**Appendix S3**

Table S3-1 Calculated absolute and relative metrics for each tree species including frequency, density, and basal area.

|  |  |  |  |
| --- | --- | --- | --- |
| **Metric** | **Formula** | **Measures** | **Interpretation** |
| Absolute frequency (%) |  | How widespread the species is | How often does this species appear in the plots? |
| Relative Frequency (%) |  | How frequent the species is compared to all species | What proportion of all species occurrences belong to this species? |
| Density (stems / ha) |  | Tree abundance per hectare | How many trees of this species exist per hectare? |
| Relative Density (%) |  | Tree dominance compared to all species | What proportion of all trees belong to this species? |
| Basal Area (m2 / ha) |  | Tree cross sectional area per hectare | How much ground area does this species occupy per hectare? |
| Relative Basal Area (%) |  | Species contribution to total basal area | What proportion of total forest area is occupied by this species? |
| **Relative importance (%)** |  | Overall species dominance | How dominant is this species when considering frequency, abundance, and basal area together? |

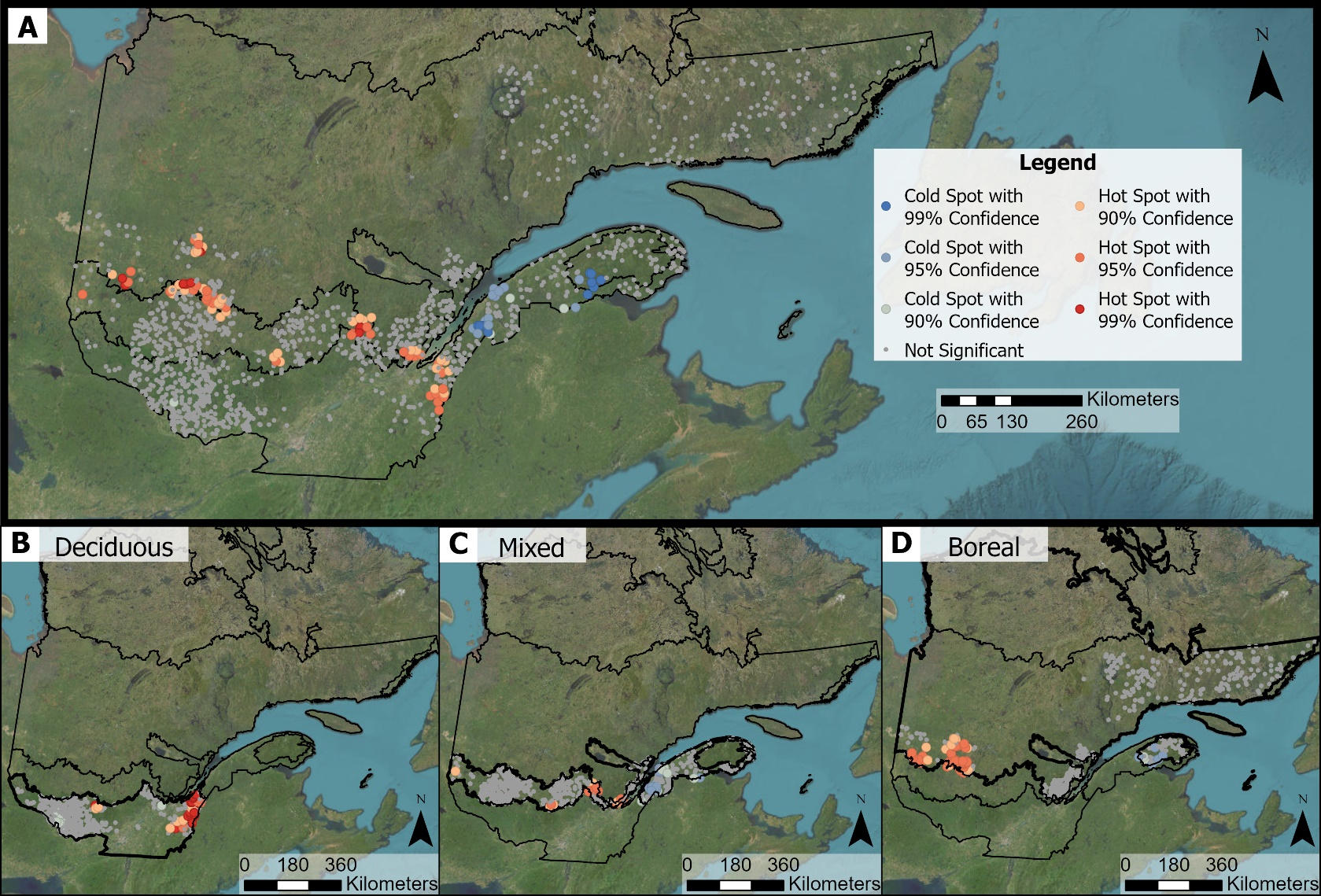


Figure S3-1 Hotspot analysis of changes in conifer percentage based on basal area (CBAP) between time period 1 (1985-1995) and time period 2 (2000-2010) across Quebec’s forest regions. (A) Displays hotspots (red) and coldspots (blue) for all regions combined, while (B) Deciduous, (C) Mixed, and (D) Boreal show results for each forest type separately. Hotspots indicate areas where conifer percentage significantly increased, while coldspots represent areas with a significant decline. Statistical confidence levels are represented by color intensity, with darker shades indicating higher confidence (99%). Non-significant areas are shown in gray.

