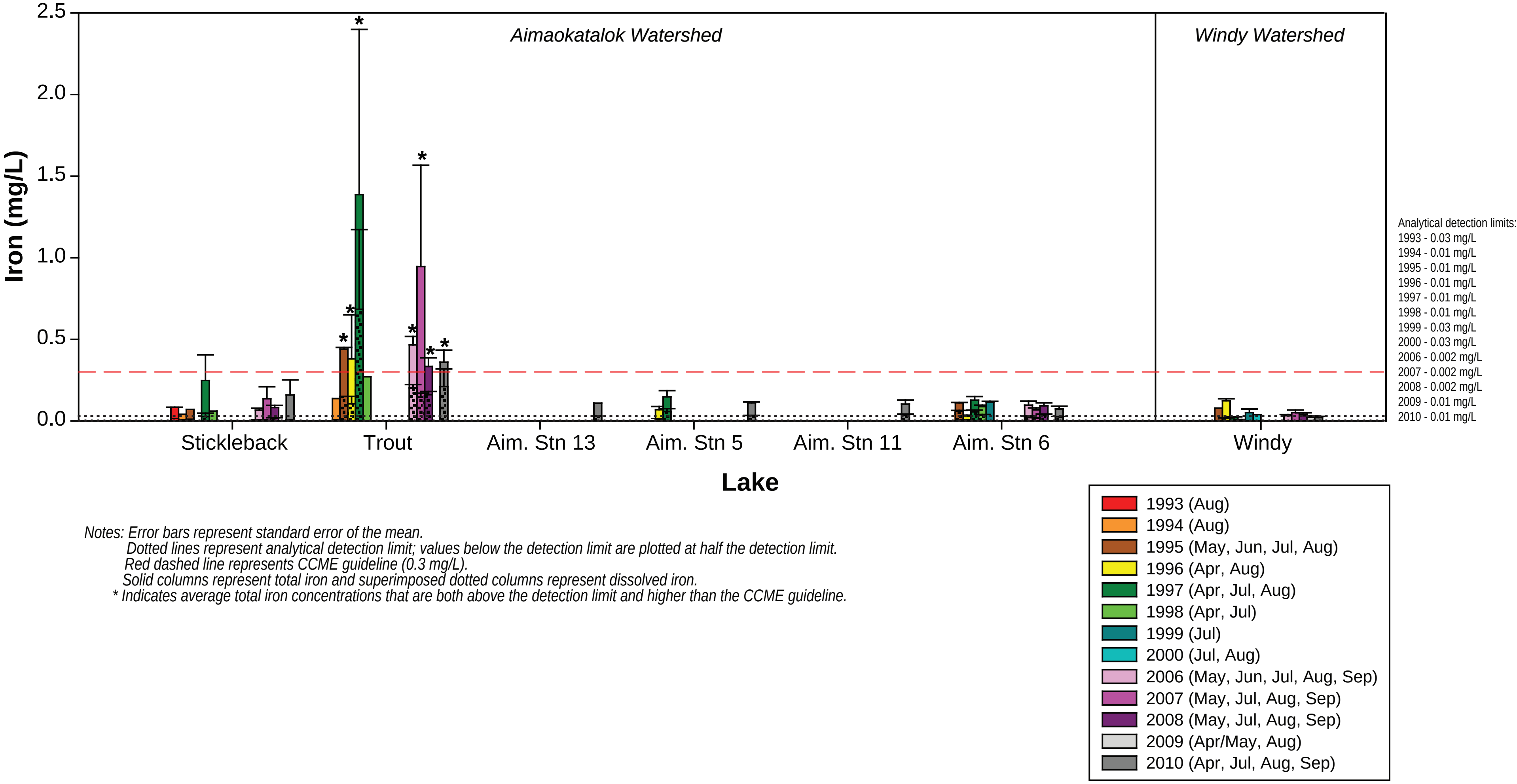
Figure 3.2-2p

NEWMONT NORTH AMERICA

Average Annual Copper Concentration in Lakes, Hope Bay Belt Project, 1993-2010

Figure 3.2-2p

Rescan Engineers & Scientists



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 (0.3 mg/L).
Solid columns represent total iron and superimposed dotted columns represent dissolved iron.
** Indicates average total iron concentrations that are both above the detection limit and higher than the CCME guideline.*

