eFRI Wetland Crosswalk and Applied Products

Final Report

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Table of Contents

1.0 Project Background

Canada's forest industry is one of the country's most important manufacturing sectors as Canada has one of the largest forest product trade balances in the world ($23.1 billion in 2016, Natural Resources Canada). However, forestry operations, such as road construction and harvesting, can be challenging because much of Canada's boreal forest is covered by aquatic ecosystems including lakes, rivers, streams, and wetlands. For example, 85% of Canada's wetlands are located within the boreal zone (Gingras et al. 2016). To operate effectively, forest resource managers require accurate, reliable, and user-friendly information to support their planning. Building upon existing datasets such as the enhanced Forest Resource Inventory (eFRI) to enhance knowledge around wetland habitat characteristics and associated inferred products can help forest managers operate on the landscape in a more efficient manner while also meeting various provincial and/or federal regulatory requirements, including Species at Risk and Migratory Birds Convention Acts, and forest certification standards (e.g. Sustainable Forestry Initiative, Forest Stewardship Council, etc.). Furthermore, having knowledge of wetlands and their environmental determinants can enhance the ability of practitioners to spatially understand and predict water movement in wetlands and across the landscape. This inferred hydrological information can help guide considerations around planning, constructing, monitoring, and decommissioning wetland crossings in forested environments.

This report details the results of a two-phase project with the goal of providing enhanced and user-friendly wetland data and associated products for the province of Ontario. More specifically, these phases were the following:

Phase 1: Enhanced Wetland Classification (EWC) crosswalk from the Ontario eFRI, and

Phase 2: Applied spatial products resulting from Phase 1.

In Phase 1, a user-friendly digital wetland inventory was developed by cross-walking eFRI ecosites to the Ducks Unlimited Canada (DUC) boreal Enhanced Wetland Classification (EWC) schema (i.e. wetland class definitions found in Smith et al. 2007). This was done for all forest management units across Ontario with available eFRI data. In Phase 2, inferred spatial products were developed by assigning each new EWC wetland class a specific hydrologic flow characteristic based on the lateral and vertical movement of water. Additionally, a spatial attribute identifying relative risk (e.g. low to high) for road planning purposes was assigned to each polygon.

With our target audience for this project being Ontario's forestry sector, we anticipate that these various project outcomes will support both strategic and operational planning requirements and also provide meaningful information for input into forest management plans and certification requirements for various forest companies operating throughout Ontario. Moreover, the knowledge gained from this project will support applications of readily available best management practices (BMP) around wetlands, particularly around road development and wetland crossings (Ducks Unlimited Canada 2014).

2.0 Methods

2.1 Study Area

This work was completed on all forest management units with available eFRI data across the province of Ontario (Figure 1), covering parts of the Boreal Shield and Hudson Plain ecozones. It should be noted that eFRI data is continually being updated, and that the data produced from this work reflects data conditions from circa 2021.

