# A comparison of design-based and model-based approaches for finite population spatial data – Supporting information.

Michael Dumelle[*,a], Matt Higham[b], Jay M. Ver Hoef[d], Anthony R. Olsen[a], Lisa Madsen[c]

[a]*United States Environmental Protection Agency, 200 SW 35th St, Corvallis, Oregon, 97333*
[b]*Saint Lawrence University Department of Mathematics, Computer Science, and Statistics, 23 Romoda Drive, Canton, New York, 13617*
[c]*Oregon State University Department of Statistics, 239 Weniger Hall, Corvallis, Oregon, 97331*
[d]*Marine Mammal Laboratory, Alaska Fisheries Science Center, National Oceanic and Atmospheric Administration, Seattle, Washington, 98115*

Recall the four sampling-analysis combinations from the simulated and real data: simple random sampling with design-based inference (SRS-DB), simple random sapling with model-based inference (SRS-MB), GRTS sampling with design-based inference (GRTS-DB), and GRTS sampling with model-based inference (GRTS-MB).

## 1. Simulated Data

For the simulated data, we considered 36 parameter configurations – the crossing of three sample sizes ($n = 50$, $n = 100$, $n = 200$), two location layouts (random and gridded), three proportions of dependent random error (DRE) (0%, 50%, 90%), and two response types (normal and skewed).

Next we present tables summarizing mean bias, RMSE, and interval coverage for all 36 simulation scenarios.

| Approach | Layout | Response | DRE% | n | MB | RMSE | Coverage |
|----------|--------|----------|------|-----|---------|--------|----------|
| SRS-DB | Gridded | Normal | 0% | 50 | -0.0112 | 0.1905 | 0.9490 |
| SRS-MB | Gridded | Normal | 0% | 50 | -0.0112 | 0.1930 | 0.9420 |
| GRTS-DB | Gridded | Normal | 0% | 50 | 0.0005 | 0.1914 | 0.9170 |
| GRTS-MB | Gridded | Normal | 0% | 50 | 0.0004 | 0.1922 | 0.9345 |

Table 1: Sampling-inference combination (Approach), population layout (Layout), response type (Response), proportion of dependent random error (DRE%), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in simulation scenario 1.

[*]Corresponding Author: Michael Dumelle (Dumelle.Michael@epa.gov)

| Approach | Layout | Response | DRE% | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|---|---|
| SRS-DB | Gridded | Skewed | 0% | 50 | -0.0048 | 0.1988 | 0.9110 |
| SRS-MB | Gridded | Skewed | 0% | 50 | -0.0110 | 0.2055 | 0.9045 |
| GRTS-DB | Gridded | Skewed | 0% | 50 | 0.0025 | 0.1947 | 0.8710 |
| GRTS-MB | Gridded | Skewed | 0% | 50 | 0.0004 | 0.1965 | 0.8955 |

Table 2: Sampling-inference combination (Approach), population layout (Layout), response type (Response), proportion of dependent random error (DRE%), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in simulation scenario 2.

| Approach | Layout | Response | DRE% | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|---|---|
| SRS-DB | Random | Normal | 0% | 50 | 0.0031 | 0.1940 | 0.9425 |
| SRS-MB | Random | Normal | 0% | 50 | 0.0045 | 0.1953 | 0.9395 |
| GRTS-DB | Random | Normal | 0% | 50 | -0.0004 | 0.1951 | 0.9065 |
| GRTS-MB | Random | Normal | 0% | 50 | -0.0002 | 0.1964 | 0.9295 |

Table 3: Sampling-inference combination (Approach), population layout (Layout), response type (Response), proportion of dependent random error (DRE%), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in simulation scenario 3.

| Approach | Layout | Response | DRE% | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|---|---|
| SRS-DB | Random | Skewed | 0% | 50 | 0.0000 | 0.1861 | 0.9225 |
| SRS-MB | Random | Skewed | 0% | 50 | -0.0059 | 0.1932 | 0.9130 |
| GRTS-DB | Random | Skewed | 0% | 50 | 0.0041 | 0.1910 | 0.8740 |
| GRTS-MB | Random | Skewed | 0% | 50 | 0.0016 | 0.1941 | 0.8985 |

