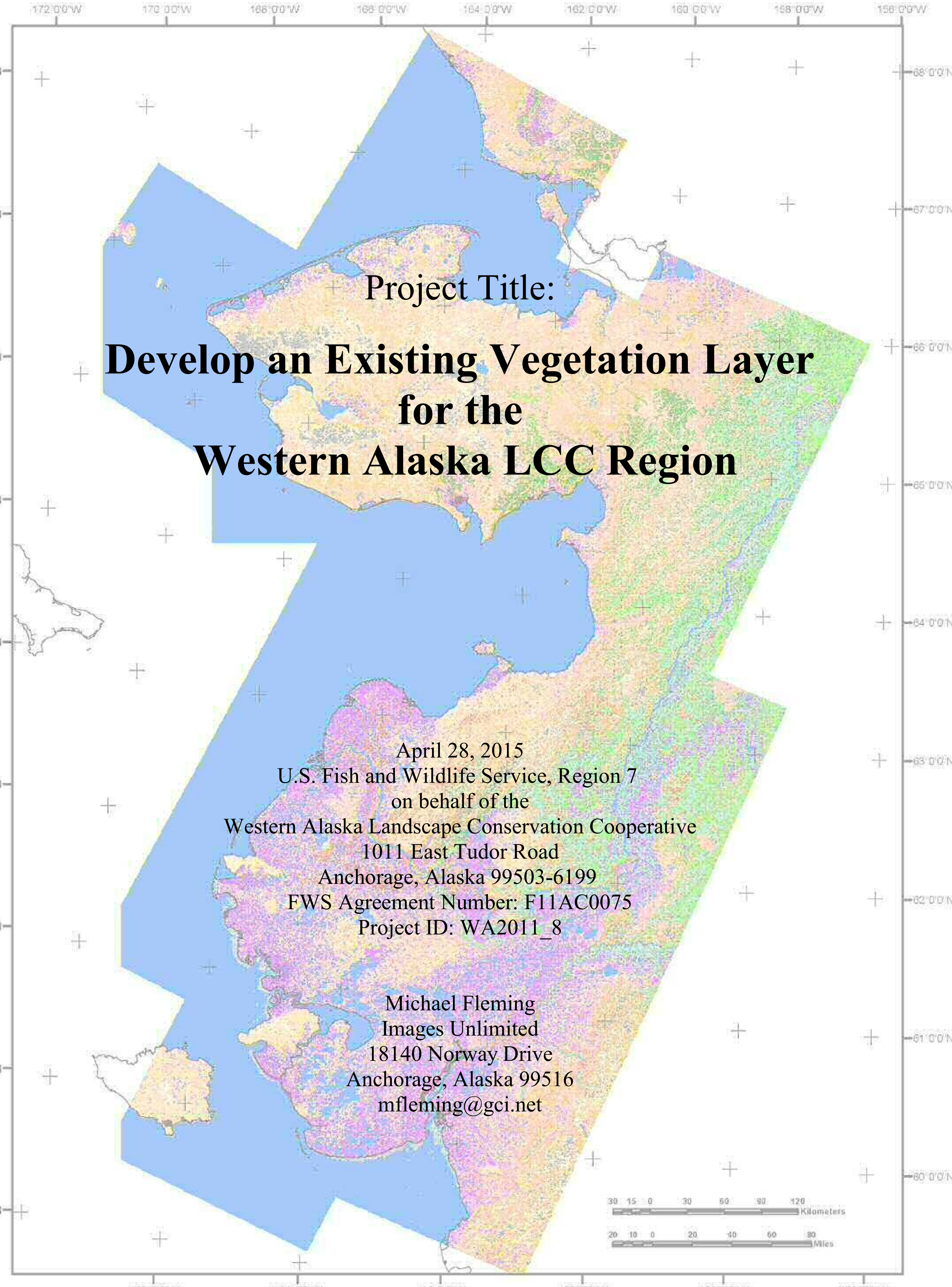

Project Title:

Develop an Existing Vegetation Layer for the Western Alaska LCC Region

April 28, 2015

U.S. Fish and Wildlife Service, Region 7
on behalf of the
Western Alaska Landscape Conservation Cooperative
1011 East Tudor Road
Anchorage, Alaska 99503-6199

FWS Agreement Number: F11AC0075
Project ID: WA2011_8

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KeyWords

Land Cover Mapping, Vegetation, Western Alaska

Tables and Figures

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Abstract

The objective of this project was to produce an Alaskan Existing Vegetation Type (AKEVT) map at 30m resolution for a portion of the Western Alaska Landscape Conservation Cooperative (WALCC) region using a very consistent (2000 +/- 1 yr.) remote sensing data set (Landsat 7 ETM+) and the same methodology. The mapped area encompasses the western and northern parts of the WALCC region, plus the Kodiak Archipelago. The legend was based on grouping the Alaska Vegetation Classification (Viereck, et al. 1992) Level IV classes to exclude the differences in vegetation height and canopy closure. Three major types of data were utilized; field plot data, Landsat 7 ETM+ spectral data, and environmental variables. All of the available field data sets across the state were compiled and processed into one database (LFRDB) by LANDFIRE project (LANDFIRE, 2014). The analysis is based on the processing of a strip of Landsat imagery, where all the scenes in the strip were from the same date. A stack with two or three dates of Landsat imagery was used for each strip. A number of environmental variables were developed and most were derived from either the USGS's DEM or NHD national data sets. The analysis/mapping consists of a two phase process. First a spectral analysis is used to develop the spectral classes naturally found in the Landsat imagery. The second is a modeling phase to split each spectral class into its various legend classes using the environmental variables (EV) and field data. Draft classifications were posted to a website and made available for review. Review comments were incorporated and each strip was checked using the surrounding strips before being finalized. The strips were composited into the final AKEVT classification and provide a uniform and seamless baseline vegetation data set for the western and northern parts of the Western Alaska LCC area.

Introduction

The objective of this project was to produce an Alaska Existing dominant Vegetation specie(s)/ land cover Type (AKEVT) map at 30m resolution for a portion of the Western Alaska Landscape Conservation Cooperative (WALCC) region (Figure 1). The big picture goal for the AKEVT project is to map the entire state using a very consistent (2000 +/- 1 yr.) remote sensing data set (Landsat 7 ETM+) and the same methodology to produce a baseline vegetation map for the entire state of Alaska (AK). This project was designed to develop the AKEVT product for the WALCC region. The lack of a consistently mapped vegetation data layer for Alaska has been identified as a primary road block for many conservation and management entities across the state. This project will address a number of the LCC conservation goals by addressing a baseline science need that is the foundation for current and future projects within the region. Only existing vegetation plot data sets, mostly from LANDFIRE (LANDFIRE, 2014), were utilized and no new field data were collected. Since the data had been through a QA/QC process as part of its incorporation into LANDFIRE, it was assumed the data was in useable condition and most of the additional processing could be completed in a semi-automated way. This turned out to not be the condition and had a significant impact on this project. The problems and their impact will be discussed in this report.