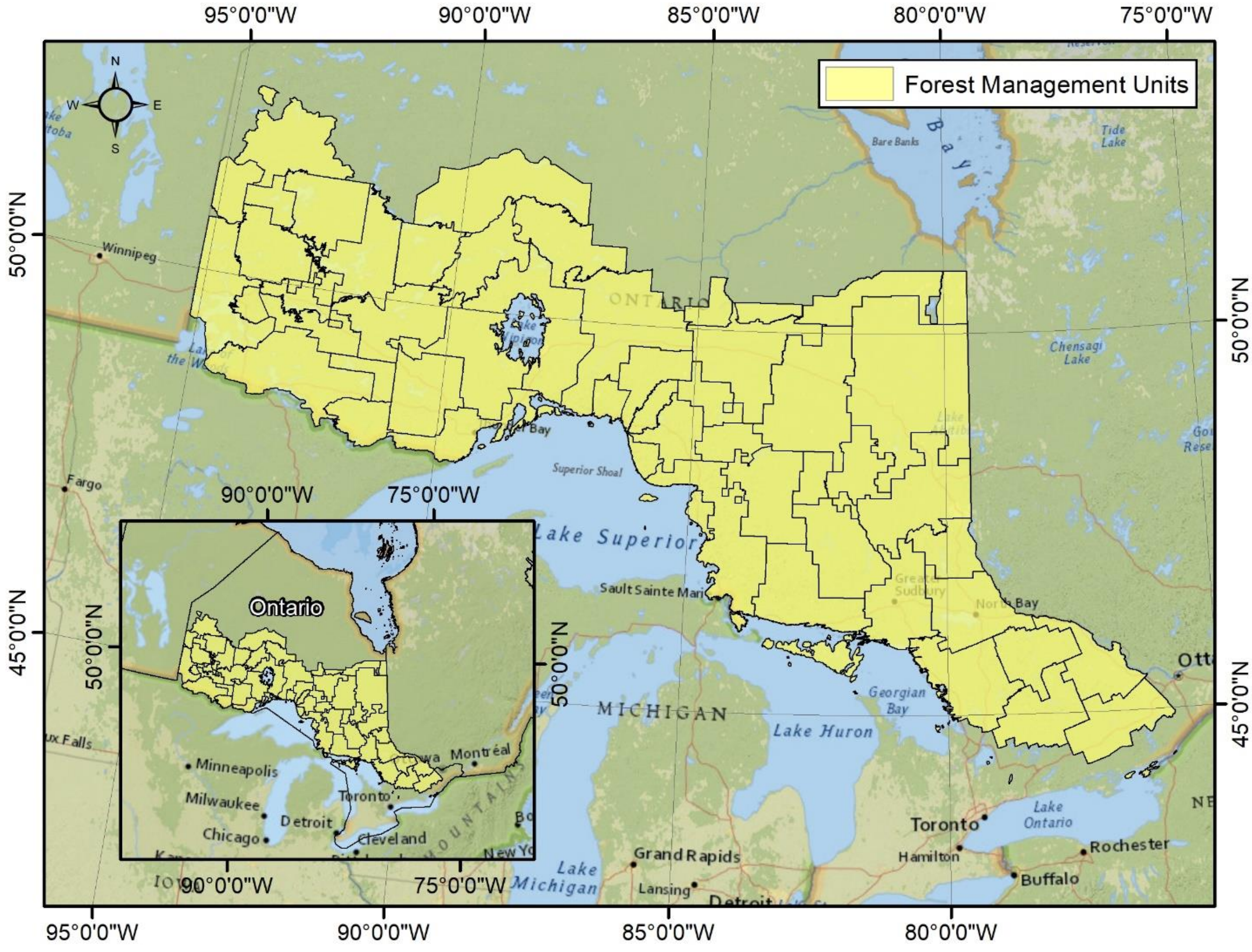

Figure 1: Spatial extent of forest management units across Ontario.

2.2 eFRI to EWC Crosswalk

The Ontario Ministry of Natural Resources (OMNR) developed an ecosite classification (OMNR, 2009) simultaneous with the development of an eFRI, which is guided by Ecological Landscape Classification (ELC) manuals and an ecosite photo interpretation manual (OMNR, 2010). The eFRI (which utilizes the OMNR ELC system) includes 33 permanently flooded/Hydric ecosite codes, all of which have their water table near, at or above the substrate surface for much of the year (i.e. they follow the Canadian Wetland Classification System definition of a wetland (CWCS; NWWG, 1997; Figure 2).

