Assessment of LANDFIRE Data
Onslow Bight Landscape, North Carolina
March 3, 2009

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Overview

This assessment presents the major results of an evaluation of LANDFIRE data in the Onslow Bight Landscape, North Carolina. Because the data was created for regional and national analyses, it is important to determine whether and how it can be used for landscape-level analysis. We assessed the LANDFIRE data by comparing it to local data. Our evaluation shows that the data is useful for summarizing the vegetation and fuels characteristics of the landscape as a whole. Compared to local data, the LANDFIRE data is usually as good, or sometimes better, at characterizing the overall landscape. In particular, the calibrated FBFM13 data is better than any other data across the Onslow Bight. The EVT data does a better job than GAP landcover data at capturing the composition of longleaf pine systems in the landscape. Therefore, LANDFIRE is an important source of data for characterizing the vegetation and fuels across the Onslow Bight.

Across smaller extents like management areas or burn units, partner feedback indicates the LANDFIRE data is less useful. In general, many of the finer-scale patterns on the landscape are not captured accurately by the LANDFIRE data. For example, in the EVT data, Tidal Marsh Systems are mapped as Swamp Systems, making the data less useful in areas that are predominantly marsh, such as Cedar Island National Wildlife Refuge. In addition, the BpS data does not accurately capture patterns in smaller management areas, and local presettlement data created by Cecil Frost is often preferable to partners across smaller extents.

Finally, feedback from partners indicates that FRCC data is difficult to interpret and misses many of the patterns across the landscape and at smaller extents. The fact that LANDFIRE FRCC is summarized for a BpS across an Ecological Subsection means that differences in departure that partners perceive within and among vegetation types are not evident in the data. Using the FRCC Mapping Tool to summarize the data across the Onslow Bight moderately improves the data. Additionally, partners find FRCC difficult to use because it does not incorporate fire history. Therefore, as it is, LANDFIRE FRCC has limited utility both for summarizing landscape-level characteristics, and for informing priorities on the ground.

Background: Onslow Bight Landscape and Partners

The Onslow Bight is a 3-million-acre landscape on the Coastal Plain of North Carolina, where a Fire Learning Network has been established to facilitate the maintenance and restoration of fire-adapted ecosystems. Partners include the North Carolina Wildlife Resources Commission (WRC), USFS Croatan National Forest, US Marine Corps Camp LeJeune, US Marine Corps Cherry Point, USFWS Cedar Island National Wildlife Refuge, NC State Parks, and The Nature Conservancy (TNC).

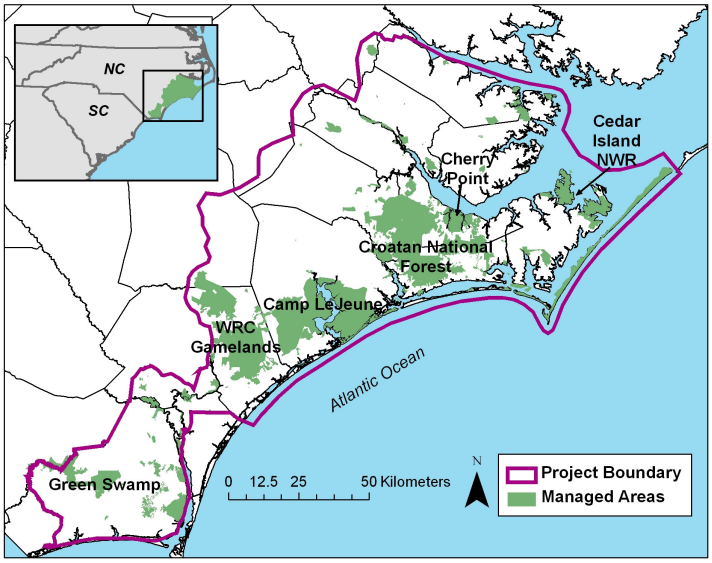

Figure 1: The Onslow Bight landscape.

Overall Objective

This assessment aims to inform how LANDFIRE data is used and how future versions of the data are created. We compared the EVT, BpS, FBFM13, and FRCC data layers data to other sources of information about fire regimes and vegetation in the Onslow Bight.