Figure 3.2-2q

NEWMONT NORTH AMERICA

Average Annual Iron Concentration in Lakes, Hope Bay Belt Project, 1993-2010

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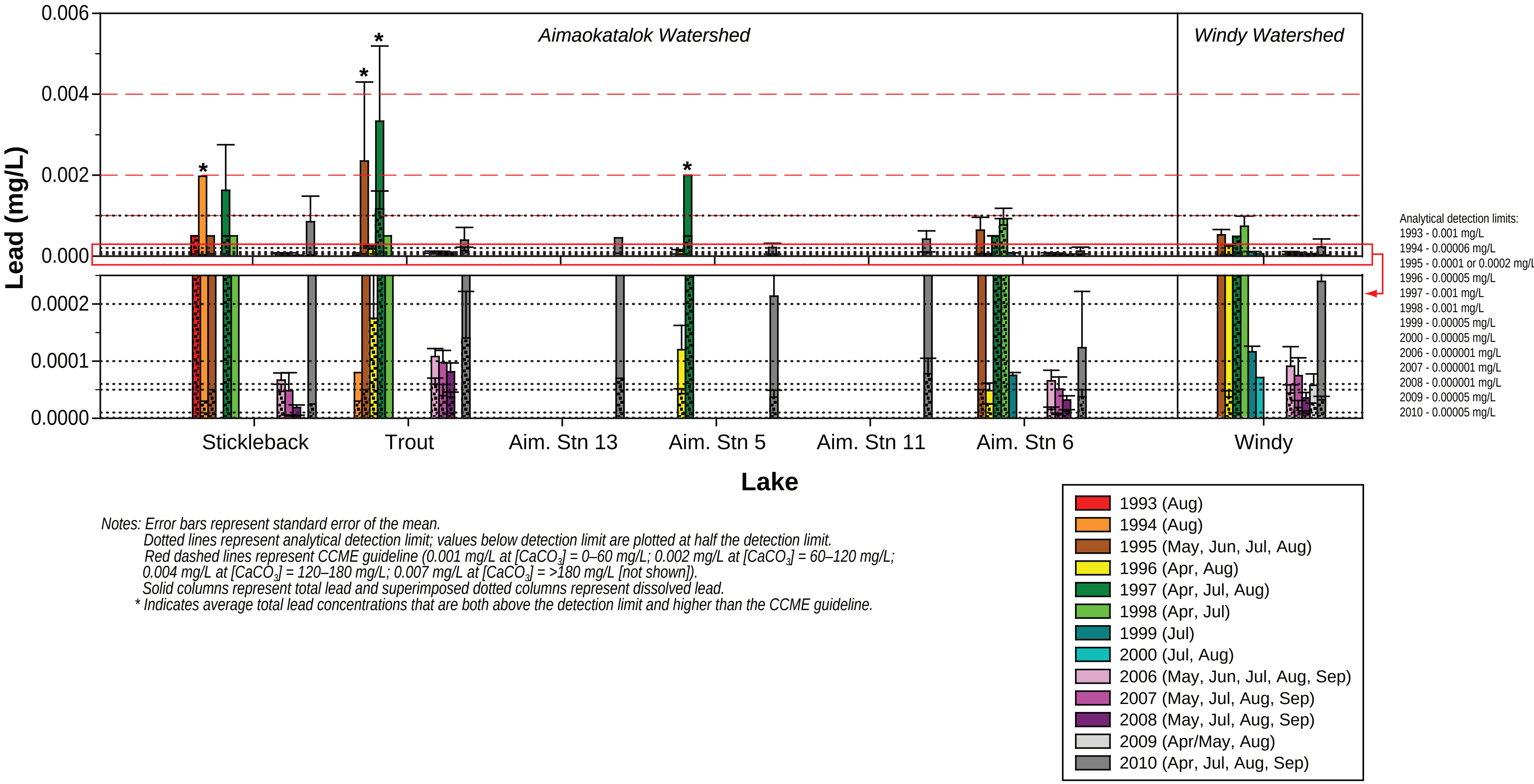

Notes: Error bars represent standard error of the mean.
Dotted lines represent analytical detection limit; values below detection limit are plotted at half the detection limit.
Red dashed lines represent CCME guideline (0.001 mg/L at [$CaCO_3$] = 0–60 mg/L; 0.002 mg/L at [$CaCO_3$] = 60–120 mg/L; 0.004 mg/L at [$CaCO_3$] = 120–180 mg/L; 0.007 mg/L at [$CaCO_3$] = >180 mg/L [not shown]).
Solid columns represent total lead and superimposed dotted columns represent dissolved lead.
** Indicates average total lead concentrations that are both above the detection limit and higher than the CCME guideline.*