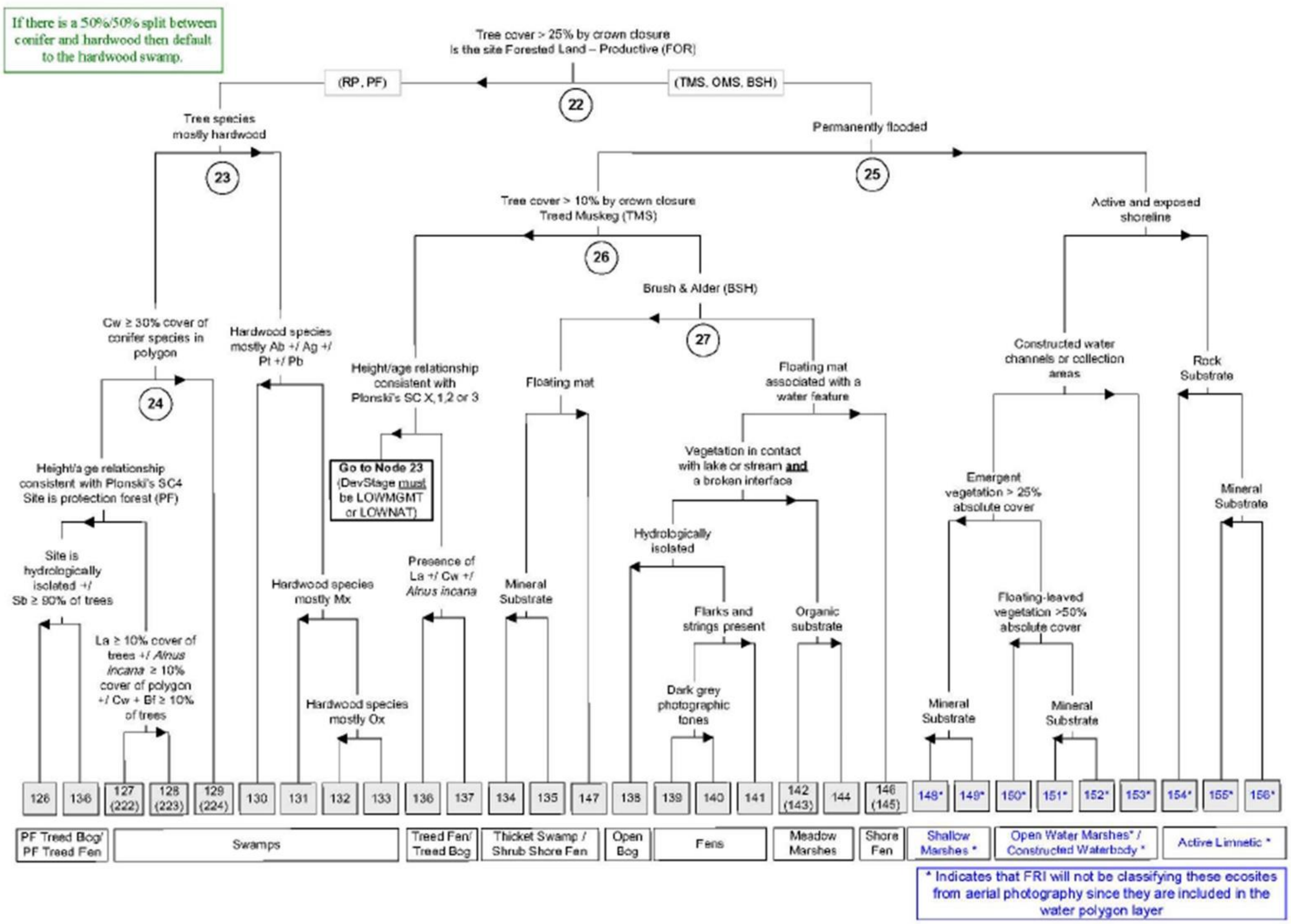

Figure 2: Permanently flooded/hydric ecosites key directly obtained from the Ontario Ministry of Natural Resources Photo Interpretation Manual for Ecosites in Ontario (OMNR, 2010).

To facilitate DUC's interpretation of the wetlands present across the eFRI datasets, in addition to developing more concise and user-friendly information for practitioners and forest managers, a crosswalk from OMNR's eFRI permanently flooded/Hydric ecosites to DUC's EWC (Smith et al., 2007; Figure 3) boreal wetland classes was completed. This attribute crosswalk (i.e. translation of classes from one system to another) is detailed in Table 1. 14 EWC classes were identified from this crosswalk exercise. The translation of classes from one classification system to another was completed by analysing the species composition (i.e. presence), heights, and coverage for each code/class as described in their classification system documentation.