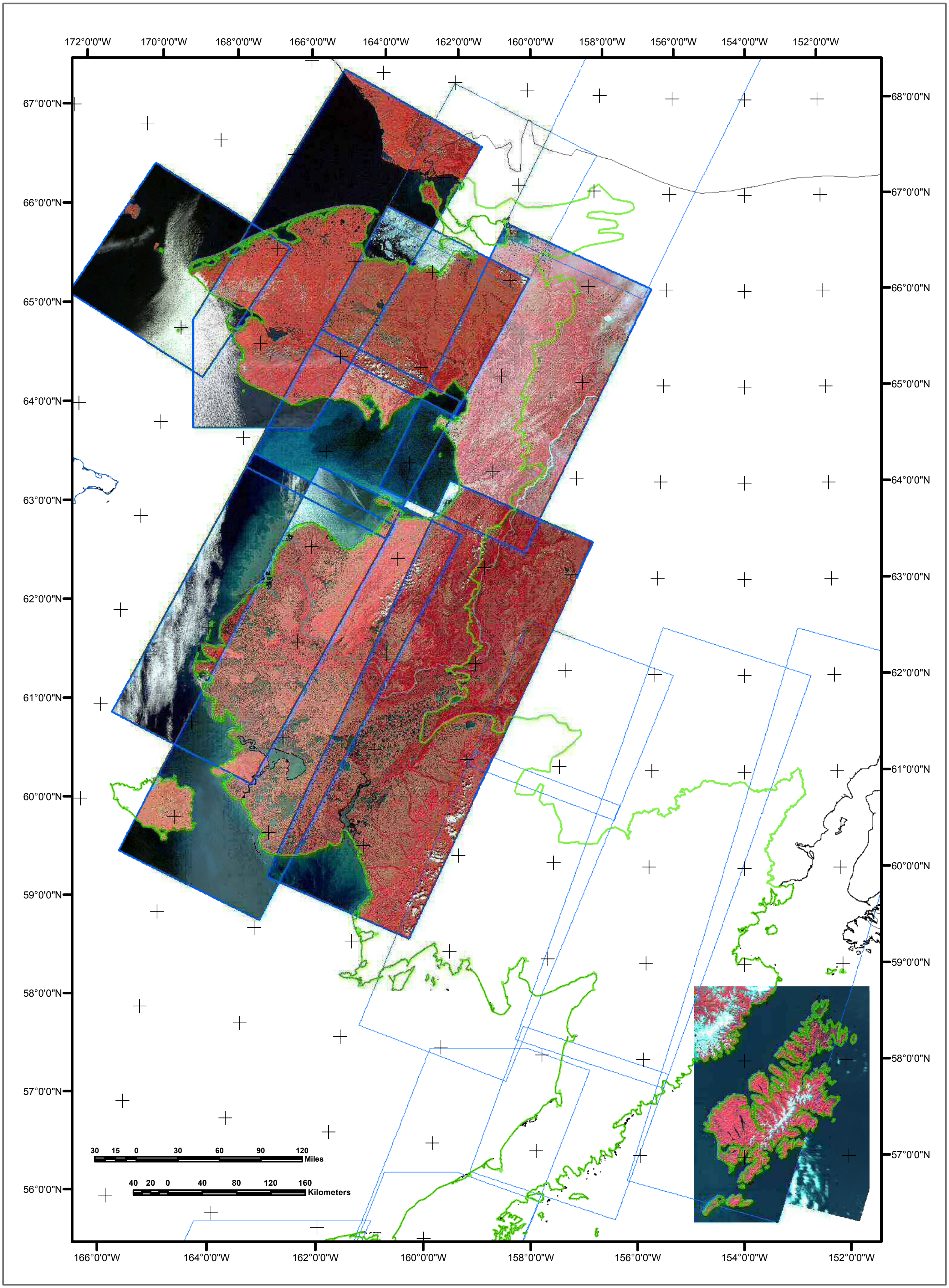
Project Area

The project area encompasses the western and northern parts of the Western Alaska Landscape Conservation Cooperative (WALCC) region (Figure 1), plus the Kodiak Archipelago. The area consists of 90 million acres of western Alaska, extending from Kotzebue in the north, southward to the Aleutians Islands. This project's original plan was to generate a map using the Alaska Vegetation Classification (AVC) (Viereck, et al. 1992) derived legend for the entire WALCC area. However, complications with imagery and datasets prevented our including the Bristol Bay and Alaska Peninsula sections of the Western Alaska LCC area in the final product. There are numerous land ownerships in the project area including: Fish and Wildlife Service, Bureau of Land Management, Department of Defense, National Park Service, native, state and private. The area covers a wide range of vegetation types, geology, climate, and soils which makes for a complex mix of vegetation classes that are mostly within tundra and taiga systems (Unified Ecoregions of Alaska, 2001).