Figure 3.2-2r

NEWMONT. NORTH AMERICA

Average Annual Lead Concentration in Lakes, Hope Bay Belt Project, 1993-2010

Figure 3.2-2r

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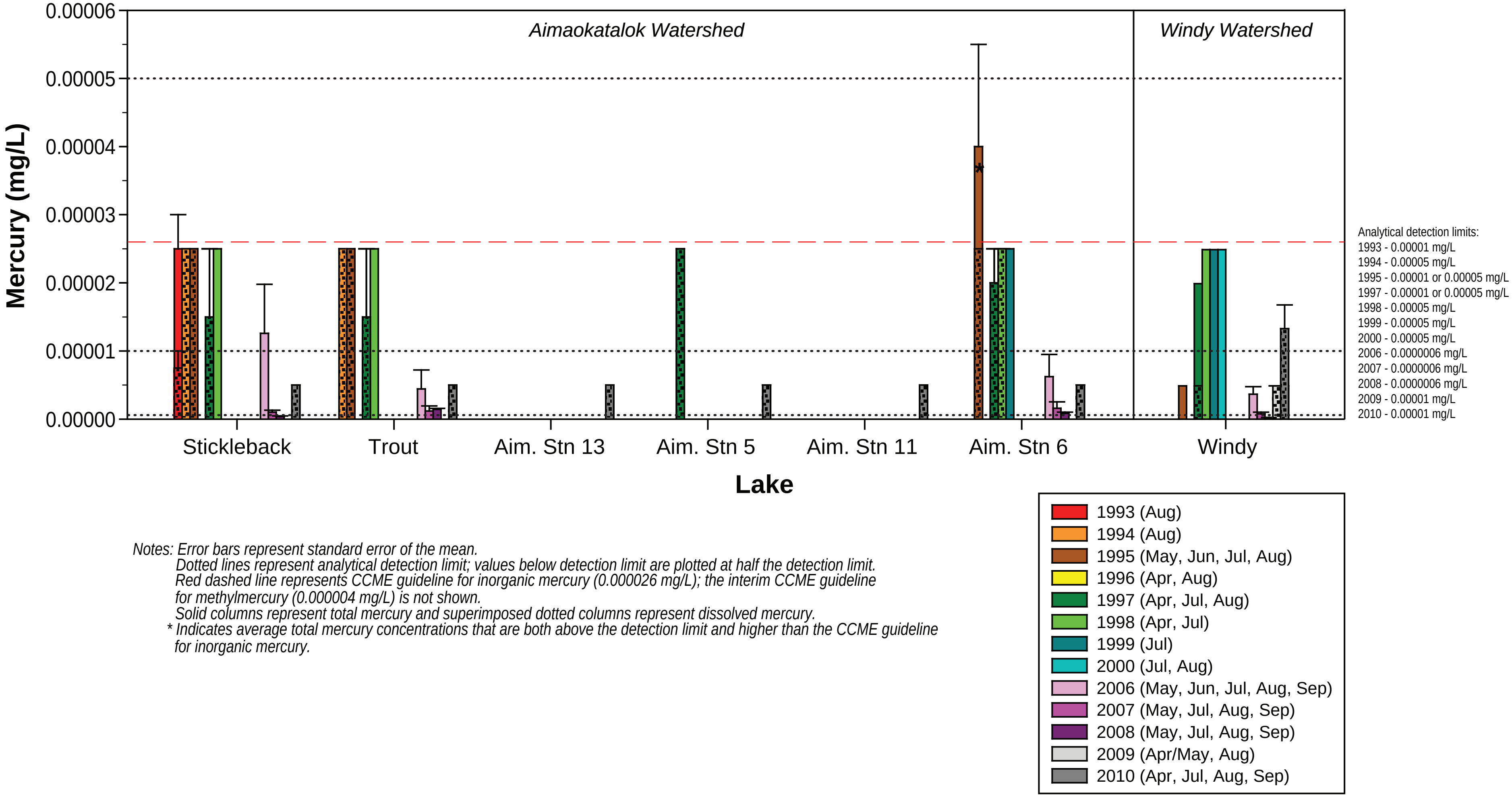

Notes: Error bars represent standard error of the mean.
Dotted lines represent analytical detection limit; values below detection limit are plotted at half the detection limit.
Red dashed line represents CCME guideline for inorganic mercury (0.000026 mg/L); the interim CCME guideline for methylmercury (0.000004 mg/L) is not shown.
Solid columns represent total mercury and superimposed dotted columns represent dissolved mercury.
** Indicates average total mercury concentrations that are both above the detection limit and higher than the CCME guideline for inorganic mercury.*