Table 1: OMNR ELC ecosite crosswalk (i.e. translation) to EWC wetland classes and their associated major wetland class according to the CWCS.

ELC Key	ELC Ecosite	CWCS Major Class	EWC Minor Class
B126	Treed Bog	Bog	Treed Bog
B137	Sparse Treed Bog	Bog	Shrubby Bog
B138	Open Bog	Bog	Open Bog
B139	Poor Fen	Fen	Graminoid Poor Fen
B136	Sparse Treed Fen	Fen	Treed Poor Fen
B140	Open Moderately Rich Fen	Fen	Graminoid Rich Fen
B141	Open Extremely Rich Fen	Fen	Graminoid Rich Fen
B146	Open Shore Fen	Fen	Graminoid Rich Fen
B147	Shrub Shore Fen	Fen	Shrubby Rich Fen
B130	Intolerant Hardwood Swamp	Swamp	Hardwood Swamp
B131	Maple Hardwood Swamp	Swamp	Hardwood Swamp
B132	Oak Hardwood Swamp	Swamp	Hardwood Swamp
B133	Hardwood Swamp	Swamp	Hardwood Swamp
B134	Mineral Thicket Swamp	Swamp	Shrub Swamp
B135	Organic Thicket Swamp	Swamp	Shrub Swamp
B127	Poor Conifer Swamp	Swamp	Conifer Swamp
B128	Intermediate Conifer Swamp	Swamp	Conifer Swamp
B129	Rich Conifer Swamp	Swamp	Conifer Swamp
B222	Mineral Poor Conifer Swamp	Swamp	Conifer Swamp
B223	Mineral Intermediate Conifer Swamp	Swamp	Conifer Swamp
B224	Mineral Rich Conifer Swamp	Swamp	Conifer Swamp
B142	Mineral Meadow Marsh	Marsh	Meadow Marsh
B143	Rock Meadow Marsh	Marsh	Meadow Marsh
B144	Organic Meadow Marsh	Marsh	Meadow Marsh
B145	Floating Marsh	Marsh	Emergent Marsh
B148	Mineral Shallow Marsh	Marsh	Emergent Marsh
B149	Organic Shallow Marsh	Marsh	Emergent Marsh
B150	Open Water Marsh: Floating-Leaved	Shallow Open Water	Aquatic Bed
B151	Open Water Marsh: Mineral	Shallow Open Water	Aquatic Bed
B152	Open Water Marsh: Organic	Shallow Open Water	Aquatic Bed
B154	Active Limnetic Rock	Shallow Open Water	Open Water
B155	Active Limnetic Mineral	Shallow Open Water	Open Water
B156	Active Limnetic Organic	Shallow Open Water	Open Water

Note* ELC, Ecological Landscape Classification (OMNR, 2009); CWCS, Canadian Wetland Classification System (NWWG, 1997); EWC, Enhanced Wetland Classification (Smith et al., 2007).