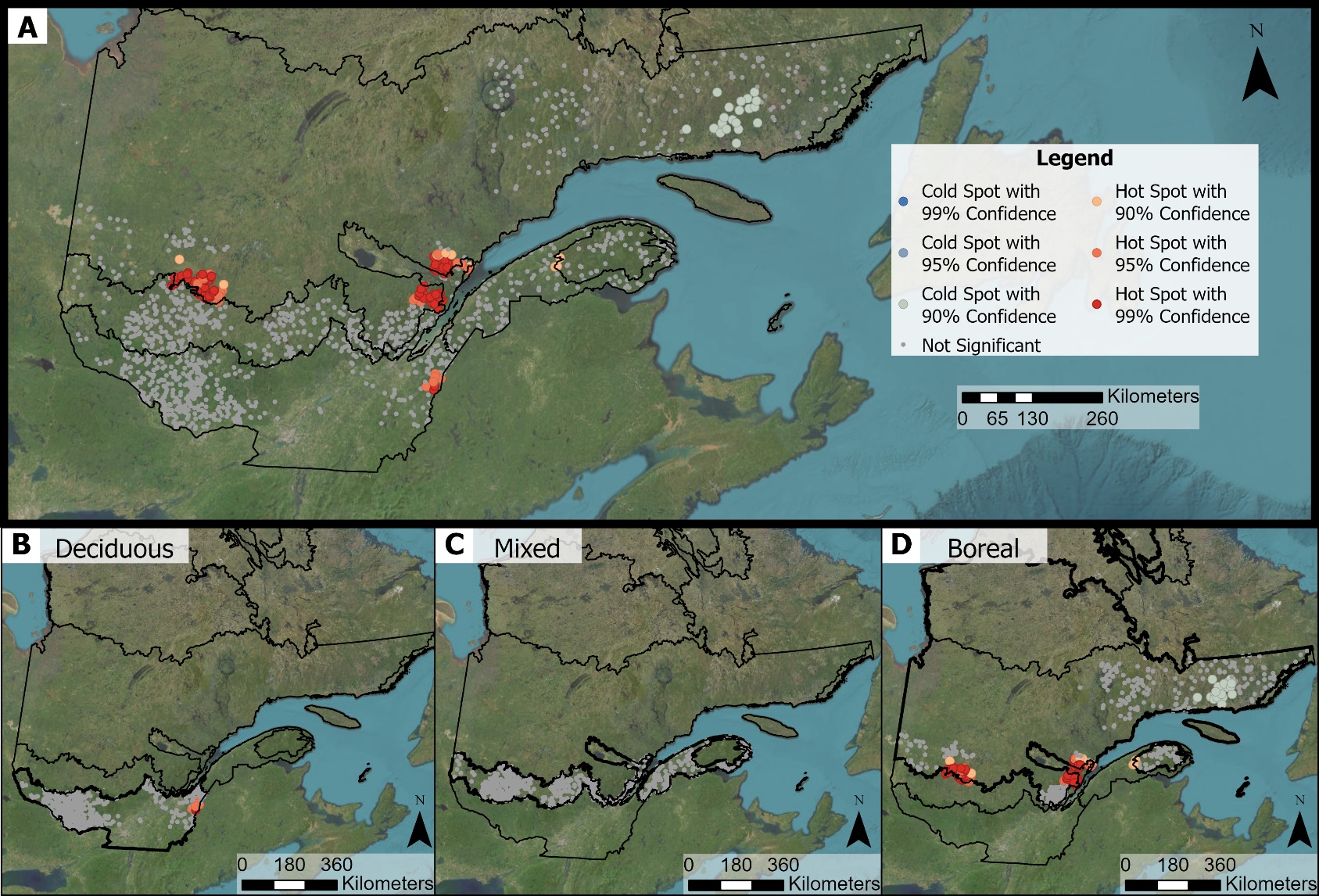


Figure S3-2 Hotspot analysis of changes in conifer percentage based on basal area (CBAP) between time period 2 (2000-2010) and time period 3 (2011-2021) across Quebec’s forest regions. (A) Displays hotspots (red) and coldspots (blue) for all regions combined, while (B) Deciduous, (C) Mixed, and (D) Boreal show results for each forest type separately. Hotspots indicate areas where conifer percentage significantly increased, while coldspots represent areas with a significant decline. Statistical confidence levels are represented by color intensity, with darker shades indicating higher confidence (99%). Non-significant areas are shown in gray.

Table S3-2 Common and scientific names for each tree species found in the study area

|  |  |
| --- | --- |
| **Common name** | **Scientific name** |
| American beech | *Fagus grandifolia* |
| American elm | *Ulmus americana* |
| American hornbeam | *Carpinus caroliniana* |
| American mountain ash | *Sorbus americana* |
| Balsam fir | *Abies balsamea* |
| Balsam poplar | *Populus balsamifera* |
| Basswood | *Tilia americana* |
| Black ash | *Fraxinus nigra* |
| Black cherry | *Prunus serotina* |
| Black maple | *Acer nigrum* |
| Black spruce | *Picea mariana* |