Questions Addressed

The following questions guide this assessment:

1. How do LANDFIRE data layers compare with local data, especially on a landscape-wide basis?
2. Does LANDFIRE data match what partners know about the landscape on the ground, especially at finer scales?
3. In what ways can LANDFIRE data best be used?

Data Assessment

EVT

EVT classes were aggregated and crosswalked to match an aggregated version of the landcover classes mapped by the Southeast Gap Analysis Project (GAP). A pixel-to-pixel comparison was made between EVT and GAP data for the Onslow Bight. In addition, feedback about the EVT data was gathered from partners at Cedar Island, Croatan, Camp LeJeune, Cherry Point, and TNC.

Landscape-wide assessment

Across the Onslow Bight, patterns in the EVT data generally match what partners expect as well as what the GAP data show, with some important exceptions.

- There is a 49% agreement between EVT data and GAP landcover data, when compared on a pixel-to-pixel basis.

- The percent composition of vegetation classes in the landscape seems reasonable, and does not differ markedly between EVT and GAP (Table 1). However, there is slightly more pocosin mapped in the EVT data, and more longleaf pine mapped by GAP (Table 1). GAP acknowledges that they likely overmap longleaf pine.
- A major issue in the EVT data is that many areas that should be Coastal Plain Tidal Marsh Systems were mapped as Gulf and Atlantic Coastal Plain Swamp Systems. There is only 11% agreement between EVT and GAP for Tidal Marsh Systems, and 56% of Swamp Systems mapped by EVT were mapped as Tidal Marsh by GAP. When EVT Swamp pixels are reclassified as Marsh, there is a 71% agreement between the two maps for Marsh.
- Partners agree that the patterns mapped in EVT across the Onslow Bight are acceptable, with the exception of the mis-mapping of Tidal Marsh.

Individual management units

When EVT data is examined across smaller extents in the Onslow Bight, partner feedback is mixed.

- Partners notice the mis-mapping of Marsh as Swamp in their management districts. Because much of Cedar Island should be mapped as Marsh and is instead mapped as Swamp, the EVT data does not seem reasonable there overall. This is a more minor issue at Camp LeJeune and Cherry Point.
- In the Croatan and in TNC's Shaken Creek preserve, Floodplain Systems are mapped across a larger extent than what partners would expect.
- In the southern part of the landscape in TNC's Green Swamp Preserve, xeric longleaf pine savannas are underrepresented in the EVT layer. Most are mapped as mesic longleaf pine.
- Partners from the Croatan and Camp LeJeune think the EVT data does a good job at capturing the patterns on their management areas, despite minor discrepancies between the what the data shows and partners' view of the land.

Table 1: Comparison of percent composition between LANDFIRE EVT and GAP 2001 landcover data. Classes have been aggregated and crosswalked between the two data sets.

Crosswalked Class	LANDFIRE EVT	GAP 2001 Landcover
Barren	0.8%	0.4%
Carolina Bay	0.0%	0.0%
Dry and Dry-Mesic Oak Forest	1.5%	5.5%
General Agriculture	14.7%	14.8%
General Developed	6.3%	6.1%
General Floodplain	6.6%	4.2%
General Longleaf Pine	10.8%	19.0%
General Maritime Forest/Grassland	0.9%	1.4%
General Marsh	1.2%	3.9%
General Pocosin	23.0%	14.5%
General Riparian	5.7%	1.2%
General Swamp	6.9%	7.4%
Managed Tree Plantation	17.4%	21.5%
Mesic Hardwood and Mixed Forest	4.5%	0.0%

Recommendations for use of the EVT Data
Overall, the EVT data captures most of the vegetation patterns in the Onslow Bight. Based on comparisons with GAP and partner feedback, this data is useful for summaries across the landscape and for comparison with vegetation composition across other landscapes. In particular, EVT does a better job than the GAP data at capturing patterns of longleaf pine across the landscape. If the mapping of Marsh were improved, EVT would be useful at the scale of most single management units within the landscape.

BpS
BpS classes were aggregated and crosswalked to match an aggregated version of the classes in Cecil Frost's (2006) presettlement vegetation map of the Onslow Bight. A pixel-to-pixel comparison was made between BpS data and Frost's map. In addition, feedback about the BpS data was gathered from partners at Croatan, Camp LeJeune, Cherry Point, and TNC.