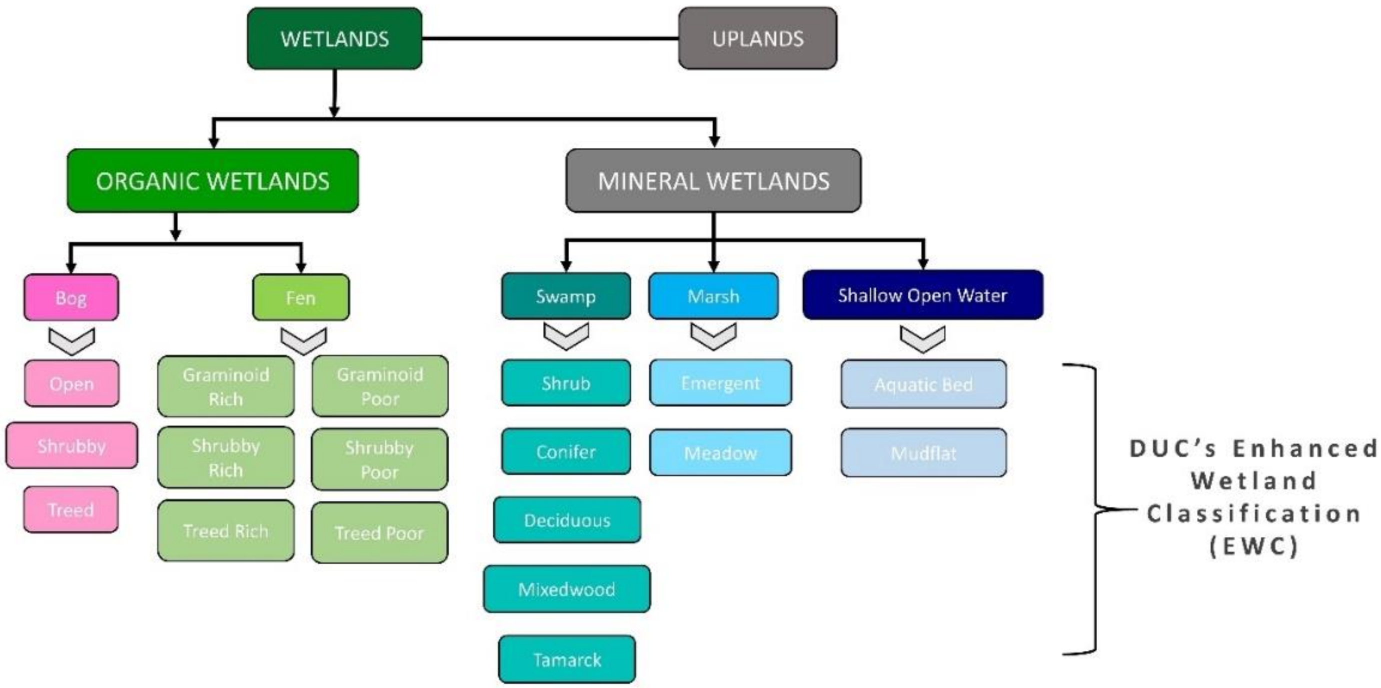

Figure 3: Ducks Unlimited Canada's Enhanced Wetland Classification (EWC) data model, consisting of 19 distinct minor wetland classes that conform to the five major classes of the Canadian Wetland Classification System (CWCS). Note* 14 EWC classes were identified after cross-walking the eFRI classes, which are labelled in Table 1.

2.3 Hydrodynamics and Risk Assessment

After cross-walking the eFRI ecosites to an enhanced wetland call, inferred water flow characteristics and relative risk ratings were then assigned to each wetland polygon area within the Ontario forest management units. This was done using the edatopic grid found in Figure 4 as a guiding principle (Ducks Unlimited Canada 2011). The lateral and vertical movement of water through wetlands (i.e. hydrodynamics) is an important factor in the determination of wetland types. As seen in Figure 4 and in Table 2, a wetlands hydrodynamic regime can be fairly static, such as the percolation/capillary action of ombrotrophic bogs (i.e., they receive all water from direct precipitation), to highly variable conditions such as shoreline marshes that are exposed to regular water table drawdowns.