Figure 3.2-2s

NEWMONT NORTH AMERICA

Average Annual Mercury Concentration in Lakes, Hope Bay Belt Project, 1993-2010

Figure 3.2-2s

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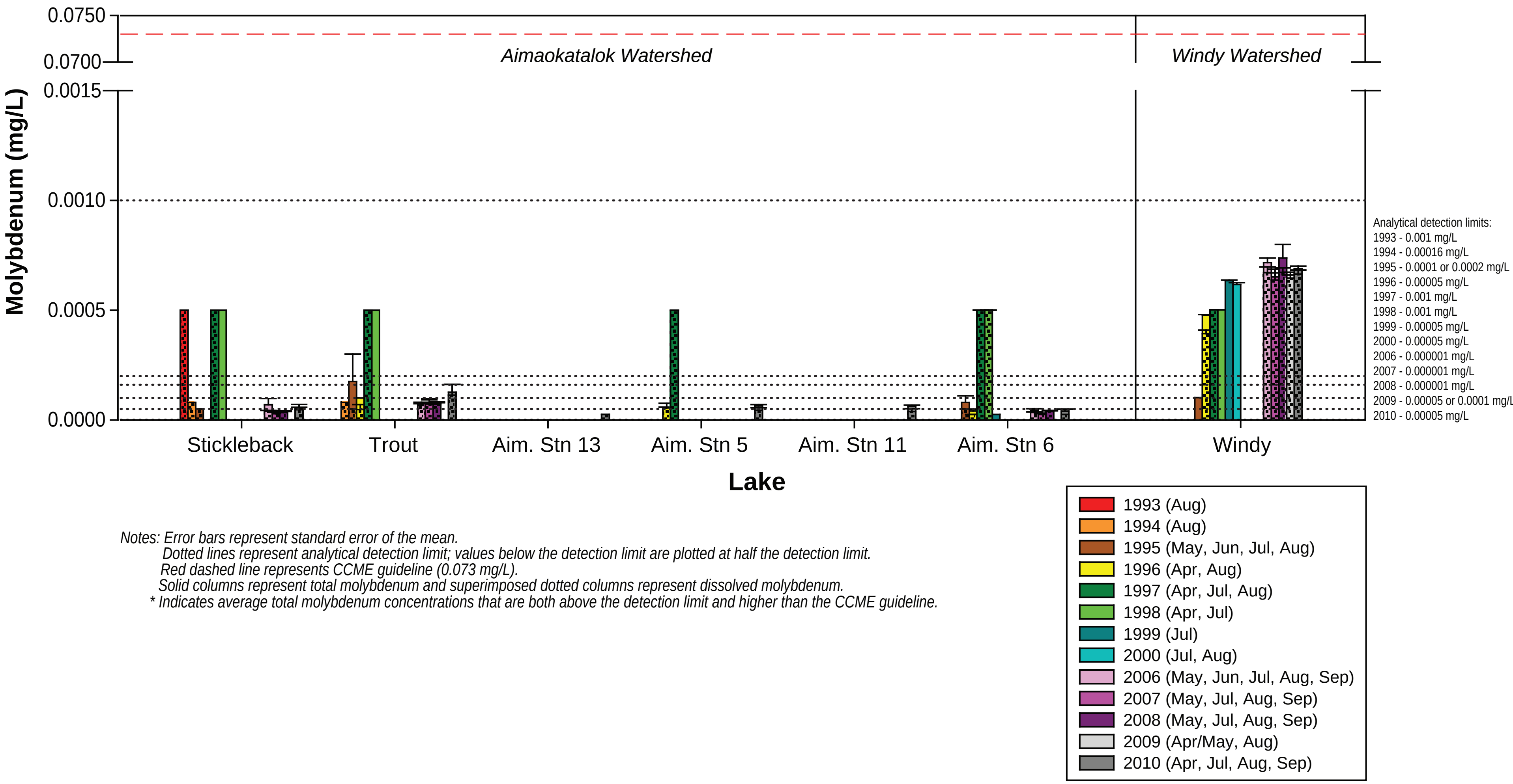


Notes: Error bars represent standard error of the mean.
Dotted lines represent analytical detection limit; values below the detection limit are plotted at half the detection limit.
Red dashed line represents CCME guideline (0.073 mg/L).
Solid columns represent total molybdenum and superimposed dotted columns represent dissolved molybdenum.
** Indicates average total molybdenum concentrations that are both above the detection limit and higher than the CCME guideline.*