Landscape-wide assessment
Across the Onslow Bight, the BpS data shows a similar composition to Frost's map, as well as the overall patterns that partners expect to see in the landscape.

- BpS and Frost's map show 53% agreement when compared on a pixel-to-pixel basis.
- Overall, the composition of vegetation classes is approximately the same between the two data layers. BpS shows slightly more Marsh, Riparian, and Floodplain classes, while Frost's map shows more pocosin (Table 2).
- Partners agree that BpS generally shows the composition they would expect across the landscape.

Individual management units
At extents smaller than the Onslow Bight, partners see some problems with BpS, especially across smaller management units. At this scale, the pixilated nature of the data becomes more apparent.

- In the Croatan and Camp LeJeune, BpS looks accurate overall, but small stream riparian systems are overmapped in the Croatan.
- In TNC's Shaken Creek Preserve, many of the patterns do not seem correct. Floodplain and small stream riparian are over mapped, and pocosin is mapped where longleaf would have probably been.
- At Cherry Point, they use another presettlement vegetation map that was made by Bob Mickler. Some of the patterns shown in the BpS layer are very different from Mickler's map. For example, where BpS shows Tidal Marsh in Atlantic Field, Mickler's map shows mesic longleaf and pocosin.
- In the southern part of the Onslow Bight, TNC's Green Swamp Preserve and in Boiling Spring Lakes, xeric longleaf pine savannas are mapped as mesic longleaf savannas, and wet longleaf savannas are mapped as pocosin.

- The reliability of BpS is lower for smaller management areas. Cherry Point's properties and the Shaken Creek preserve are smaller areas (under 10,000 acres each) which indicates that the BpS data becomes less accurate as spatial extent decreases.
- Frost's map is polygon-based, which partners seem to prefer over the raster BpS data when looking at smaller extents.

Table 2: Comparison of percent composition between LANDFIRE BpS and Frost's Presettlement Vegetation data. Classes have been aggregated and crosswalked between the two data sets.

Crosswalked Class	LANDFIRE BpS	Frost's Presettlement Vegetation
Clay-Based Carolina Bay Wetland	0.8%	0.1%
General Floodplain	6.6%	0.0%
General Marsh	6.4%	3.5%
General Riparian	10.3%	5.5%
General Swamp	1.9%	1.7%
Mesic Hardwood and Mixed Forest	2.4%	0.3%
Nonriverine Swamp and Wet Hardwood Forest	3.6%	5.5%
Longleaf Pine Savanna and Woodland	47.3%	54.3%
Pocosin and Canebrake	19.0%	27.4%
Dune/Maritime Forest and Grassland	0.8%	0.8%
Dry and Dry-Mesic Oak Forest	0.2%	0.0%
Barren/Disturbed	0.7%	0.8%

Recommendations for use of the BpS Data

BpS data is useful for summarizing patterns across the Onslow Bight and for comparing the Onslow Bight with other landscapes or regions. However, there are some inaccuracies when using the data across or within a single management unit, and local data is preferable at those scales. Furthermore, local data for presettlement vegetation is vector based (polygons). Partners find the vector data easier to use because it avoids the problem of pixilation when zooming in to smaller extents.

FBFM13

A pixel-to-pixel comparison was made between FBFM13 data and the Fuel Models map produced by the Southern Wildfire Risk Assessment (SWRA). In addition, feedback about the BpS data was gathered from partners at Croatan, Camp LeJeune, Cedar Island, Cherry Point, and TNC.

Landscape-wide assessment

Although it has a low agreement with the SWRA fuels data, partners agree that across the Onslow Bight, the calibrated FBFM13 data does a good job at capturing overall patterns and composition of fuels in the landscape.

- Prior to the calibration of the FBFM13 layer, partners thought there was too much FM2 and FM5 on the landscape. FM2 underestimates fuel loads in longleaf pine areas where much of the burning is done on the landscape. During the calibration

in Charleston, SC, many of the FM2 pixels were changed to FM7 or FM9. These fuel models are more realistic because they contain either a shrub or litter component to the fuels. In areas that are Marsh but were mismapped as Swamp, many of the FM5 pixels were changed to FM3.