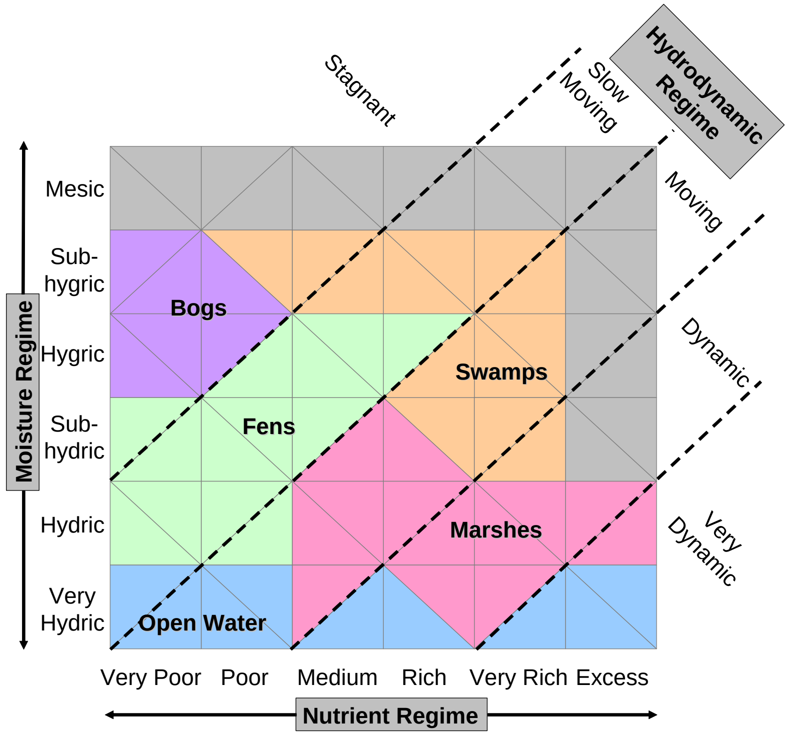

Figure 4: Ducks Unlimited Canada's wetland edatopic grid showing the relative distribution of major wetland classes in relation to their hydrodynamic regimes (2-d z-axis) and other regimes (e.g. moisture and nutrient; DUC, 2011).

Understanding the type of flow can help guide industrial practices, such as operational forestry activities, occurring in and around wetlands. For example, resource roads built over wetlands are generally subject to settlement and compaction of on-site soils, flooding, or erosion, impacting road performance, construction, and maintenance costs. Therefore, the inferred wetland flow (e.g. stagnant, slow lateral flow, seasonally fluctuating, or inundated/flooded) was used to provide a risk assessment in terms of potential impacts on flow and associated consequences on wetland function. All wetlands have the potential to move water and even wetland classes characterized as stagnant under average conditions may act as water sources under wet conditions, transmitting water to adjacent wetlands and uplands. While stagnant wetlands are often considered lower risk for impeding natural water movement, they too are not without risk. The risk assessment ratings seen in Table 2 can be applied to road planning, design, and construction to reduce potential negative impacts on wetlands, such as: impediment of surface and/or subsurface water movement from soil compaction, or ponding of water due to inadequate water flow through the road.

Table 2: EWC wetland classes and their associated inferred classifications according to Ducks Unlimited Canada (2011).

EWC Class	Risk
Open Water	High
Aquatic Bed	High
Emergent Marsh	High
Meadow Marsh	High
Graminoid Poor Fen	Medium
Graminoid Rich Fen	Medium
Shrubby Rich Fen	Medium
Treed Poor Fen	Low
Open Bog	Low
Shrubby Bog	Low
Treed Bog	Low
Shrub Swamp	Medium
Hardwood Swamp	Medium
Conifer Swamp	Low

3.0 Results

The eFRI to EWC crosswalk process described in the previous section was spatially applied to all forest management units with existing eFRI data. This was completed on 43 forests by applying a custom Python script using ArcGIS Pro software. This GIS python script used the primary ecosite code field (i.e. rather than secondary ecosite codes) found in each forest inventory to assign an associated EWC class, hydrodynamic regime, and risk crossing rating for every polygon. This resulted in the creation of three new text fields within each forest management unit attribute database. Figure 5 provides an example of the attribute table database for one forest management unit after applying the custom Python script, while Figure 6 is a visual example of the spatial products. Note that for polygons identified as non-wetland based on their primary ecosite code, that their cross-walked attributes were assigned as 'NoData'.

PRI_ECO	EWC	Hydrodynamic	CrossingRisk
G136TlD n	Treed Poor Fen	Slow Moving	Low
G135S D n	Shrub Swamp	Dynamic	Medium
G067TtM n	No Data	No Data	No Data
G129TtD n	Conifer Swamp	Stagnant	Low
G129TtD n	Conifer Swamp	Stagnant	Low
G135S D n	Shrub Swamp	Dynamic	Medium
G139S D n	Graminoid Poor Fen	Slow Moving	Medium
G135S D n	Shrub Swamp	Dynamic	Medium

Figure 5: Example of a final attribute table database as viewed using ArcGIS Pro software for a forest management unit.