Data Preparation

Legend

The mapping legend for this project was based on the Alaska Vegetation Classification Level IV (AVCL4) classes (Viereck, et al. 1992) which consist of three components: dominate species, height and canopy cover. The AKEVT legend is the dominate species component. The legend was developed by grouping the AVCL4 classes to exclude the differences in vegetation height and canopy closure (to be mapped separately). The result was a legend (Table 1) that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	AKEVT Legend Classes			FBFM40 Class		
				Wood/	Open/	Closed
Class	**Class**	**Strata**	**Viereck L4 Class(s)**	**Dwarf**	**Low**	**Tall**
0	No Data - Outside Imagery	-	-			
1	White Spruce Forest	Forest	1A1J;1A2E;1A3C		TU5	TU1
2	Black Spruce Forest	Forest	1A1K;1A2F		TU4	TU3
3	Black-White Spruce Forest***	Forest	1A1L;1A2G		TU5	TU1
4	Black Spruce w/Tussock Forest	Forest	1A3Da	GR2		
5	Black Spruce w/Lichen-Moss Forest	Forest	1A3Db,E	TU4		
6	Black Spruce-Tamarack Forest	Forest	1A2H		TU5	
7	Western Hemlock Forest	Forest	1A1B			TL1
8	Western Hemlock-Western Red Cedar Forest	Forest	1A1D,G			TL1
9	Mountain Hemlock Forest	Forest	1A1F,1A2C		TL1	TL1
10	Mountain Hemlock-Alaska Cedar Forest	Forest	1A1E			TL1
11	Sitka Spruce Forest	Forest	1A1A,1A2A,1A3B	TL1	TL1	TL1
12	Sitka Spruce-Balsam Poplar Forest	Forest	-		TL1	
13	Sitka Spruce-Western Hemlock Forest	Forest	1A1C,H,I;1A2B;1A2D	TL1	TL1	TL1
14	Red Alder	Forest	1B1A			TL2
15	Lodgepole Pine Forest	Forest	1A3A	TL1		
16	Paper Birch Forest	Forest	1B2A		TU1	
17	Paper Birch-Quaking Aspen Forest	Forest	1B1D,E,F,G			TU1
18	Paper Birch-Balsam Poplar Forest	Forest	1B3A,B,C	GR1		
19	Quaking Aspen Forest	Forest	1B2B		TL2	
20	Balsam Poplar (Black Cottonwood) Forest	Forest	1B1B,C;1B2C		TL2	TL2
21	Spruce-Paper Birch-Quaking Aspen Forest	Forest	1C1A,C,D,1C2A,B;1C3A	TL6	TL6	TL6
22	White Spruce-Paper Birch-Balsam Poplar Forest	Forest	1C1B,E;1C2C,D		TU1	TU1
23	Mountain Hemlock Scrub	Shrub	2A1A,B,2A2B		SH1	SH1
24	Black Spruce Scrub	Shrub	2A2A;2A3A	TU4	TU4	
25	Willow Shrub	Shrub	2B1A;2B2A;2C1B;(2C2G;2D3A**)	GR1**	TU1	TU1
26	Alder Shrub	Shrub	2B1B;2B2B;(2C2L*)	GS1*	TU1	
27	Alder-Willow Shrub	Shrub	2B1D;2B2D;2C1E;(2C2K*)	GS1*	TU1	TU1
28	Birch Shrub	Shrub	2B1C,2B2C			SH3
29	Birch-Willow Shrub	Shrub	2B1E,2B2E;2C1A,C;(2C2F*)	GR2*	SH2	SH3
30	Shrub Swamp	Shrub	2B1F;2B2F		SH1	SH1
31	Sweetgale-Graminoid Bog	Shrub	2C2J		GR1	
32	Ericaceous Shrub	Shrub	2C1D;2D2A,B	GR1	SH2	
33	Mixed Shrub-Sedge Tussock Tundra-Bog	Shrub	2C2A,B		GR2	
34	Birch-Ericaceous Shrub	Shrub	2C2C		GR3	
35	Ericaceous Shrub Bog	Shrub	2C2D,E		GR2	
36	Willow-Sedge Shrub Tundra	Shrub	2C2H		GR2	
37	Willow-Graminoid Shrub Bog	Shrub	2C2I		GR1	
38	Sagebrush-Juniper	Shrub	2C2M		SH2	
39	Sagebrush-Grass	Shrub	2C2N		GS1	
40	Dryas Dwarf Shrub Tundra	Shrub	2D1A,B		GR1	
41	Dryas/Lichen Dwarf Shrub Tundra	Shrub	2D1C		GR1	
42	Mtn Heath-Cassiope Dwarf Shrub Tundra	Shrub	2D2D,E		GR1	
43	Crowberry Dwarf Shrub Tundra	Shrub	2D2A.B,C		GR1	
44	Elymus	Herb	3A1A		SH4	
45	Grass-Shrub	Herb	3A1B,C,E		GR2	
46	Grass-Herb	Herb	3A1D		GR1	
47	Bluejoint Meadow	Herb	3A2A		GR4	
48	Bluejoint-Shrub-Herb	Herb	3A2B,C		GR2	
49	Tussock Tundra	Herb	3A2D		GR3	
50	Tussock/Lichen Tundra	Herb	-		?	
51	Mesic Sedge-Grass-Herb Meadow-Tundra	Herb	3A2E,F,G		GR2	
52	Sedge-Willow-Dryas Tundra	Herb	3A2H,J		GR1	
53	Sedge-Birch Tundra	Herb	3A2I		GR2	
54	Wet Meadow Tundra	Herb	3A3A,B,C		GR1	
55	Wet Sedge-Grass Meadow-Marsh	Herb	3A3D,E,F,G		GR1	
56	Wet Sedge Bog-Meadow	Herb	3A3J,K		GR1	
57	Seral Herbs	Herb	3B1A		NB7	
58	Alpine Herb-Sedge (Snowbed)	Herb	3B1B		NB6	
59	Alpine Herbs	Herb	3B1C		NB7	
60	Mesic Forb Herbaceous	Herb	3B2A,B,C,D		GR1	
61	Wet Forb Herbaceous	Herb	3B3A,B,C		NB6	
62	Halophytic Wet Meadow	Herb	3A3H,I;3B3D		NB6	
63	Wet Bryophyte (Moss)	Herb	3C1A		NB6	
64	Dry Bryophyte (Moss)	Herb	3C1B		NB7	
65	Crustose Lichen	Herb	3C2A		NB9	
66	Foliose and Fruticose Lichen - Lowlands	Herb	3C2Ba		GR1	
67	Foliose and Fruticose Lichen - Ridge	Herb	3C2Bb		NB7	
68	Aquatic Herbaceous	Herb	3D (all)		NB8	
69	Snow-Ice	Non-Veg	-		NB	
70	Water	Non-Veg	-		NB	
71	Rock-Talus-Glacial	Non-Veg	-		NB	
72	Sand-Gravel-Mud	Non-Veg	-		NB	
73	Recent Burn	Non-Veg	-		NB	
74	No Data	-	-		-	
75	Salmonberry-Elderberry	Shrub	-		?	
76	Recently Logged (forest->non-forest)	Non-Veg	-		?	

* Open and Low; ** Open and Low, or Dwarf; *** Both or non-specified (growth form and mapped as of White Spruce)

describes the vegetative specie(s) of the dominate cover type or land cover (non-vegetated). For taller vegetation types, forests and tall shrubs, it's a usually just one or two species. As the vegetation types get shorter, generally more species are present and groups of co-dominate species are mapped. As the initial application for this legend was for fire management, some classes were not grouped that normally would have been so different fuel models could be distinguished, i.e. several black spruce classes with different under stories. Table 1 shows the legend class names, as well as a list of the AVCL4 classes included in each legend class and the Scott and Burgan Fire Behavior Fuel Model (FBFM40, 2014) fuel model, when combined with vegetation height and vegetation canopy cover. The descriptions of the AVCL4 classes in Viereck et al. (1992) provide an excellent description of the vegetation communities included in each of the AKEVT classes. Some classes are not found in AVC, mainly the non-vegetated (snow-ice, water, rock-talus, mud-sand-gravel, and recent burn), but there were also several vegetated classes that were not present. These include; salmonberry-elderberry, Sitka spruce-balsam popular forest, and tussock/lichen tundra.