| Bur oak | *Quercus macrocarpa* |
| Butternut | *Juglans cinerea* |
| Eastern cottonwood | *Populus deltoides* |
| Eastern hemlock | *Tsuga canadensis* |
| Eastern white pine | *Pinus strobus* |
| Eastern white-cedar | *Thuja occidentalis* |
| Green ash | *Fraxinus pennsylvanica* |
| Grey alder | *Alnus incana* |
| Grey birch | *Betula populifolia* |
| Hophornbeam | *Ostrya virginiana* |
| Jack pine | *Pinus banksiana* |
| Largetooth aspen | *Populus grandidentata* |
| Mountain maple | *Acer spicatum* |
| Northern red oak | *Quercus rubra* |
| Norway spruce | *Picea abies* |
| Paper birch | *Betula papyrifera* |
| Pin cherry | *Prunus pensylvanica* |
| Red maple | *Acer rubrum* |
| Red pine | *Pinus resinosa* |
| Red spruce | *Picea rubens* |
| Rock elm | *Ulmus thomasii* |
| Serviceberry | *Amelanchier* |
| Showy mountain ash | *Sorbus decora* |
| Silver maple | *Acer saccharinum* |
| Striped maple | *Acer pensylvanicum* |
| Sugar maple | *Acer saccharum* |
| Swamp white oak | *Quercus bicolor* |
| Tamarack | *Larix laricina* |
| Trembling aspen | *Populus tremuloides* |
| White ash | *Fraxinus americana* |
| White oak | *Quercus alba* |
| White spruce | *Picea glauca* |
| Yellow birch | *Betula alleghaniensis* |