Table 4: Sampling-inference combination (Approach), population layout (Layout), response type (Response), proportion of dependent random error (DRE%), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in simulation scenario 4.

| Approach | Layout | Response | DRE% | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|---|---|
| SRS-DB | Gridded | Normal | 50% | 50 | -0.0013 | 0.1775 | 0.9460 |
| SRS-MB | Gridded | Normal | 50% | 50 | -0.0007 | 0.1617 | 0.9355 |
| GRTS-DB | Gridded | Normal | 50% | 50 | -0.0030 | 0.1501 | 0.9205 |
| GRTS-MB | Gridded | Normal | 50% | 50 | -0.0031 | 0.1472 | 0.9400 |

Table 5: Sampling-inference combination (Approach), population layout (Layout), response type (Response), proportion of dependent random error (DRE%), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in simulation scenario 5.

| Approach | Layout | Response | DRE% | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|---|---|
| SRS-DB | Gridded | Skewed | 50% | 50 | -0.0047 | 0.1891 | 0.9100 |
| SRS-MB | Gridded | Skewed | 50% | 50 | -0.0083 | 0.1787 | 0.8990 |
| GRTS-DB | Gridded | Skewed | 50% | 50 | -0.0041 | 0.1610 | 0.8995 |
| GRTS-MB | Gridded | Skewed | 50% | 50 | -0.0060 | 0.1605 | 0.9085 |

Table 6: Sampling-inference combination (Approach), population layout (Layout), response type (Response), proportion of dependent random error (DRE%), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in simulation scenario 6.

| Approach | Layout | Response | DRE% | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|---|---|
| SRS-DB | Random | Normal | 50% | 50 | 0.0061 | 0.1744 | 0.9445 |
| SRS-MB | Random | Normal | 50% | 50 | 0.0042 | 0.1615 | 0.9350 |
| GRTS-DB | Random | Normal | 50% | 50 | -0.0092 | 0.1513 | 0.9165 |
| GRTS-MB | Random | Normal | 50% | 50 | -0.0097 | 0.1507 | 0.9315 |

Table 7: Sampling-inference combination (Approach), population layout (Layout), response type (Response), proportion of dependent random error (DRE%), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in simulation scenario 7.

| Approach | Layout | Response | DRE% | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|---|---|
| SRS-DB | Random | Skewed | 50% | 50 | 0.0014 | 0.1804 | 0.9195 |
| SRS-MB | Random | Skewed | 50% | 50 | -0.0051 | 0.1808 | 0.9065 |
| GRTS-DB | Random | Skewed | 50% | 50 | 0.0021 | 0.1618 | 0.8880 |
| GRTS-MB | Random | Skewed | 50% | 50 | -0.0021 | 0.1624 | 0.9000 |

Table 8: Sampling-inference combination (Approach), population layout (Layout), response type (Response), proportion of dependent random error (DRE%), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in simulation scenario 8.

| Approach | Layout | Response | DRE% | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|---|---|
| SRS-DB | Gridded | Normal | 90% | 50 | 0.0055 | 0.1621 | 0.9355 |
| SRS-MB | Gridded | Normal | 90% | 50 | 0.0044 | 0.1137 | 0.9435 |
| GRTS-DB | Gridded | Normal | 90% | 50 | -0.0021 | 0.1072 | 0.9280 |
| GRTS-MB | Gridded | Normal | 90% | 50 | -0.0037 | 0.0960 | 0.9400 |

Table 9: Sampling-inference combination (Approach), population layout (Layout), response type (Response), proportion of dependent random error (DRE%), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in simulation scenario 9.

| Approach | Layout | Response | DRE% | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|---|---|
| SRS-DB | Gridded | Skewed | 90% | 50 | 0.0007 | 0.1546 | 0.9345 |
| SRS-MB | Gridded | Skewed | 90% | 50 | -0.0011 | 0.1217 | 0.9130 |
| GRTS-DB | Gridded | Skewed | 90% | 50 | -0.0017 | 0.1129 | 0.9180 |
| GRTS-MB | Gridded | Skewed | 90% | 50 | -0.0039 | 0.1039 | 0.9205 |

Table 10: Sampling-inference combination (Approach), population layout (Layout), response type (Response), proportion of dependent random error (DRE%), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in simulation scenario 10.