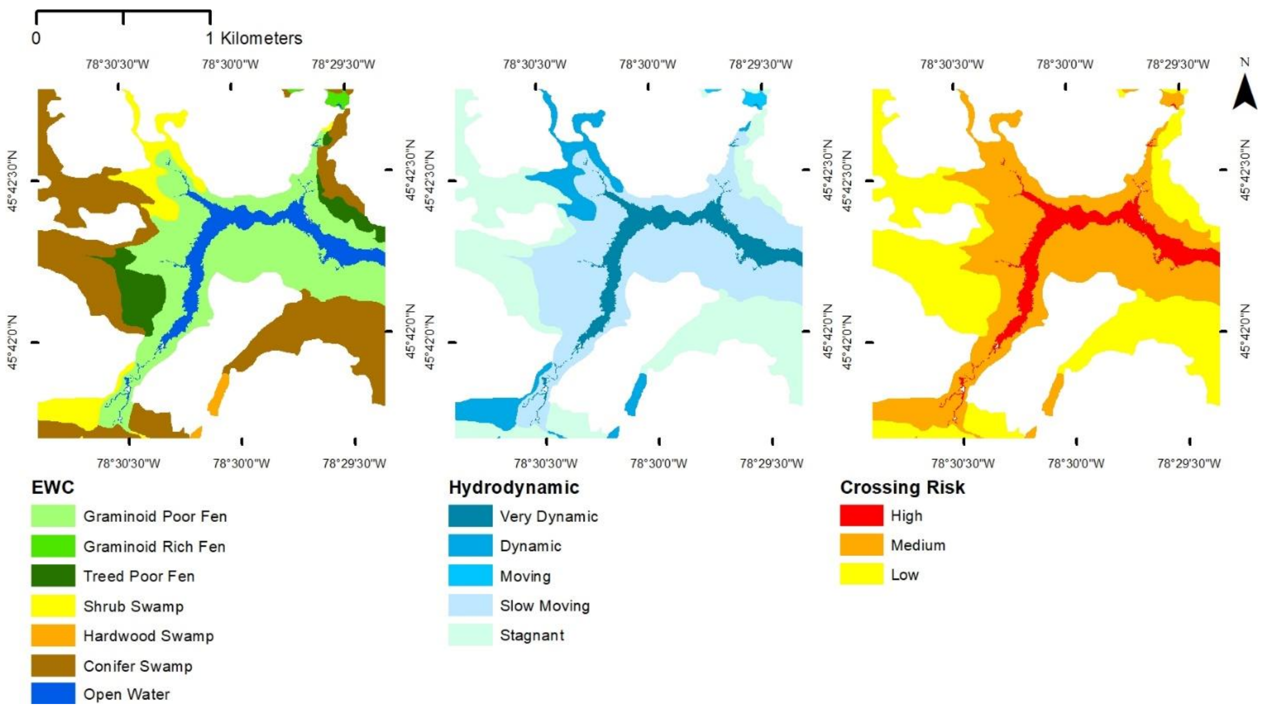

Figure 6: A visual example of the applied EWC crosswalk and associated hydrodynamic and risk crossing products.

The final EWC inventories for all forest management units are made available as feature classes stored in geodatabase (GDB) format. Figure 7 shows an example of these geodatabases viewed in ArcGIS Pro Catalog.

4.0 Acknowledgements

We would like to thank the Forestry Futures Trust Ontario organization for funding this work through the Knowledge Transfer and Tool Development (KTTD) program. Without this financial support, this work would not be possible.