**A black and white grid with lines

AI-generated content may be incorrect.**

Figure S3-3 Frequency, density, basal area, and relative importance (calculated as the average of relative frequency, relative density, and relative basal area) of tree species with DBH > 9 cm across all study regions (deciduous, mixed, and boreal), along with changes in these metrics between time period 1 (1985–1995) and time period 3 (2011–2021). Adapted from Duchesne & Ouimet (2008).

**A black and white grid with lines

AI-generated content may be incorrect.**

Figure S3-4 Frequency, density, basal area, and relative importance (calculated as the average of relative frequency, relative density, and relative basal area) of tree species with DBH > 9 cm in the deciduous forest region, along with changes in these metrics between time period 1 (1985–1995) and time period 3 (2011–2021). Adapted from Duchesne & Ouimet (2008).

**A black and white grid with lines

AI-generated content may be incorrect.**

Figure S3-5 Frequency, density, basal area, and relative importance (calculated as the average of relative frequency, relative density, and relative basal area) of tree species with DBH > 9 cm in the mixed forest region, along with changes in these metrics between time period 1 (1985–1995) and time period 3 (2011–2021). Adapted from Duchesne & Ouimet (2008).

**A black and white grid with lines

AI-generated content may be incorrect.**

Figure S3-6 Frequency, density, basal area, and relative importance (calculated as the average of relative frequency, relative density, and relative basal area) of tree species with DBH > 9 cm in the boreal forest region, along with changes in these metrics between time period 1 (1985–1995) and time period 3 (2011–2021). Adapted from Duchesne & Ouimet (2008).

**A graph with different colored bars

AI-generated content may be incorrect.**

Figure S3-7 Change in relative importance of each tree species within the forest inventory plots covering the deciduous forest region from time period one (1985-1995) to time period three (2011-2021). Relative importance is calculated using relative frequency, relative density, and relative basal area.

**A graph with different colored bars

AI-generated content may be incorrect.**

Figure S3-8 Change in relative importance of each tree species within the forest inventory plots covering the mixed forest region from time period one (1985-1995) to time period three (2011-2021). Relative importance is calculated using relative frequency, relative density, and relative basal area.

**A graph with different colored bars

AI-generated content may be incorrect.**

Figure S3-9 Change in relative importance of each tree species within the forest inventory plots covering the boreal forest region from time period one (1985-1995) to time period three (2011-2021). Relative importance is calculated using relative frequency, relative density, and relative basal area.

Table S3-3 Predictors used in Cubist models by time period and input set, without applying recursive feature elimination