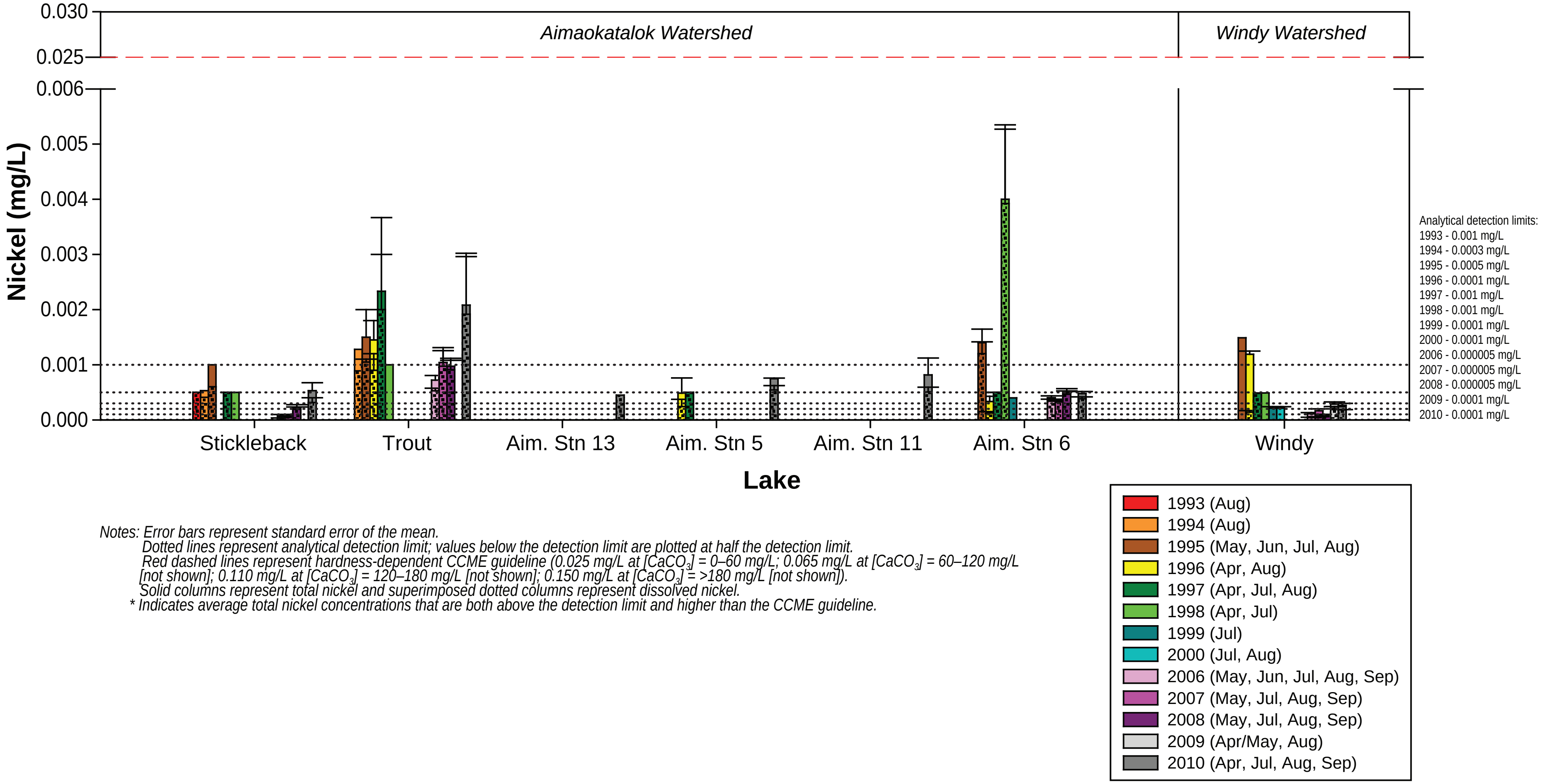
Figure 3.2-2t

NEWMONT NORTH AMERICA

Average Annual Molybdenum Concentration in Lakes, Hope Bay Belt Project, 1993-2010

Figure 3.2-2t

Rescan Engineers & Scientists



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 lines represent hardness-dependent CCME guideline (0.025 mg/L at [$CaCO_3$] = 0–60 mg/L; 0.065 mg/L at [$CaCO_3$] = 60–120 mg/L [not shown]; 0.110 mg/L at [$CaCO_3$] = 120–180 mg/L [not shown]; 0.150 mg/L at [$CaCO_3$] = >180 mg/L [not shown]).
Solid columns represent total nickel and superimposed dotted columns represent dissolved nickel.
** Indicates average total nickel concentrations that are both above the detection limit and higher than the CCME guideline.*

Figure 3.2-2u

NEWMONT NORTH AMERICA

Average Annual Nickel Concentration in Lakes, Hope Bay Belt Project, 1993-2010

Figure 3.2-2u

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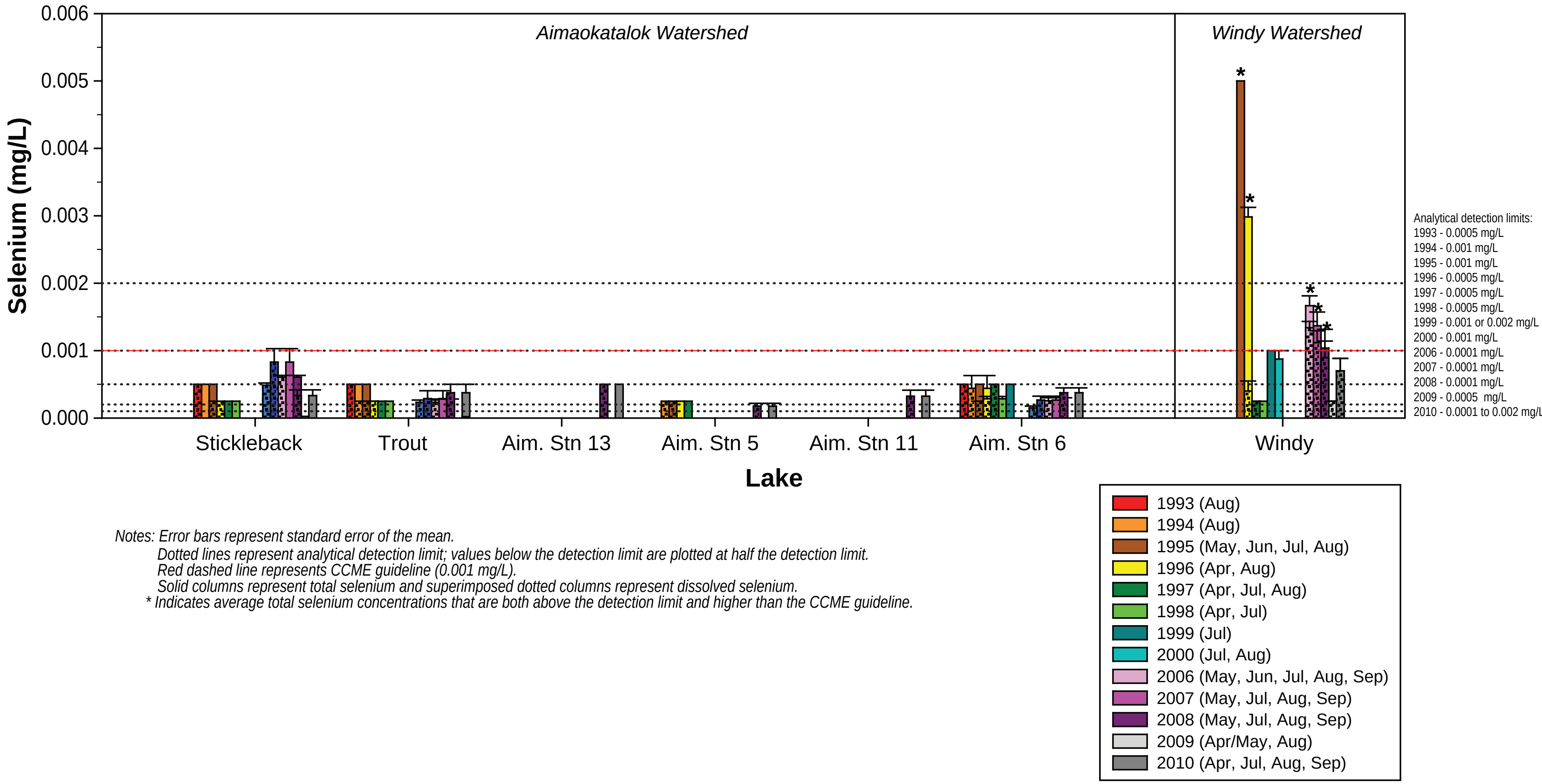