| Approach | Layout | Response | DRE% | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|---|---|
| SRS-DB | Random | Normal | 90% | 50 | 0.0058 | 0.1575 | 0.9470 |
| SRS-MB | Random | Normal | 90% | 50 | 0.0045 | 0.1093 | 0.9445 |
| GRTS-DB | Random | Normal | 90% | 50 | -0.0017 | 0.1054 | 0.9295 |
| GRTS-MB | Random | Normal | 90% | 50 | -0.0011 | 0.0940 | 0.9410 |

Table 11: Sampling-inference combination (Approach), population layout (Layout), response type (Response), proportion of dependent random error (DRE%), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in simulation scenario 11.

| Approach | Layout | Response | DRE% | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|---|---|
| SRS-DB | Random | Skewed | 90% | 50 | -0.0022 | 0.1772 | 0.9305 |
| SRS-MB | Random | Skewed | 90% | 50 | -0.0046 | 0.1301 | 0.9180 |
| GRTS-DB | Random | Skewed | 90% | 50 | -0.0026 | 0.1250 | 0.9175 |
| GRTS-MB | Random | Skewed | 90% | 50 | -0.0026 | 0.1127 | 0.9225 |

Table 12: Sampling-inference combination (Approach), population layout (Layout), response type (Response), proportion of dependent random error (DRE%), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in simulation scenario 12.

| Approach | Layout | Response | DRE% | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|---|---|
| SRS-DB | Gridded | Normal | 0% | 100 | -0.0028 | 0.1352 | 0.9475 |
| SRS-MB | Gridded | Normal | 0% | 100 | -0.0026 | 0.1362 | 0.9405 |
| GRTS-DB | Gridded | Normal | 0% | 100 | -0.0011 | 0.1345 | 0.9210 |
| GRTS-MB | Gridded | Normal | 0% | 100 | -0.0010 | 0.1352 | 0.9445 |

Table 13: Sampling-inference combination (Approach), population layout (Layout), response type (Response), proportion of dependent random error (DRE%), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in simulation scenario 13.

| Approach | Layout | Response | DRE% | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|---|---|
| SRS-DB | Gridded | Skewed | 0% | 100 | -0.0001 | 0.1384 | 0.9210 |
| SRS-MB | Gridded | Skewed | 0% | 100 | -0.0024 | 0.1412 | 0.9150 |
| GRTS-DB | Gridded | Skewed | 0% | 100 | 0.0082 | 0.1304 | 0.8945 |
| GRTS-MB | Gridded | Skewed | 0% | 100 | 0.0077 | 0.1307 | 0.9155 |

Table 14: Sampling-inference combination (Approach), population layout (Layout), response type (Response), proportion of dependent random error (DRE%), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in simulation scenario 14.

| Approach | Layout | Response | DRE% | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|---|---|
| SRS-DB | Random | Normal | 0% | 100 | -0.0004 | 0.1339 | 0.9450 |
| SRS-MB | Random | Normal | 0% | 100 | -0.0007 | 0.1344 | 0.9435 |
| GRTS-DB | Random | Normal | 0% | 100 | 0.0021 | 0.1315 | 0.9280 |
| GRTS-MB | Random | Normal | 0% | 100 | 0.0019 | 0.1318 | 0.9460 |

Table 15: Sampling-inference combination (Approach), population layout (Layout), response type (Response), proportion of dependent random error (DRE%), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in simulation scenario 15.

| Approach | Layout | Response | DRE% | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|---|---|
| SRS-DB | Random | Skewed | 0% | 100 | 0.0021 | 0.1322 | 0.9280 |
| SRS-MB | Random | Skewed | 0% | 100 | 0.0005 | 0.1342 | 0.9280 |
| GRTS-DB | Random | Skewed | 0% | 100 | 0.0043 | 0.1311 | 0.8990 |
| GRTS-MB | Random | Skewed | 0% | 100 | 0.0039 | 0.1315 | 0.9230 |

Table 16: Sampling-inference combination (Approach), population layout (Layout), response type (Response), proportion of dependent random error (DRE%), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in simulation scenario 16.