- Partners agree that this updated layer is much improved, and that it captures the overall patterns and fuel model composition on the landscape.
- When the calibrated FBFM13 layer is compared with SWRA data, there is only a 19% agreement between the two.
- According to partners, the calibrated FBFM13 data provides a better overall representation of the landscape than the SWRA data does. Overall, the composition of the FBFM13 data better represents the fuels on the landscape. There is less FM4 and FM8, and more FM7 in the FBFM13 data (Table 3), which is probably better. However, FM5 is probably overmapped in the FBFM13 data.

Individual management units

When partners assessed the FBFM13 data at the scale of their individual management areas, they think it is fairly accurate, but are unlikely to use the data to inform their management.

- The calibrated FBFM13 data looks good to partners overall in Cedar Island, the Croatan, and at Cherry Point.
- In the southern part of the Onslow Bight, in the Green Swamp Preserve and Boiling Spring Lakes, there is too much FBFM5 mapped. It should be FM6 in some places, and 2 or 7 in others.
- In Camp LeJeune, FBFM13 looks relatively good, but there should be a bit more FM5 where there is shrub and grass litter build-up.

Table 3: Comparison of percent composition between LANDFIRE FBFM13 and the SWRA Fuel Models data.

Class	LANDFIRE FBFM13	SWRA Fuels
Fuel Model 2	6.3%	8.3%
Fuel Model 3	3.5%	3.0%
Fuel Model 4	6.2%	32.4%
Fuel Model 5	14.6%	0.0%
Fuel Model 6	0.0%	0.4%
Fuel Model 7	16.3%	6.7%
Fuel Model 8	10.5%	21.0%
Fuel Model 9	7.4%	7.3%
Urban	5.2%	2.2%
Agriculture	12.1%	0.0%
Barren	0.6%	0.2%

Recommendations for use of theFBFM13 Data

Overall, the FBFM13 data is the best fuel model data that exists across the Onslow Bight, and captures patterns relatively well. Therefore, when landscape-wide summaries or

comparisons with other landscapes need to be made, FBFM13 should be used. Across single management units, the data is usually fairly accurate as an overall characterization. However, fuels change somewhat quickly, and partners tend to have better knowledge of the fuel models present in any given burn unit, so the FBFM13 model has limited utility for informing work on the ground.

FRCC

No locally-created FRCC layer exists for the Onslow Bight, and such a layer was not feasible to create for this assessment. However, the FRCC Mapping Tool was used to create a version of FRCC based on a summary of LANDFIRE BpS and S-class data across the Onslow Bight landscape. Because the USFS uses FRCC in their reporting, a third FRCC layer was created based on a summary across the Croatan National Forest. Because FRCC is scale-dependent, it is useful to compare the original LANDFIRE FRCC layer to both of these layers. In addition, feedback about the LANDFIRE FRCC data was gathered from partners at Croatan, Camp LeJeune, Cherry Point, Cedar Island, and TNC.

Partner feedback

Overall, partners raised several concerns with the FRCC data. Overall, the data do not capture differences between and among vegetation types on the ground.

- The scale-dependence of FRCC and the fact that it does not incorporate fire regime are misleading to partners.
- Partners expect to see differences in FRCC between areas that have been burned frequently and non-burned areas. If burn history is accounted for, some areas that are mapped as FRCC 3 should be 2, and areas mapped as FRCC 2 should be 1.
- The fact that LANDFIRE FRCC is summarized for a BpS across an Ecological Subsection means that differences that partners perceive in FRCC within and among vegetation types are not apparent in the data.
- In the Croatan, at least half of the landscape should be more FRCC 3, especially in the central pocosins, which are currently mapped as FRCC 2.
- In Camp LeJeune and TNC's Shaken Creek, there should be more FRCC 1 in areas that have been burned.
- In TNC's Green Swamp Preserve, longleaf pine savannas that have been burned regularly are mapped as FRCC 3, and should be FRCC 2 or 1. Areas that have not been burned in over 60 years are mapped as FRCC 2, and should be FRCC 3.

Local data: FRCC Mapping Tool

Using the Mapping Tool (MT) to summarize LANDFIRE BpS and S-class across the Onslow Bight resulted in a map that has more FRCC 1 and 3 than the original version (see Figure 2), which more closely matches the way partners view the landscape.