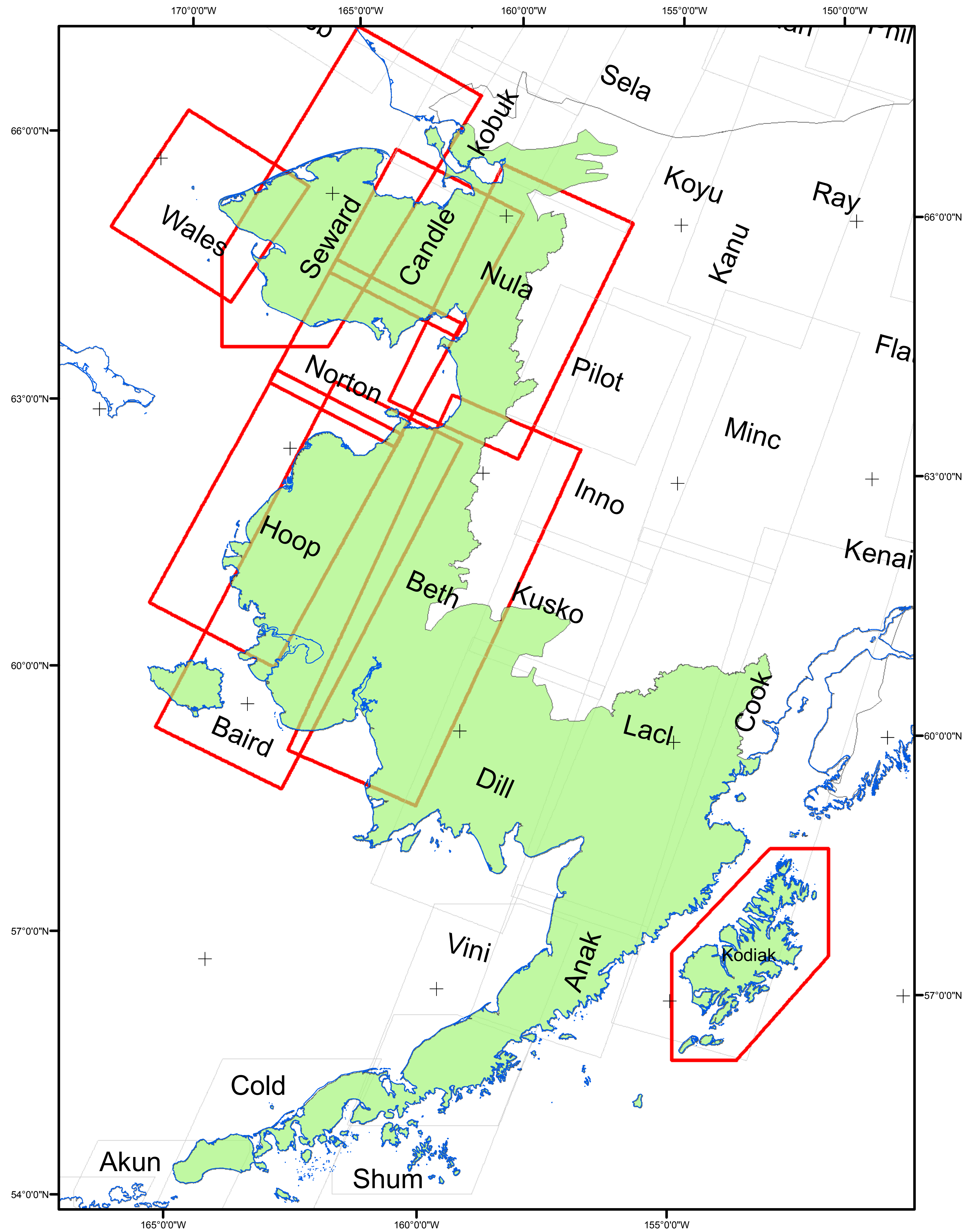
Field Data

The first major input data source needed was the field plot data. LANDFIRE (2014) compiled and processed all of the available field data sets, including a QA/QC, across the state into one database (LFRDB). The field data sets had been collected between 1984 and 2007. Since then, a few new field data sets have been collected and were prepared for the analysis. Figure 2 shows the location of the known, publically available field plots across the region, after QA/QC of the plots. All of the field data sets underwent further QA/QC checks to make sure the plots were useable. The evaluation indicated that due to inaccurate locations and inaccurate conversion of the field data to the legend classes, the plots would require extensive editing to make them useful for a direct inclusion in the analysis process in either the training or the evaluation stages. This required changing the methodology in the environment variable modeling phase of the analysis and will be discussed in the Analysis/Mapping section. It also made generation of a quantitative estimate of the accuracy impossible.

All field plots within each strip were still utilized for that strip's analysis, but required a manual interpretation process to figure out the correct location and legend class of the field observations. This process consisted of first determining the probable location of the plot using the Landsat data, higher resolution imagery and any field data or photos, if available. The second stage involved interpreting the imagery, field photos and field data collected to determine the correct legend class assignment. In some cases this required going back to the original plot data and field form to get enough detailed information on the vegetation present. This process of interpretation to determine the plot location and legend class was done on the fly as needed during the analysis. These edits were not made to the field data records due to the time consuming process required that was not planned for this project.

Spectral Imagery

The analysis area is based on the processing of a scene of Landsat imagery, or a strip of scenes (1 to 5 scenes can make up a strip) where all the scenes in the strip are from the same date. Figure 3 shows the eighteen strips that were needed to cover the WALCC region. The terrain-corrected Landsat ETM+ data is at 30m resolution (0.22acre), and includes eight bands of imagery: six spectral, a thermal, and a hi-resolution panchromatic (15m). For each strip a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Candle
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Nula
Pilot
Norton
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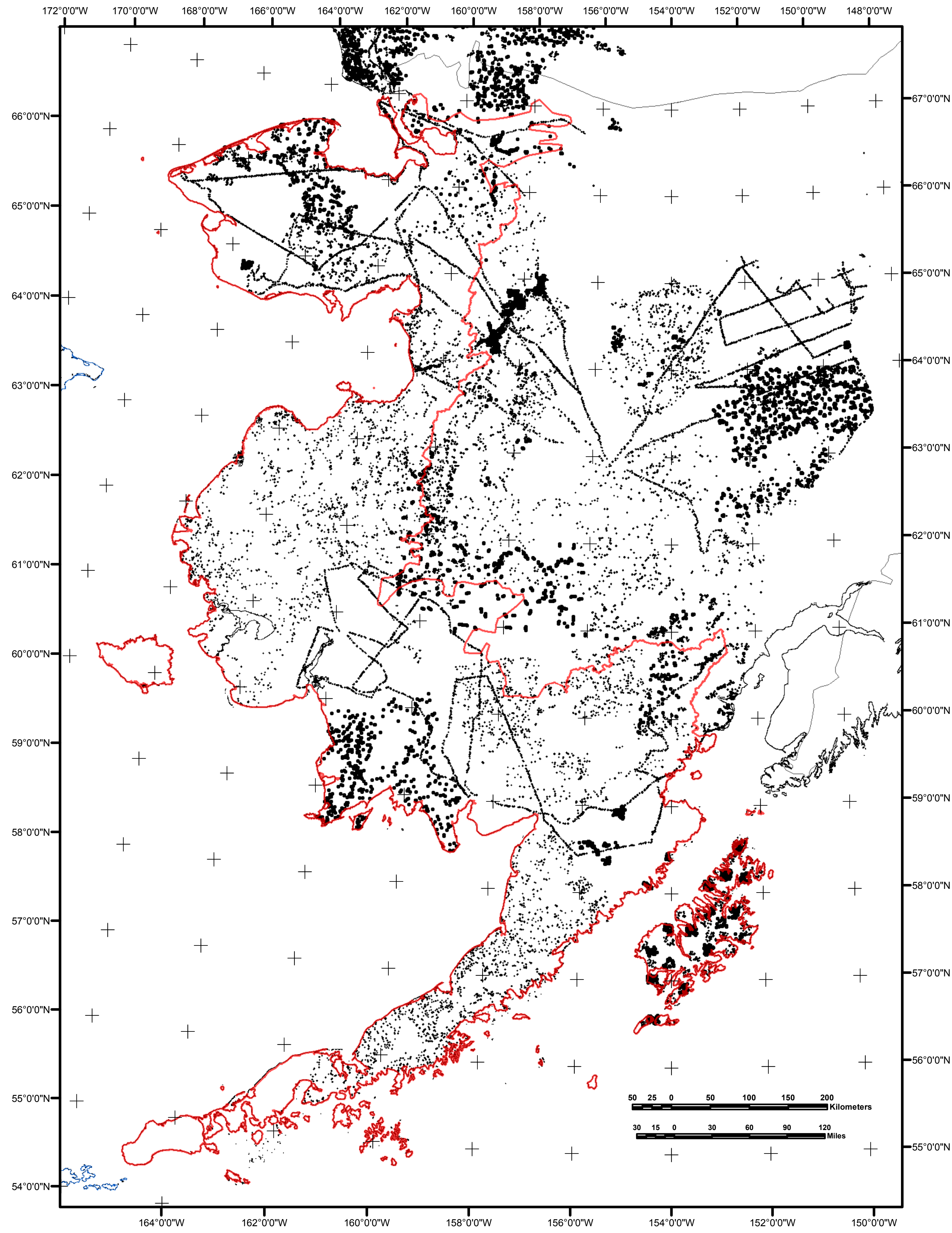
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Kilometers
30 15 0 30 60 90 120
Miles