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Model ID** | **Time Period** | **Predictor Set** | **Number of Predictors** | **Number of Predictors Used** | **Variables used in the model** |
| M1 | 1992 & 1993 | Bands only | 24 | 13 | NIR\_SUMMER, BLUE\_SUMMER, RED\_START, SWIR1\_START, SWIR1\_SUMMER, RED\_FALL, RED\_WINTER, SWIR1\_FALL, GREEN\_SUMMER, SWIR2\_FALL, BLUE\_START, SWIR2\_START |
| M2 | 1992 & 1993 | Indices only | 24 | 8 | SD\_SWIR\_SUMMER, CV\_WINTER, NDVI\_WINTER, SR\_WINTER, VARI\_START, LSWI\_SUMMER, SD\_SWIR\_FALL, SR\_FALL |
| M3 | 1992 & 1993 | Bands + Indices | 48 | 17 | SD\_SWIR\_SUMMER, SWIR2\_SUMMER, BLUE\_SUMMER, RED\_START, NIR\_START, SWIR1\_SUMMER, RED\_WINTER, CV\_WINTER, NDVI\_START, SR\_START, SR\_FALL, SR\_WINTER, VARI\_SRART, VARI\_FALL, LSWI\_START, NDVI\_FALL, VARI\_WINTER |
| M10 | 2016 & 2017 | Bands only | 24 | 7 | GREEN\_SUMMER, NIR\_SUMMER, SWIR1\_SUMMER, SWIR2\_SUMMER, GREEN\_FALL, NIR\_FALL, NIR\_WINTER |
| M11 | 2016 & 2017 | Indices only | 24 | 10 | SD\_SWIR\_SUMMER, CV\_SUMMER, NDVI\_SUMMER, NDVI\_FALL, NDVI\_WINTER, SR\_SUMMER, VARI\_SUMMER, LSWI\_WINTER, VARI\_START, LSWI\_SUMMER |
| M12 | 2016 & 2017 | Bands + Indices | 48 | 13 | NIR\_SUMMER, SWIR1\_START, SWIR2\_START, GREEN\_SUMMER, RED\_SUMMER, GREEN\_FALL, SWIR1\_FALL, RED\_WINTER, CV\_FALL, NDVI\_FALL, SWIR2\_FALL, SD\_SWIR\_START, SD\_SWIR\_SUMMER |
| M19 | Combined | Bands only | 25 | 13 | NIR\_SUMMER, BLUE\_START, GREEN\_START, SWIR2\_START, GREEN\_SUMMER, SWIR1\_SUMMER, SWIR2\_SUMMER, GREEN\_WINTER, NIR\_WINTER, SWIR1\_WINTER, SWIR1\_START, RED\_START, BLUE\_SUMMER |
| M20 | Combined | Indices only | 25 | 5 | NDVI\_SUMMER, VARI\_SUMMER, VARI\_FALL, LSWI\_WINTER, SD\_SWIR\_SUMMER |
| M21 | Combined | Bands + Indices | 49 | 8 | RED\_START, SWIR1\_SUMMER, SWIR2\_SUMMER, NIR\_WINTER, SWIR1\_WINTER, NDVI\_SUMMER, VARI\_SUMMER, LSWI\_START |