| Approach | Layout | Response | DRE% | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|---|---|
| SRS-DB | Gridded | Normal | 50% | 100 | -0.0025 | 0.1207 | 0.9420 |
| SRS-MB | Gridded | Normal | 50% | 100 | -0.0007 | 0.1058 | 0.9425 |
| GRTS-DB | Gridded | Normal | 50% | 100 | 0.0000 | 0.1003 | 0.9300 |
| GRTS-MB | Gridded | Normal | 50% | 100 | -0.0003 | 0.0993 | 0.9435 |

Table 17: Sampling-inference combination (Approach), population layout (Layout), response type (Response), proportion of dependent random error (DRE%), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in simulation scenario 17.

| Approach | Layout | Response | DRE% | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|---|---|
| SRS-DB | Gridded | Skewed | 50% | 100 | 0.0023 | 0.1221 | 0.9315 |
| SRS-MB | Gridded | Skewed | 50% | 100 | 0.0002 | 0.1135 | 0.9160 |
| GRTS-DB | Gridded | Skewed | 50% | 100 | 0.0000 | 0.1113 | 0.9025 |
| GRTS-MB | Gridded | Skewed | 50% | 100 | -0.0019 | 0.1127 | 0.9175 |

Table 18: Sampling-inference combination (Approach), population layout (Layout), response type (Response), proportion of dependent random error (DRE%), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in simulation scenario 18.

| Approach | Layout | Response | DRE% | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|---|---|
| SRS-DB | Random | Normal | 50% | 100 | -0.0016 | 0.1214 | 0.9440 |
| SRS-MB | Random | Normal | 50% | 100 | -0.0001 | 0.1079 | 0.9440 |
| GRTS-DB | Random | Normal | 50% | 100 | -0.0012 | 0.1012 | 0.9235 |
| GRTS-MB | Random | Normal | 50% | 100 | -0.0010 | 0.0997 | 0.9380 |

Table 19: Sampling-inference combination (Approach), population layout (Layout), response type (Response), proportion of dependent random error (DRE%), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in simulation scenario 19.

| Approach | Layout | Response | DRE% | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|---|---|
| SRS-DB | Random | Skewed | 50% | 100 | 0.0020 | 0.1188 | 0.9395 |
| SRS-MB | Random | Skewed | 50% | 100 | -0.0020 | 0.1097 | 0.9290 |
| GRTS-DB | Random | Skewed | 50% | 100 | 0.0013 | 0.1104 | 0.9090 |
| GRTS-MB | Random | Skewed | 50% | 100 | -0.0002 | 0.1105 | 0.9235 |

Table 20: Sampling-inference combination (Approach), population layout (Layout), response type (Response), proportion of dependent random error (DRE%), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in simulation scenario 20.

| Approach | Layout | Response | DRE% | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|---|---|
| SRS-DB | Gridded | Normal | 90% | 100 | -0.0027 | 0.1083 | 0.9460 |
| SRS-MB | Gridded | Normal | 90% | 100 | -0.0003 | 0.0701 | 0.9440 |
| GRTS-DB | Gridded | Normal | 90% | 100 | -0.0013 | 0.0670 | 0.9325 |
| GRTS-MB | Gridded | Normal | 90% | 100 | -0.0013 | 0.0602 | 0.9425 |

Table 21: Sampling-inference combination (Approach), population layout (Layout), response type (Response), proportion of dependent random error (DRE%), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in simulation scenario 21.

| Approach | Layout | Response | DRE% | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|---|---|
| SRS-DB | Gridded | Skewed | 90% | 100 | -0.0015 | 0.1108 | 0.9345 |
| SRS-MB | Gridded | Skewed | 90% | 100 | -0.0038 | 0.0767 | 0.9265 |
| GRTS-DB | Gridded | Skewed | 90% | 100 | 0.0018 | 0.0746 | 0.9270 |
| GRTS-MB | Gridded | Skewed | 90% | 100 | 0.0004 | 0.0695 | 0.9280 |

Table 22: Sampling-inference combination (Approach), population layout (Layout), response type (Response), proportion of dependent random error (DRE%), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in simulation scenario 22.

| Approach | Layout | Response | DRE% | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|---|---|
| SRS-DB | Random | Normal | 90% | 100 | 0.0002 | 0.1071 | 0.9490 |
| SRS-MB | Random | Normal | 90% | 100 | 0.0011 | 0.0675 | 0.9475 |
| GRTS-DB | Random | Normal | 90% | 100 | 0.0009 | 0.0651 | 0.9430 |
| GRTS-MB | Random | Normal | 90% | 100 | -0.0007 | 0.0570 | 0.9480 |