stack of raster data sets was built. The spectral data included three dates of Landsat imagery, a spring, a summer, and a fall scene. Almost all of the scenes were collected in 2000, plus or minus one year, thereby providing a very consistent baseline data set for the analysis. Table X2X lists for each strip the scene ID, date of scenes, path/row(s). The spring scene, all of the derivatives of the Landsat data, the thermal and panchromatic bands were only used as environmental variables in the modeling phase, as needed.

Table 2. LANDSAT 7 ETM+ scenes utilized.

					Date		Acres
Strip	**Location**	**#scenes**	**Path**	**Rows**	**Summer**	**Fall**	**Classified**
BAIRD	Baird Inlet	3	78	16 - 18	05/29/03	06/27/05	24,166,993
BETH	Bethel	3	76	16 - 18	07/31/02	09/09/99	22,696,022
CANDLE	Candle	1	79	14	06/12/00	06/28/00	8,288,734
HOOP	Hooper Bay	2	79	16 - 17	06/18/02	08/15/00	15,513,279
KODIAK	Kodiak Arch.	3	70		08/16/00	09/08/99	13,837,352
NORTON	Norton Sound	1	79	15	06/12/00	08/21/02	15,199,618
SEWARD	Seward	3	81	13 - 15	08/03/02	08/27/99	18,409,366
NULA	Nulato	2	77	14 - 15	07/22/05	09/16/99	15,506,160
WALES	Cape Wales	1	83	14	07/10/00	08/01/02	8,260,094
Total		19					141,877,618

Environmental Variables (EV)

The environmental variables were used during the analysis to split specific spectral classes into its vegetational components, the modeling methodology will be discussed in the next section. A number of environmental variables were developed at 30m resolution for each strip and are listed in Table 3. Most were derived from either the U.S. Geological Survey's national Digital Elevation Model (DEM) or National Hydrography Data(NHD) data sets. A number of coarser resolution data sets (1000-2000m) were available including: the Unified Ecoregions of Alaska (Nowacki, et. al, 2001), Natural Resources Conservation Service STATSGO (STATSGO, 2002), and climate: temperature and precipitation (Fleming, et. al, 2000), but were rarely needed during the EV modeling step. In a couple instances existing data sets did not suffice and an EV had to be developed and hand digitized to accomplish the required split, mostly equivalent to ecoregion lines. Some of the spectral imagery was also available as environmental variables including the spring Landsat imagery and the derivatives from the summer and fall scenes, but not the 12 (2x6) spectral bands used in the spectral analysis. Initially a core group of these data sets were assembled for each strip including: elevation, slope, aspect, a modified topographic position index, and the solar illumination for the summer and fall dates. The rest of EV's were only prepared if needed for a specific split.

Table 3. Environmental Variables Available

Variable	Description	Source
DEM	Digital Elevation Model	USGS-DEM
Slope	Terrain Slope	Calculated from DEM
Aspect	Terrain Aspect	Calculated from DEM
SI	Scene(s) Solar Illumination	Calculated from DEM
TPIm	Topographic Position Index (modified)	Calculated from DEM
D2Coast	Distance to Coastline	Calculated from NHD
D2Stream	Distance to Streams	Calculated from NHD
D2Stream2	Distance to 2 line Streams	Calculated from NHD
Sheds	Watersheds	USGS-NHD
Mtns	Mountain Ranges (opposite of watersheds)	Digitized
TRF	Temperate Rain Forest - boundary	Interpreted and Digitized
FireYr	Year of Fire	From Alaska Interagency Coordination Center
Ecoreg	Unified Ecoregions, or modifications	Unified Ecoregions, or digitized
D2Roads	Distance to Road	USGS-Transportation
Logged	Digitized Logged Areas	Digitized areas
D2LogRoad	Distance to Logged Road	USGS-Transportation
NDVI	Normalized Difference Vegetation Index	Calculated from Landsat scene(s)