Table S3-4 Variables selected for the Cubist models following recursive feature elimination, highlighted terms indicate predictors retained in the final model.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Model ID** | **Time Period** | **Predictor Set** | **Number of Predictors** | **Number of Predictors Used** | **Top Variables** |
| M4 | 1992 & 1993 | Bands only | Top 10 | 7 | SWIR2\_SUMMER, NIR\_SUMMER, SWIR1\_SUMMER, GREEN\_START, NIR\_WINTER, SWIR2\_WINTER, RED\_START, RED\_WINTER, GREEN\_WINTER, BLUE\_WINTER |
| M5 | 1992 & 1993 | Indices only | Top 10 | 9 | CV\_SUMMER, LSWI\_SUMMER, NDVI\_WINTER, LSWI\_WINTER, SD\_SWIR\_SUMMER, SR\_WINTER, VARI\_START, CV\_WINTER, VARI\_FALL, SR\_FALL |
| M6 | 1992 & 1993 | Bands + Indices | Top 10 | 7 | NIR\_SUMMER, SWIR2\_SUMMER, NDVI\_WINTER, VARI\_START, SWIR1\_SUMMER, SD\_SWIR\_SUMMER, LSWI\_WINTER, SR\_WINTER, CV\_WINTER, GREEN\_WINTER" |
| M7 | 1992 & 1993 | Bands only | Top 5 | 2 | SWIR2\_SUMMER, NIR\_SUMMER, SWIR1\_SUMMER, GREEN\_START, NIR\_WINTER |
| M8 | 1992 & 1993 | Indices only | Top 5 | 4 | CV\_SUMMER, LSWI\_SUMMER, NDVI\_WINTER, LSWI\_WINTER, SD\_SWIR\_SUMMER |
| M9 | 1992 & 1993 | Bands + Indices | Top 5 | 5 | NIR\_SUMMER, SWIR2\_SUMMER, NDVI\_WINTER, VARI\_START, SWIR1\_SUMMER |
| M13 | 2016 & 2017 | Bands only | Top 10 | 5 | NIR\_SUMMER, BLUE\_WINTER, RED\_FALL, NIR\_WINTER, SWIR2\_START, GREEN\_SUMMER, NIR\_FALL, SWIR1\_WINTER, RED\_START, SWIR1\_FALL |
| M14 | 2016 & 2017 | Indices only | Top 10 | 9 | SD\_SWIR\_SUMMER, SR\_SUMMER, LSWI\_WINTER, NDVI\_FALL, LSWI\_FALL, CV\_SUMMER, CV\_FALL, NDVI\_SUMMER, VARI\_SUMMER, LSWI\_SUMMER |
| M15 | 2016 & 2017 | Bands + Indices | Top 10 | 5 | NIR\_SUMMER, GREEN\_FALL, NIR\_WINTER, SWIR2\_START, CV\_SUMMER, NDVI\_FALL, LSWI\_WINTER, RED\_FALL, BLUE\_WINTER, SD\_SWIR\_SUMMER |
| M16 | 2016 & 2017 | Bands only | Top 5 | 4 | NIR\_SUMMER, BLUE\_WINTER, RED\_FALL, NIR\_WINTER, SWIR2\_START |
| M17 | 2016 & 2017 | Indices only | Top 5 | 5 | SD\_SWIR\_SUMMER, SR\_SUMMER, LSWI\_WINTER, NDVI\_FALL, LSWI\_FALL |
| M18 | 2016 & 2017 | Bands + Indices | Top 5 | 5 | NIR\_SUMMER, GREEN\_FALL, NIR\_WINTER, SWIR2\_START, CV\_SUMMER |
| M22 | Combined | Bands only | Top 10 | 10 | NIR\_SUMMER, SWIR1\_SUMMER, SWIR2\_SUMMER, RED\_START, GREEN\_START, NIR\_WINTER, SWIR1\_WINTER, BLUE\_START, RED\_WINTER, BLUE\_WINTER |
| M23 | Combined | Indices only | Top 10 | 5 | SD\_SWIR\_SUMMER, LSWI\_WINTER, LSWI\_SUMMER, CV\_SUMMER, VARI\_START, VARI\_SUMMER, CV\_WINTER, VARI\_FALL, NDVI\_SUMMER, NDVI\_WINTER |
| M24 | Combined | Bands + Indices | Top 10 | 4 | NIR\_SUMMER, NIR\_WINTER, SWIR1\_SUMMER, SWIR2\_SUMMER, SWIR1\_WINTER, SD\_SWIR\_SUMMER, LSWI\_WINTER, LSWI\_SUMMER,  RED\_FALL, GREEN\_FALL |
| M25 | Combined | Bands Only | Top 5 | 5 | NIR\_SUMMER, SWIR1\_SUMMER, SWIR2\_SUMMER, RED\_START, GREEN\_START |
| M26 | Combined | Indices only | Top 5 | 3 | SD\_SWIR\_SUMMER, LSWI\_WINTER, LSWI\_SUMMER, CV\_SUMMER, VARI\_START |
| M27 | Combined | Bands + Indices | Top 5 | 5 | NIR\_SUMMER, NIR\_WINTER, SWIR1\_SUMMER, SWIR2\_SUMMER, SWIR1\_WINTER |