- Of the three versions of FRCC produced with the MT, StandFRCC is the preferable output. In the StandFRCC data, an FRCC value is assigned separately to each s-class within a BpS; thus, it captures many of the differences in vegetation departure seen across the landscape. StrataFRCC assigns FRCC 2 to 87% of the Onslow Bight, and thus masks many of the patterns in the landscape.

- In a pixel-to-pixel comparison, there is a 46% agreement between the original FRCC and the MT FRCC (see Table 4). Many of the areas that are FRCC 2 in the LANDFIRE FRCC were mapped as FRCC 1 or 3 in the new MT FRCC layer.

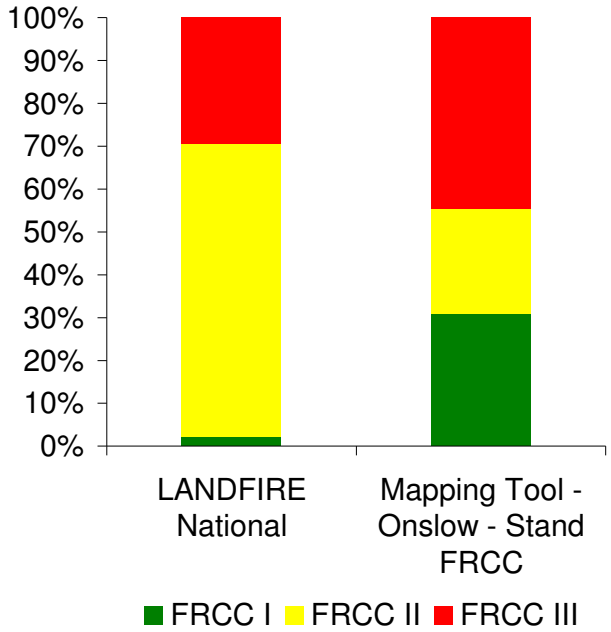

Figure 2: Composition of FRCC data layers for the Onslow Bight.

Table 4: Contingency table for the comparison of LANDFIRE FRCC to Stand FRCC in the Onslow Bight. Values are in acres. Overall agreement is 46%.

LANDFIRE National FRCC	Mapping Tool - Stand FRCC 1	2	3	Total	Producers Accuracy
1	45356	1004	6830	53190	85%
2	489958	549277	544760	1583994	35%
3	184038	15814	483326	683178	71%
Total	719352	566095	1034916	2320363	
Users Accuracy	6%	97%	47%		**46%**

Using the Mapping Tool (MT) to summarize LANDFIRE BpS and S-class across the Croatan resulted in a map that has more FRCC 1 and 3 than the original version (see Figure 3), which better matches how managers in the Croatan view their land.

- StandFRCC was also preferable to StrataFRCC in the Croatan.
- The patterns captured by the MT FRCC are preferable to the original LANDFIRE data. Pocosin areas that have not burned in a while show up as FRCC 3, and longleaf areas that have been burned more regularly show up as FRCC 1.

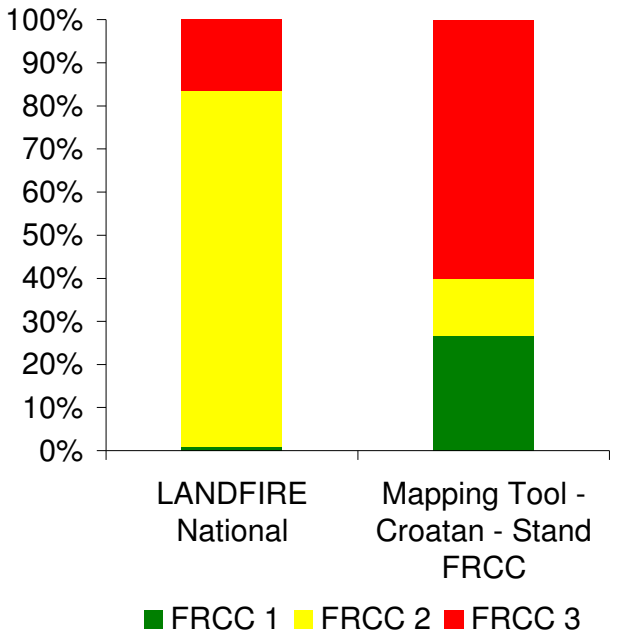

Figure 3: Composition of FRCC data layers for the Croatan National Forest.