Analysis/Mapping

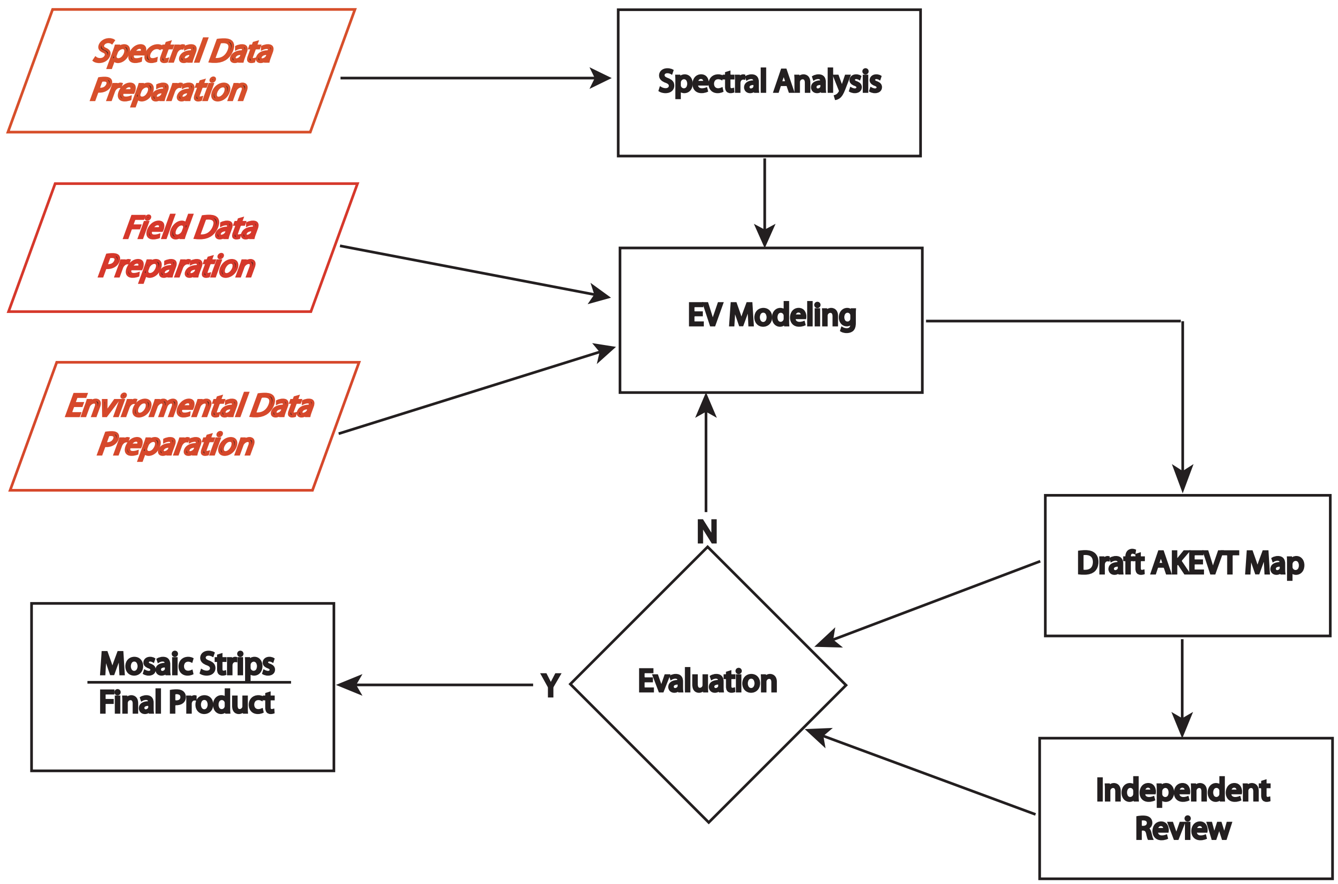
Overview

The following is a short summary of the overall mapping process. The steps involved in the mapping are shown in Figure 4. The first step was preparing the input data sets, as described in the previous section. The analysis/mapping consists of a two phase process. First is a spectral analysis to develop a set of spectral classes naturally found in the Landsat imagery. The second is a modeling phase to split each spectral class into its various legend classes using the environmental variables (EV). For example, a common model is to split a class that contains both "water" in flat areas and "talus- rock" in terrain shadow, by using solar illumination or some combination of elevation, slope, aspect and/or topographic position. The process is repeated for each of the spectral classes and then all of the models are run to generate the classification. The resulting classification is then evaluated and the EV model(s) are modified/adjusted and rerun as necessary.

Once an acceptable draft classification was developed for a strip, it was posted to the UA/GINA website [http://akevt.gina.alaska.edu] and made available to anyone interested in reviewing the classification. After a review period any comments received were evaluated and incorporated where needed. Each strip was also checked using the surrounding scenes before being finalized. The edge-matching process provides a good idea of the accuracy of the classifications and readily identifies areas where problems exist in the classification(s). The strips were then composited into a single continuous geo-referenced AKEVT data set for the project area. The data was then split into two pieces, a northern Seward Peninsula region and a southern Y-K Delta region, to make the data set a more manageable size.

Figure 4. Overall analysis methodology.

Alaska Existing Vegetation Type (AKEVT) Mapping



Step 1. Spectral Analysis

Once all of the input data sets were prepared, the first step in the analysis was to complete a spectral analysis of the Landsat imagery. A series of unsupervised cluster analyses (ESRI-ISO CLUSTER & LAS-ISODATA) were run to split the spectral data into cluster classes using the summer and fall Landsat scenes. The first cluster analysis used both dates of imagery. The results were reviewed to identify any classes that contained bad data on one of the two dates, (i.e. clouds/cloud shadows, snow, smoke, volcanic ash, fog, contrails, or bad data lines). The initial cluster classes were sorted into five groups:

1. Vegetated and good data on both dates.
2. Non-Vegetated and good data on both dates.
3. Bad data on the first date.
4. Bad data on the second date.
5. Bad data on both dates.

Then an additional cluster analysis was run on groups three and four using the single, good date of imagery. In cases where the initial cluster analysis resulted in a small number of vegetated cluster classes (group 1), a cluster analysis was run on the group using both dates to get a more detailed split of the spectral data. If there were any cluster classes in group 5, a cluster analysis was run using one or both dates, depending on an evaluation of the situation. In some cases it was necessary to further cluster one or more cluster classes to refine the splits and extract more information. The last step in the spectral analysis was to group all of the unsupervised classes generated during the splitting phase into a set of classes that were homogenous, spectrally and spatially. This was accomplished by grouping spectrally similar classes to match the spatial patterns visible in the Landsat data. This essentially aggregated the fragments from the clustering step to make spectrally and spatially homogeneous classes.

Step 2. EV Modeling

The second step in the analysis was to split each spectral class into its legend classes using the environmental variables and field data. The original plan was to complete this modeling step automatically using the field data and a data mining tool (See5, 2014). However the poor quality of the field data prevented the automatic development of the models and required a manual expert option approach. The manual approach consisted of evaluating each spectral class and identifying EV(s) which could be used to split the spectral class into its component vegetation and landcover classes. This process basically consisted of reviewing the spatial distribution of each spectral class, manually interpreting any field plots on or near the spectral class to determine what legend class(es) are represented, and then developing a strategy to split the spectral class using one or more of the environmental variables. For example, as mentioned earlier, a spectral class that was predominately water might be split into water and talus using a low solar illumination value (i.e. in shadow). Another example would be a spectral class that was mostly a wet graminoid marsh class, but contained both halophytic wet meadow at low elevations and near the coast, and a mesic graminoid tundra at higher elevations. Some were as simple as: on the ocean side of a mountain range it was one type, and something quite different on the interior side of the mountains. A model was developed for each spectral class using one or more of the environmental variables. The coarser resolution data sets (~1km) were used only if needed to solve a specific problem. The models were then applied to the data and a classification generated. It was then qualitatively reviewed for accuracy and any edits to models that needed to be modified, deleted, or new models added, were made and the classification rerun. This was repeated several times, until all of the problems were either fixed or identified as not possible to correct, i.e. bad data on both dates, resulting in the final draft product for each strip. To be acceptable, the qualitatively estimated accuracy for each class needed to be above 75 to 80%.

Step 3. Independent Review

Once an acceptable draft classification was developed it was posted on a UA/GINA (ref) website [http://akevt.gina.alaska.edu] and made available to anyone interested in reviewing the classification. A workshop was developed and presented (including webinar) to all interested in reviewing the draft classifications. The workshop discussed the project, legend, and methods to review the data and provide useful feedback. Over 30 people attended the workshop. An email was periodically distributed to update those interested on status, new strips that had been posted and notes on the classifications. The reviews were then to be compiled for each strip and used in the evaluation phase.

Step 4. Evaluation

The classified strips were QA/QC'd by reviewing comments received, checking the edge matching with the surrounding strips and a final overall check of the classification. Comments from independent reviewers were to be addressed and incorporated. The overlap of the classifications at the edges of the strips results in essentially independent predictions of the legend classes. This provides a powerful tool for evaluating the classifications. Classes that don't match indicate one, or both, of the classifications are in error. For any problems that were identified, new models were developed, applied and re-evaluated.

Step 5. Strip Compositing & Final Products

The strips were then mosaiced to generate a seamless, continuous coverage for the entire region. The final products include: the digital raster geo-spatial database of the dominate vegetation species (AKEVT) for the region, with an attribute table; and a FGDC compliant meta data file. No quantitative accuracy assessment was available.