Table 23: Sampling-inference combination (Approach), population layout (Layout), response type (Response), proportion of dependent random error (DRE%), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in simulation scenario 23.

| Approach | Layout | Response | DRE% | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|---|---|
| SRS-DB | Random | Skewed | 90% | 100 | -0.0019 | 0.1165 | 0.9325 |
| SRS-MB | Random | Skewed | 90% | 100 | -0.0031 | 0.0757 | 0.9315 |
| GRTS-DB | Random | Skewed | 90% | 100 | 0.0026 | 0.0751 | 0.9225 |
| GRTS-MB | Random | Skewed | 90% | 100 | 0.0023 | 0.0671 | 0.9230 |

Table 24: Sampling-inference combination (Approach), population layout (Layout), response type (Response), proportion of dependent random error (DRE%), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in simulation scenario 24.

| Approach | Layout | Response | DRE% | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|---|---|
| SRS-DB | Gridded | Normal | 0% | 200 | 0.0005 | 0.0891 | 0.9465 |
| SRS-MB | Gridded | Normal | 0% | 200 | 0.0003 | 0.0894 | 0.9440 |
| GRTS-DB | Gridded | Normal | 0% | 200 | 0.0032 | 0.0842 | 0.9520 |
| GRTS-MB | Gridded | Normal | 0% | 200 | 0.0032 | 0.0843 | 0.9610 |

Table 25: Sampling-inference combination (Approach), population layout (Layout), response type (Response), proportion of dependent random error (DRE%), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in simulation scenario 25.

| Approach | Layout | Response | DRE% | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|---|---|
| SRS-DB | Gridded | Skewed | 0% | 200 | -0.0018 | 0.0894 | 0.9440 |
| SRS-MB | Gridded | Skewed | 0% | 200 | -0.0023 | 0.0895 | 0.9445 |
| GRTS-DB | Gridded | Skewed | 0% | 200 | 0.0006 | 0.0891 | 0.9360 |
| GRTS-MB | Gridded | Skewed | 0% | 200 | 0.0005 | 0.0892 | 0.9405 |

Table 26: Sampling-inference combination (Approach), population layout (Layout), response type (Response), proportion of dependent random error (DRE%), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in simulation scenario 26.

| Approach | Layout | Response | DRE% | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|---|---|
| SRS-DB | Random | Normal | 0% | 200 | 0.0019 | 0.0905 | 0.9385 |
| SRS-MB | Random | Normal | 0% | 200 | 0.0017 | 0.0907 | 0.9375 |
| GRTS-DB | Random | Normal | 0% | 200 | 0.0008 | 0.0881 | 0.9400 |
| GRTS-MB | Random | Normal | 0% | 200 | 0.0009 | 0.0882 | 0.9480 |

Table 27: Sampling-inference combination (Approach), population layout (Layout), response type (Response), proportion of dependent random error (DRE%), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in simulation scenario 27.

| Approach | Layout | Response | DRE% | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|---|---|
| SRS-DB | Random | Skewed | 0% | 200 | 0.0007 | 0.0867 | 0.9400 |
| SRS-MB | Random | Skewed | 0% | 200 | 0.0005 | 0.0869 | 0.9390 |
| GRTS-DB | Random | Skewed | 0% | 200 | -0.0011 | 0.0873 | 0.9345 |
| GRTS-MB | Random | Skewed | 0% | 200 | -0.0011 | 0.0873 | 0.9395 |

Table 28: Sampling-inference combination (Approach), population layout (Layout), response type (Response), proportion of dependent random error (DRE%), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in simulation scenario 28.

| Approach | Layout | Response | DRE% | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|---|---|
| SRS-DB | Gridded | Normal | 50% | 200 | -0.0016 | 0.0777 | 0.9520 |
| SRS-MB | Gridded | Normal | 50% | 200 | -0.0004 | 0.0678 | 0.9510 |
| GRTS-DB | Gridded | Normal | 50% | 200 | 0.0036 | 0.0688 | 0.9330 |
| GRTS-MB | Gridded | Normal | 50% | 200 | 0.0039 | 0.0679 | 0.9375 |