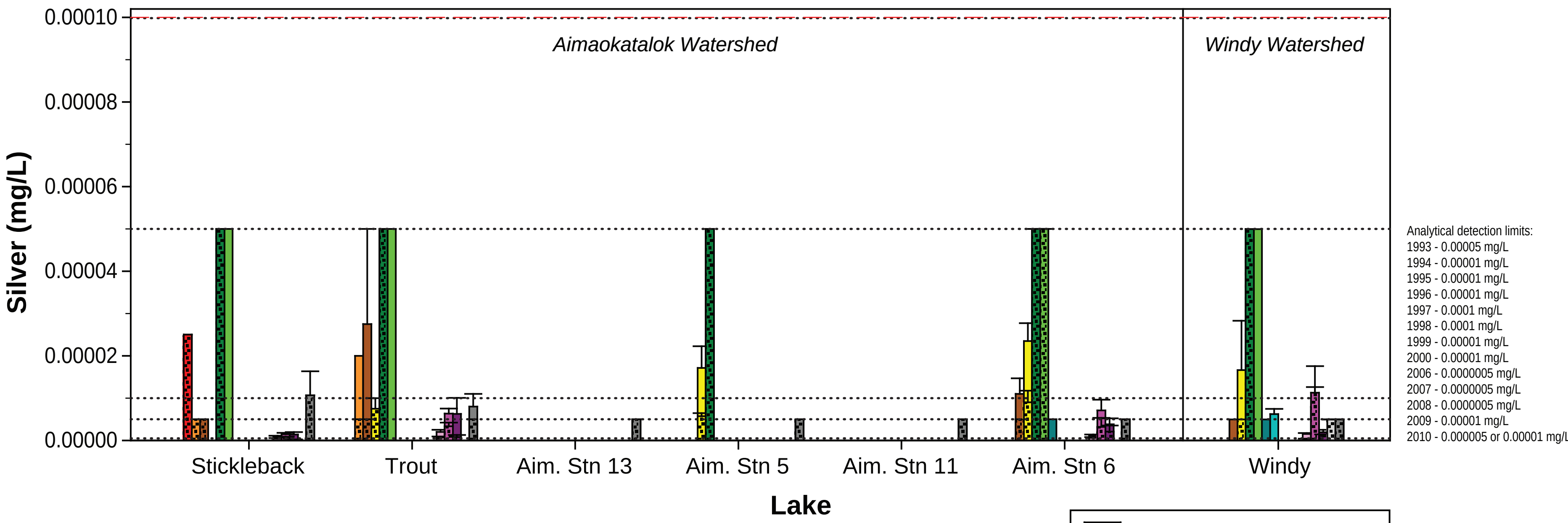
Notes: Error bars represent standard error of the mean.
Dotted lines represent analytical detection limit; values below the detection limit are plotted at half the detection limit.
Red dashed line represents CCME guideline (0.001 mg/L).
Solid columns represent total selenium and superimposed dotted columns represent dissolved selenium.
** Indicates average total selenium concentrations that are both above the detection limit and higher than the CCME guideline.*