Step 6. Accuracy Assessment

Due to inaccurate locations and inaccurate conversions of the field calls to the legend classes, the field plots were unacceptable for use as a quantitative QA/QC, as intended. Instead the qualitative QA/QC results from the Evaluation in step 4 will be relied on for an estimate of the accuracy for each class.

Results

Overview

Figure 5 shows an overview of the AKEVT data set covering the project area for the Western Alaska LCC. The final product is a digital raster data set of the AKEVT classification; including an attribute table with basic information for each legend class, and a metadata file describing the data set. The AKEVT classification provides a uniform and seamless baseline vegetation data set for the western and northern parts of the Western Alaska LCC area. The level of detail and accuracy should provide a useful data set for many applications.

Workshops were conducted to introduce the classification method, the products, and the voluntary review process to potential reviewers, and other interested parties. Unfortunately no review comments were received.

Not having accurate field data had a significant effect on the methodology and analysis, changing it from basically an automated execution of the EV modeling to a completely manual interpretation approach. This significantly lengthened the time required to complete the analysis. But compared to other similar analysis with good field data (including Kodiak), the manual approach tends to result in a better classification. The automated approach tends to over split the data and results in a "specklely" classification. Note: there is significantly more information in the spectral data, but to extract it requires better quality field data. For this level of mapping, all that is required from the field data is an accurate location and a AVC Level IV call (field photos can be helpful).

Field Data

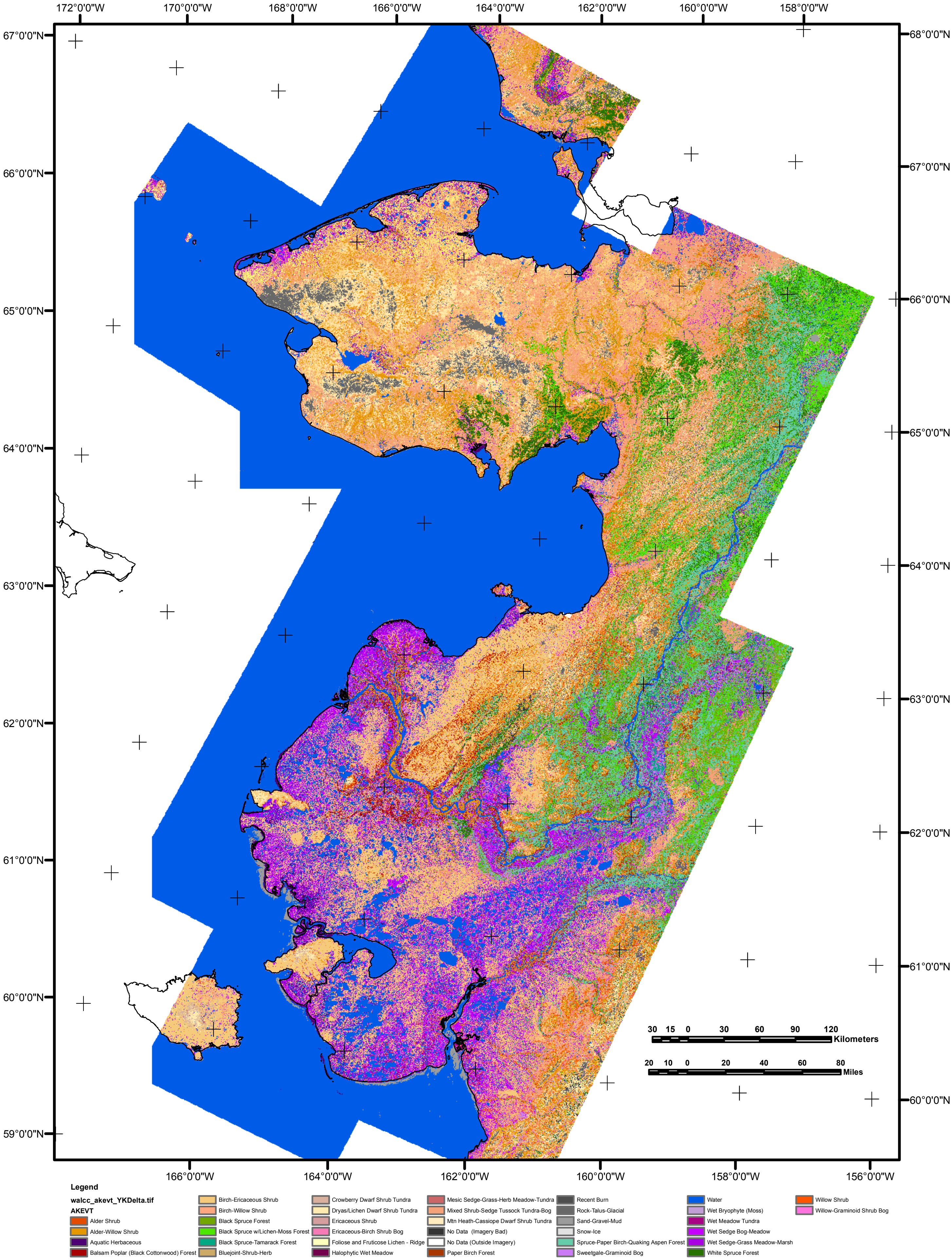
As previously mentioned, significant problems were encountered in utilizing the existing automated (GIS) field data sets. This required altering the digital analysis and prevented obtaining a quantitative estimate of the accuracy. The modified analysis process was significantly slower, but did not reduce the accuracy of the final product. A summary of the main types of problems with the field data was requested and will be discussed in this section.

The basic requirements for usable field data include: an accurate location, to within the 50m geometric accuracy of the Landsat data; and an accurate description of the vegetation/land cover conditions on the plot. Enough vegetation detail is required from the plot information to determine the legend class, basically AVCL4 without height or canopy cover. I would estimate that less than 5% of the roughly 72,000 existing QA/QC'd plots across the state currently meet both of these requirements. Overall, many of the plots could be made useful, the information is there, but will require time, effort and expertise to fix.

The different types of problems with the existing field data sets include:

1. Sample design. This is related to the distribution of the existing plots. These include from a larger scale to a smaller scale: lack of plots in some areas, mostly state lands; poor distribution of the plots across a project area, i.e. vegetation types of interest are well sampled, other types are not; and a number of plots from a project, but are representative of a very small area or vegetation type. For example, the Ducks Unlimited (DU) field plots focus more on wetland classes, at the expense of other vegetation associations. Another example is the FIA plots that follow a 4k sampling grid that is not dense enough in the coastal areas of Alaska since many plots fall on water, rock or ice-snow and relatively few on vegetation. Alternatively, The result was wide variation among the spectral classes developed during this analysis in the

AKEVT Classification for Western Alaska



number of associated field sample plots for a spectral class – from none to over ten. This will require new field data collection to solve.

2. Collection. This included many different types of errors, ranging from only very general information collected (i.e. "deciduous forest") to incorrect identification of the vegetation (i.e. aquatic sedges species on a dry/mesic mountain slope), or field information not fully or inaccurately captured. The DU plots were about the only plots across the state that, generally, a AVCL4 class could be determined from the field data and photos.