Table 29: Sampling-inference combination (Approach), population layout (Layout), response type (Response), proportion of dependent random error (DRE%), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in simulation scenario 29.

| Approach | Layout | Response | DRE% | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|---|---|
| SRS-DB | Gridded | Skewed | 50% | 200 | 0.0013 | 0.0816 | 0.9400 |
| SRS-MB | Gridded | Skewed | 50% | 200 | 0.0016 | 0.0747 | 0.9400 |
| GRTS-DB | Gridded | Skewed | 50% | 200 | 0.0019 | 0.0698 | 0.9325 |
| GRTS-MB | Gridded | Skewed | 50% | 200 | 0.0018 | 0.0691 | 0.9360 |

Table 30: Sampling-inference combination (Approach), population layout (Layout), response type (Response), proportion of dependent random error (DRE%), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in simulation scenario 30.

| Approach | Layout | Response | DRE% | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|---|---|
| SRS-DB | Random | Normal | 50% | 200 | 0.0008 | 0.0816 | 0.9389 |
| SRS-MB | Random | Normal | 50% | 200 | 0.0005 | 0.0713 | 0.9444 |
| GRTS-DB | Random | Normal | 50% | 200 | 0.0005 | 0.0655 | 0.9474 |
| GRTS-MB | Random | Normal | 50% | 200 | 0.0009 | 0.0643 | 0.9510 |

Table 31: Sampling-inference combination (Approach), population layout (Layout), response type (Response), proportion of dependent random error (DRE%), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in simulation scenario 31.

| Approach | Layout | Response | DRE% | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|---|---|
| SRS-DB | Random | Skewed | 50% | 200 | -0.0041 | 0.0789 | 0.9510 |
| SRS-MB | Random | Skewed | 50% | 200 | -0.0048 | 0.0729 | 0.9350 |
| GRTS-DB | Random | Skewed | 50% | 200 | -0.0001 | 0.0680 | 0.9400 |
| GRTS-MB | Random | Skewed | 50% | 200 | -0.0007 | 0.0679 | 0.9385 |

Table 32: Sampling-inference combination (Approach), population layout (Layout), response type (Response), proportion of dependent random error (DRE%), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in simulation scenario 32.

| Approach | Layout | Response | DRE% | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|---|---|
| SRS-DB | Gridded | Normal | 90% | 200 | -0.0011 | 0.0730 | 0.9450 |
| SRS-MB | Gridded | Normal | 90% | 200 | -0.0008 | 0.0418 | 0.9445 |
| GRTS-DB | Gridded | Normal | 90% | 200 | -0.0010 | 0.0418 | 0.9455 |
| GRTS-MB | Gridded | Normal | 90% | 200 | -0.0008 | 0.0376 | 0.9475 |

Table 33: Sampling-inference combination (Approach), population layout (Layout), response type (Response), proportion of dependent random error (DRE%), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in simulation scenario 33.

| Approach | Layout | Response | DRE% | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|---|---|
| SRS-DB | Gridded | Skewed | 90% | 200 | 0.0038 | 0.0768 | 0.9430 |
| SRS-MB | Gridded | Skewed | 90% | 200 | -0.0007 | 0.0475 | 0.9365 |
| GRTS-DB | Gridded | Skewed | 90% | 200 | 0.0018 | 0.0482 | 0.9370 |
| GRTS-MB | Gridded | Skewed | 90% | 200 | 0.0010 | 0.0423 | 0.9375 |

Table 34: Sampling-inference combination (Approach), population layout (Layout), response type (Response), proportion of dependent random error (DRE%), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in simulation scenario 34.

| Approach | Layout | Response | DRE% | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|---|---|
| SRS-DB | Random | Normal | 90% | 200 | 0.0026 | 0.0713 | 0.9495 |
| SRS-MB | Random | Normal | 90% | 200 | 0.0011 | 0.0408 | 0.9480 |
| GRTS-DB | Random | Normal | 90% | 200 | 0.0016 | 0.0418 | 0.9450 |
| GRTS-MB | Random | Normal | 90% | 200 | 0.0014 | 0.0368 | 0.9475 |

Table 35: Sampling-inference combination (Approach), population layout (Layout), response type (Response), proportion of dependent random error (DRE%), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in simulation scenario 35.