Two additional comparisons were done with the FRCC data in the Onslow Bight. First, an assessment of FRCC within recently-burned areas versus non-burned areas was done because partners often expect FRCC at a site to correspond to burn history. Second, FRCC was compared with the Level of Concern (LOC) data from the Southern Wildfire Risk Assessment.

FRCC and burn history

We used burn history data from 1990 to 2008 across 215,969 acres of managed areas throughout the Onslow Bight, and restricted the FRCC layer to those areas with a burn history.

- Across the Onslow Bight, all FRCC levels were significantly different ($F < 0.0001$) with respect to the total number of times burned. Contrary to our expectations, areas of FRCC 3 were burned the most number of times. FRCC 1 areas were burned the least number of times (Table 5).
- When the analysis was restricted to the smaller area of the Croatan National Forest (67,205 acres), results were reversed: FRCC 1 areas were burned the most number of times and FRCC 3 areas were burned the least number of times. Again, all results were significantly different ($F < 0.001$).
- The relationship between FRCC and the burn history of a site must be interpreted with caution, as there is a correlation between the two factors, but it is not necessarily a result of causation.
- These results show that FRCC does not capture the differences in burn history throughout the landscape. This may be because 20 years of burn history data is not enough time to accurately characterize the burn history of a site. Additionally, FRCC data may not be able to accurately capture differences in understory vegetation that result from burning in the Onslow Bight. For example, areas that

are off-site loblolly pine may be characterized as FRCC 3, when they have been burned frequently and have the desired open understory. Further ground-truthing may be required to assess these potential flaws in the FRCC data.

Table 5: Mean total number of times burned for managed areas across the Onslow Bight and managed areas of the Croatan National Forest.

Managed Areas	FRCC Level 1	2	3
Onslow Bight	1.50	2.54	2.63
Croatan	3.43	3.27	3.21

FRCC and LOC

LOC assigns values to areas based on both accessibility and the value of property, and thus could be an alternative to FRCC for assigning priority to areas in the Onslow Bight. LOC is divided into 9 classes on a scale of 1 to 100, with class 9 (values 80-100) being the highest level of concern.

- In the Onslow Bight, LOC class 6 is the highest class found, however it only comprises 0.04% of the total area of the Onslow Bight (Figure 4). Likewise, LOC class 5 only comprises 1.39% of the Onslow Bight. The vast majority of the Onslow Bight is of low level of concern, made up primarily of class 0 through class 3 (82.5%).
- Therefore, high levels of concern do not relate well with high departure areas of FRCC. In fact, when comparing areas of FRCC 3 that overlap areas of LOC classes 5 & 6, there is only a 2.05% overlap.
- While FRCC and LOC do not emphasize the same high burn priority areas, taken individually they provide a mosaic of options for managers in determining high burn priority areas based upon departure from pre-colonial vegetation types and the risk assessment of the property.

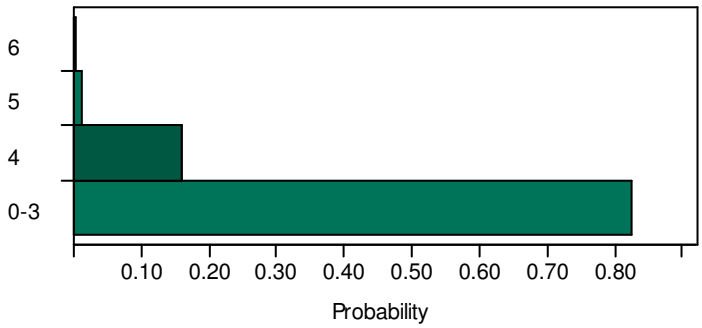

Figure 4: Composition of LOC classes in the Onslow Bight.

Recommendations for use of the FRCC Data

Overall, FRCC data has limited utility in the Onslow Bight, both for summarizing patterns across the landscape and for informing priorities on the ground. FRCC data is difficult to interpret and misses many of the patterns across the landscape and at smaller extents. Additionally, partners find FRCC difficult to use because it does not incorporate fire history. Using the FRCC Mapping Tool to summarize the data across the Onslow

Bight moderately improves the data, but only for summaries across the landscape or larger management units such as the Croatan National Forest.