Figure 3.2-2v

NEWMONT NORTH AMERICA

Average Annual Selenium Concentration in Lakes, Hope Bay Belt Project, 1993-2010

Rescan Engineers & Scientists



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.*

Figure 3.2-2w

NEWMONT NORTH AMERICA

Average Annual Silver Concentration in Lakes, Hope Bay Belt Project, 1993-2010

Figure 3.2-2w

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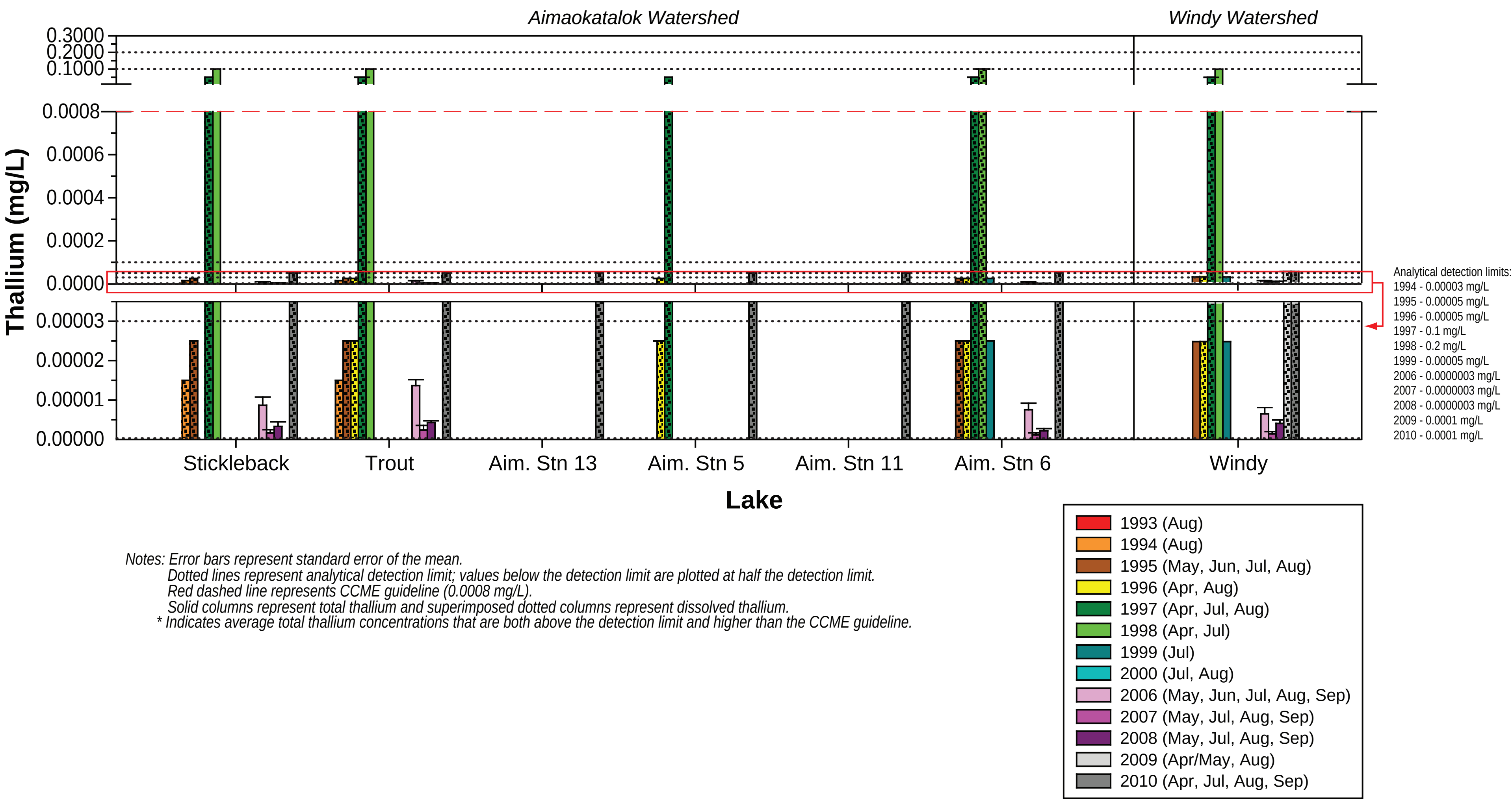


Notes: Error bars represent standard error of the mean.
Dotted lines represent analytical detection limit; values below the detection limit are plotted at half the detection limit.
Red dashed line represents CCME guideline (0.0008 mg/L).
Solid columns represent total thallium and superimposed dotted columns represent dissolved thallium.
** Indicates average total thallium concentrations that are both above the detection limit and higher than the CCME guideline.*