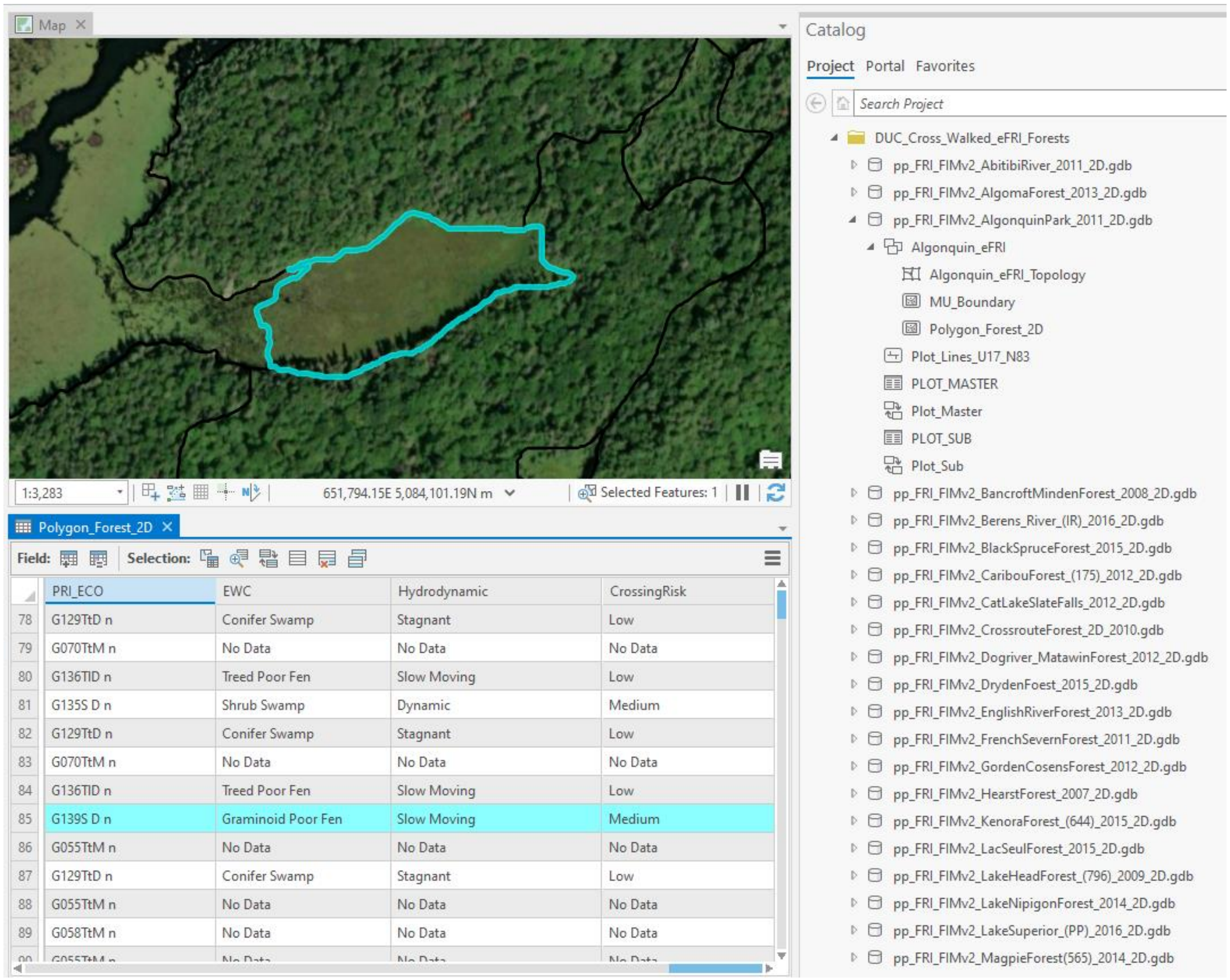

Figure 7: An example of the final, DUC cross-walked eFRI forests and their associated geodatabases. A total of 43 geodatabases from 43 forest inventories were developed in this project. In this example, the Algonquin forest eFRI is being displayed, with a cross-walked graminoid poor fen polygon highlighted.

5.0 References

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