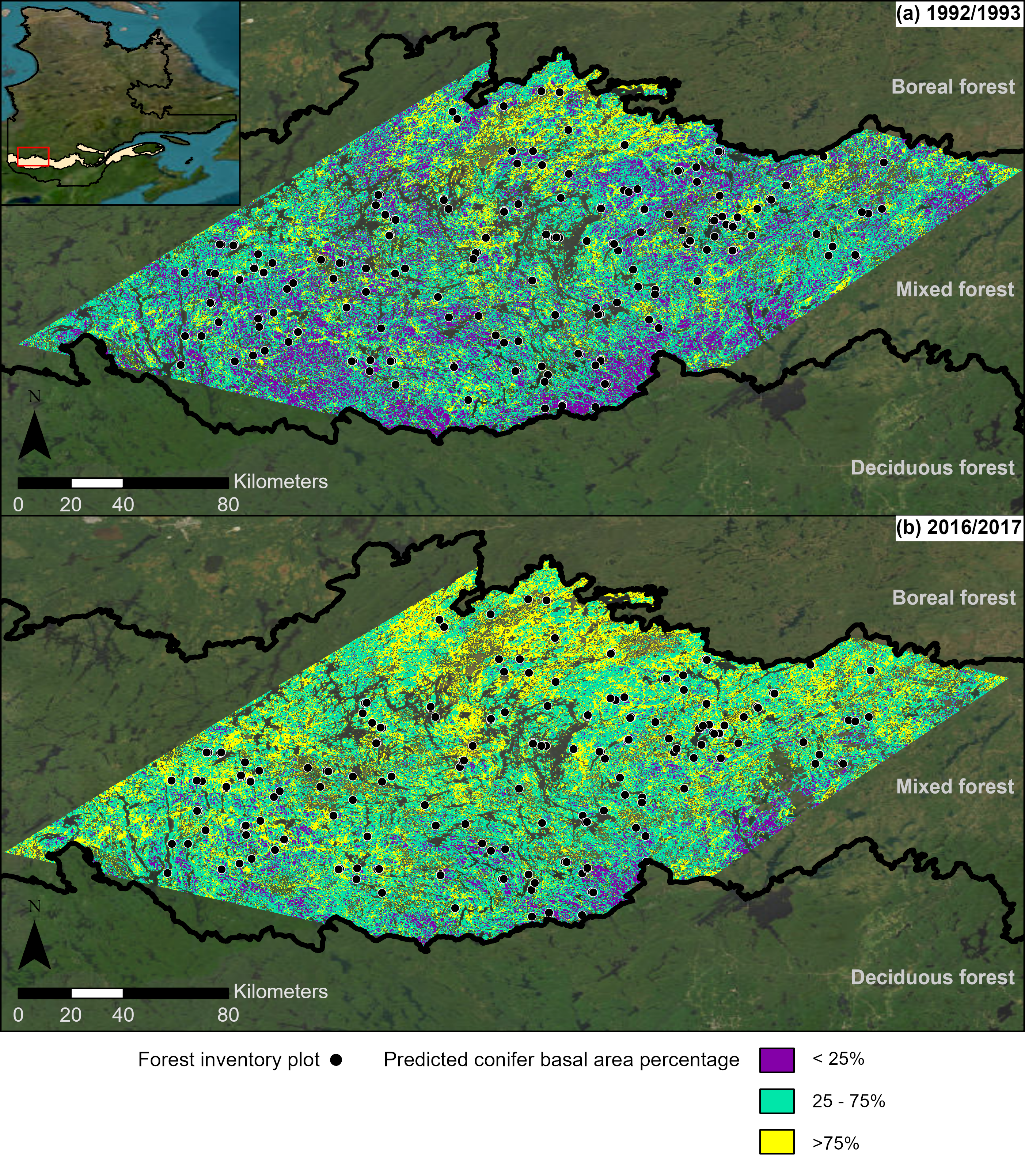
****

Figure S3-10 Predicted conifer basal area percentage (CBAP) classes for (a) 1992/1993 using Landsat 5 and (b) 2016/2017 using Landsat 8, based on the selected Cubist model (M24). Class thresholds defined by the forest ministry: deciduous (<25% CBAP), mixed (25%–75%), and coniferous (>75%)