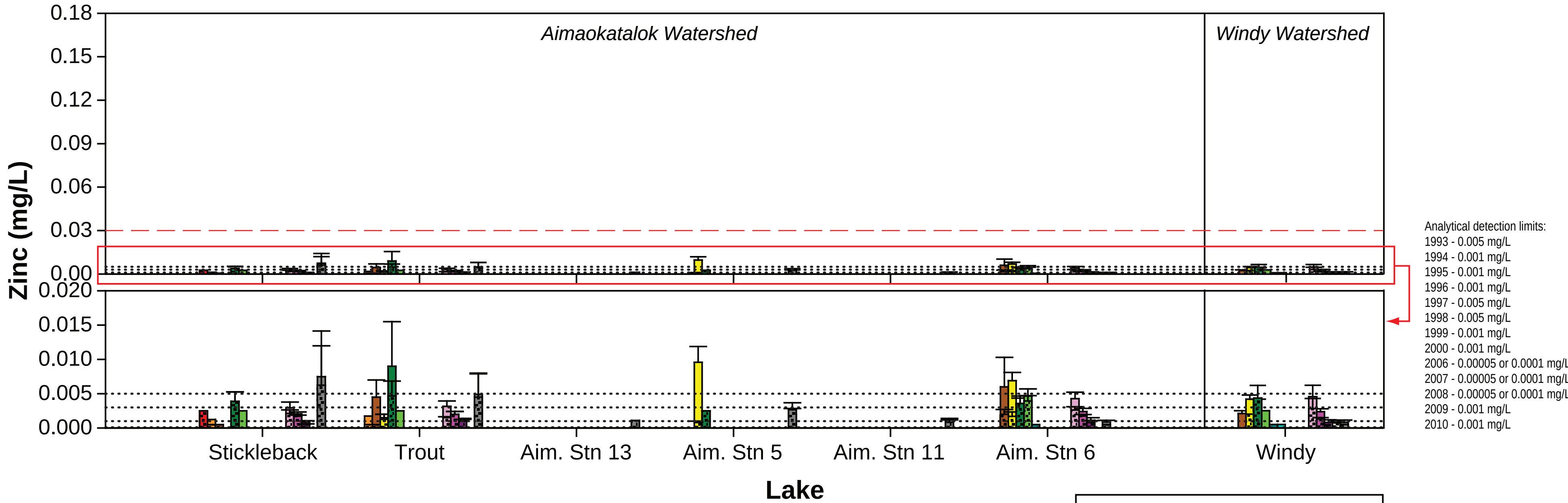
Figure 3.2-2x

NEWMONT NORTH AMERICA

Average Annual Thallium Concentration in Lakes, Hope Bay Belt Project, 1993-2010

Figure 3.2-2x

Rescan Engineers & Scientists



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.*

- 1993 (Aug)
- 1994 (Aug)
- 1995 (May, Jun, Jul, Aug)
- 1996 (Apr, Aug)
- 1997 (Apr, Jul, Aug)
- 1998 (Apr, Jul)
- 1999 (Jul)
- 2000 (Jul, Aug)
- 2006 (May, Jun, Jul, Aug, Sep)
- 2007 (May, Jul, Aug, Sep)
- 2008 (May, Jul, Aug, Sep)
- 2009 (Apr/May, Aug)
- 2010 (Apr, Jul, Aug, Sep)

Figure 3.2-2y

NEWMONT NORTH AMERICA

Average Annual Zinc Concentration in Lakes, Hope Bay Belt Project, 1993-2010

Figure 3.2-2y

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3.3 STREAM AND RIVER WATER QUALITY

Stream and river water quality samples were collected in April, June (freshet), August, and September of 2010 (Table 2.1-5). Historical data are also available for some streams and rivers in the study area (Figures 2.14-1a to 2.14-1c; Table 2.14-2). The 2010 raw water quality data for streams and rivers are provided in Appendix 3.3-1. All water quality data collected were compared to CCME guidelines for the protection of freshwater aquatic life (CCME 2007).

3.3.1 Seasonal Variation

During the winter, concentrations of many nutrients and metals are expected to be higher than in summer due to natural processes, including solute exclusion resulting from ice formation, and changes in redox chemistry and biological uptake. During the freshet in June, snow and ice melt flows into streams and rivers, allochthonous materials into downstream waterbodies, particularly if the elevated discharge flows through a highly erodible watershed (i.e., the presence of esker habitat). This could result in increased concentrations of suspended solids, metals, nutrients, and other materials. On the other hand, the increased volume can also result in the dilution of water quality parameters, thus reducing their concentrations.

Stream and river water quality data collected in 2010 are presented in Figures 3.3-1a to 3.3-1y. The only sites sampled successfully in winter (April) were two sites in the Koignuk River (Koig. R., Koig. U/S) and one site in Aimaokatalok Outflow (Aim. OF). The other stream sites were not sampled due to safety constraints (e.g., Ang. R. Ref.) or because they were frozen to the bottom (e.g., Aim. R. and Koig. D/S). There were few apparent differences between winter and summer samples. The Koignuk River under-ice samples and Aim. OF surface grab samples had higher hardness levels in winter than in summer (Figure 3.3-1b). TOC and nitrate concentrations were also relatively high during winter compared to summer levels (Figures 3.3-1f and 3.3-1g).

During the freshet in June, hardness, TDS, and sulphate levels were generally lower than in April, August, or September (Figures 3.3-1b, 3.3-1e, 3.3-1k). However, for most parameters, the seasonal patterns varied between sites with no clear trends.

3.3.2 Spatial Variation

All streams surveyed were similar in pH, with slightly acidic to slightly basic pH levels ranging from 6.2 at Stickleback OF in June to 8.1 at Aim. R. in August (Figure 3.3-1a). Turbidity was variable across sites, ranging from 0.25 NTU (AWRe in June) to 41 NTU (AWRa in June; Figure 3.3-1c). Turbidity tended to be higher in the Koignuk/Aimaokatalok Watershed than in the other watersheds (East, Aimaokatalok).

Total phosphorus concentrations were variable across stream sites, ranging from 0.003 mg/L at S6 in August and September to 0.060 mg/L at AWRa in June. Aim. NE IF, Koig D/S, and AWRa generally contained the highest total phosphorus concentrations, although concentrations were seasonally variable(Figure 3.3-1j). Maximum total phosphorus concentrations at these sites fell within the range expected for a eutrophic waterbody based on the CCME trigger ranges for total phosphorus (CCME 2004). Most sampled streams and rivers would be considered oligotrophic to meso-eutrophic. Stream S6 was the only site that would be categorized as ultra-oligotrophic. Total phosphorus tended to be higher in the East and Koignuk/Aimaokatalok watersheds than in Aimaokatalok Watershed.