| Approach | Layout | Response | DRE% | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|---|---|
| SRS-DB | Random | Skewed | 90% | 200 | 0.0028 | 0.0708 | 0.9504 |
| SRS-MB | Random | Skewed | 90% | 200 | 0.0011 | 0.0437 | 0.9414 |
| GRTS-DB | Random | Skewed | 90% | 200 | -0.0008 | 0.0431 | 0.9504 |
| GRTS-MB | Random | Skewed | 90% | 200 | -0.0001 | 0.0396 | 0.9419 |

Table 36: Sampling-inference combination (Approach), population layout (Layout), response type (Response), proportion of dependent random error (DRE%), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in simulation scenario 36.

**2. National Lakes Assessment Data**

Next we present tables summarizing mean bias, RMSE, and interval coverage
for all six data scenarios.

| Approach | Response | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|
| SRS-DB | Hg ppb | 50 | 0.2539 | 12.9467 | 0.9215 |
| SRS-MB | Hg ppb | 50 | 0.0573 | 11.3760 | 0.9020 |
| GRTS-DB | Hg ppb | 50 | -0.1880 | 10.5558 | 0.8970 |
| GRTS-MB | Hg ppb | 50 | -0.5604 | 10.4434 | 0.9070 |

Table 37: Sampling-inference combination (Approach), response type (Response), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in a data application scenario 1.

| Approach | Response | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|
| SRS-DB | ZMMI | 50 | 0.0461 | 2.4502 | 0.9440 |
| SRS-MB | ZMMI | 50 | 0.0000 | 2.1477 | 0.9395 |
| GRTS-DB | ZMMI | 50 | -0.0047 | 1.9953 | 0.9210 |
| GRTS-MB | ZMMI | 50 | -0.1191 | 1.9608 | 0.9355 |

Table 38: Sampling-inference combination (Approach), response type (Response), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in a data application scenario 2.

| Approach | Response | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|
| SRS-DB | Hg ppb | 100 | -0.1390 | 8.9667 | 0.9290 |
| SRS-MB | Hg ppb | 100 | -0.4213 | 7.4820 | 0.9190 |
| GRTS-DB | Hg ppb | 100 | 0.0075 | 7.1415 | 0.9045 |
| GRTS-MB | Hg ppb | 100 | -0.4156 | 7.0344 | 0.9230 |

Table 39: Sampling-inference combination (Approach), response type (Response), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in a data application scenario 3.

| Approach | Response | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|
| SRS-DB | ZMMI | 100 | -0.0541 | 1.6901 | 0.9460 |
| SRS-MB | ZMMI | 100 | -0.0942 | 1.3920 | 0.9445 |
| GRTS-DB | ZMMI | 100 | -0.0066 | 1.3219 | 0.9205 |
| GRTS-MB | ZMMI | 100 | -0.0968 | 1.2958 | 0.9450 |

Table 40: Sampling-inference combination (Approach), response type (Response), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in a data application scenario 4.

| Approach | Response | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|
| SRS-DB | Hg ppb | 200 | -0.0876 | 5.9176 | 0.9450 |
| SRS-MB | Hg ppb | 200 | -0.1775 | 4.6970 | 0.9400 |
| GRTS-DB | Hg ppb | 200 | -0.0538 | 4.5051 | 0.9325 |
| GRTS-MB | Hg ppb | 200 | -0.2762 | 4.3998 | 0.9410 |

Table 41: Sampling-inference combination (Approach), response type (Response), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in a data application scenario 5.

| Approach | Response | n | MB | RMSE | Coverage |
|---|---|---|---|---|---|
| SRS-DB | ZMMI | 200 | -0.0093 | 1.1311 | 0.9455 |
| SRS-MB | ZMMI | 200 | -0.0736 | 0.9090 | 0.9450 |
| GRTS-DB | ZMMI | 200 | 0.0193 | 0.8524 | 0.9460 |
| GRTS-MB | ZMMI | 200 | -0.0311 | 0.8280 | 0.9450 |

Table 42: Sampling-inference combination (Approach), response type (Response), sample size (n), mean bias (MB), root-mean-squared error (RMSE), and 95% interval coverage (Coverage) in a data application scenario 6.