3. Vegetation identification and interpretation (class assignment). The legends for most of the projects were based on the AVC classification, but often did not use or correctly identify the community/association using the AVC definitions. For many of the plots, particularly DU's, sufficient information was collected, but needs to be reinterpreted and a consistent vegetation community/association assigned. For example, in one instance a very homogeneous spectral class contained five plots, but two were labeled "sweetgale", two "willow and one "wet graminoid". All five by AVC definitions would have been "sweetgale-graminoid bog" (AVC IIC2J). All had 35-50 percent sweetgale and varying amounts of willow and graminoids. A class level QA/QC of the plots is needed to identify the problems with plot type calls.

4. Location. The most common and serious problem was with the location of the plots. This probably resulted from data used that was the pre-Landsat 7 and not terrain corrected, or incorrect datum assigned or transformed. This was often evident from a fairly consistent shift in one direction and distance of the location for a group of plots. While other groups had very random shifts in the plot locations. Although the DU plots were often close, very few were accurately located. Point plots are much more difficult to assess for locational accuracy since there is no spatial shape to match in the imagery. This type of error can be fixed for polygonal plots, but the difficulty varies greatly, depending whether the shift is random or systematic.

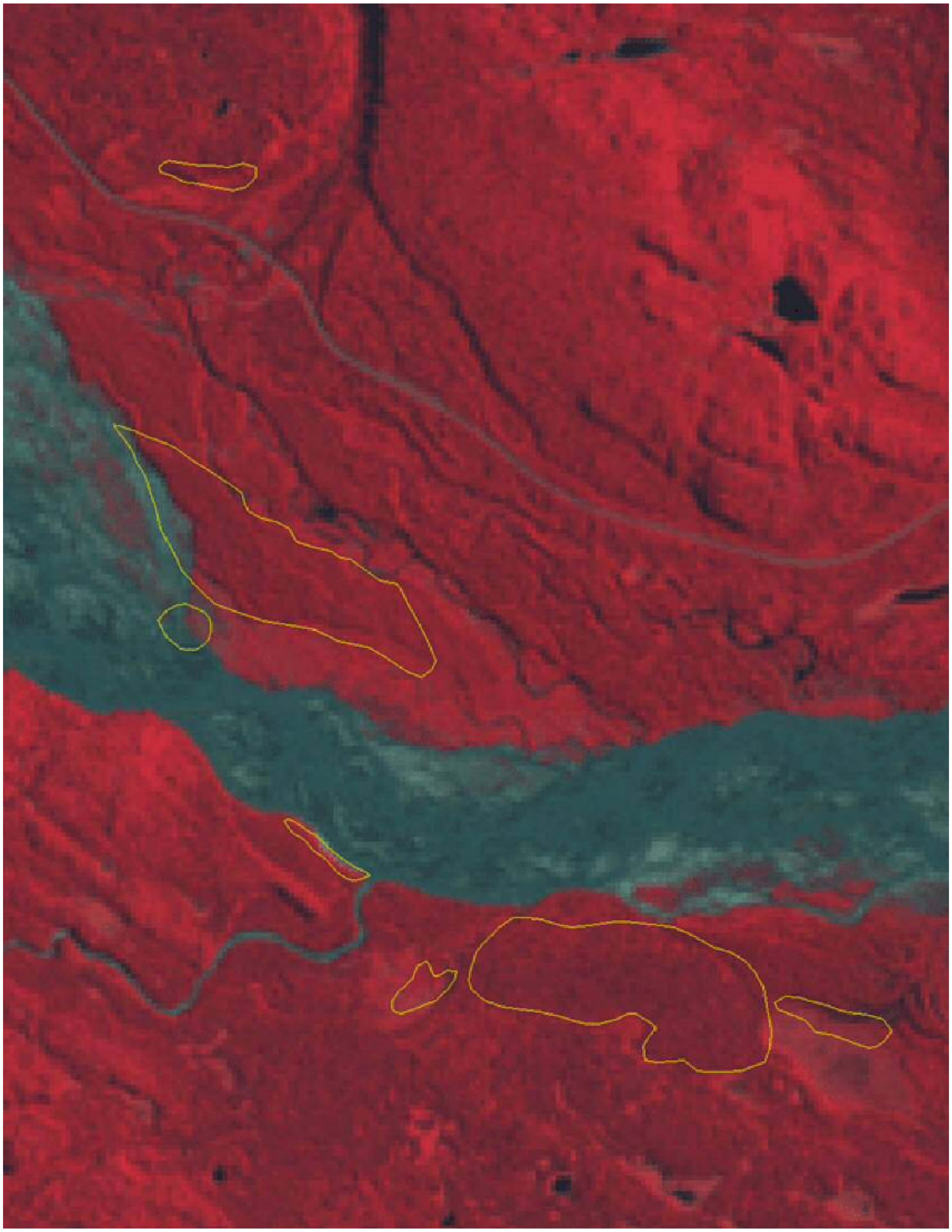
5. Automation. Other types of problems resulted from automation of the field data. These include: plot data incorrectly entered, data sets not completely assembled in the geospatial data base with all tables and links to the correct photographs. Bits and pieces are often missing or incorrect. These types of errors can be fairly easily fixed.

6. Inaccurate conversion of the field information to legend classes. Incorrect or incomplete conversion of the field information to the AKEVT (and the LANDFIRE EVT) classes. Many plots failed QA/QC because they could not be assigned a legend class. Others were assigned incorrect AKEVT and LF EVT classes through misinterpretation of the field information.

7. Landcover change. In some cases the landscape has changed since the field visit, for example fire or flooding may have significantly changed the vegetation on the plot. Examples of some of the problems are illustrated in Figure Y6Y. These can be fixed fairly easily, and should be identified during the QA/QC process.

Overall, the most frequent problem with the plot information was an incorrect plot location, easily fixable with some groups of plots. The more difficult problem to fix is the field data call assigned to each plot, between the lack of information on some plots to inconsistent vegetation type calls on others. Part of this is because making a AVC Level IV or V, type call was not an objective of the field effort collecting the data. One of the most useful aids where they existed, was the aerial oblique photographs shot for the LF project. Note, none of the field data collected across the state by FWS and BLM in the early 1980's was included in LFRDB.

Figure 5. Example of problems with field plots.



AKEVT Product

A dominate specie(s) vegetation/land cover classification (AKEVT) was generated for the western and northern portions of the Western Alaska LCC region. A qualitatively estimated overall average accuracy of 80%, and 75% for most individual classes was obtained. Although the goal was to provide a quantitative accuracy assessment, we are unable to due to the limited availability of useable plot data and the lack of volunteer reviewer response for most classes and locations.

Metadata and Attribute Table

An attribute table was built for the classification and includes for each legend class: the class number, AKEVT name, acreages, and the class's percent of land (Table 4 below).

Class	AKEVT Name	Pixels	Acres	SqKm	Land%
0	No Data (Outside Imagery)	338214831	75215596	304393348	0.00
1	White Spruce Forest	11981060	2664468	10782954	4.68
2	Black Spruce Forest	6551011	1456879	5895910	2.56
5	Black Spruce w/Lichen-Moss Forest	11258893	2503865	10133004	4.40
6	Black Spruce-Tamarack Forest	2489378	553613	2240440	0.97
16	Paper Birch Forest	2132607	474270	1919346	0.83
20	Balsam Poplar (Black Cottonwood) Forest	3349079	744802	3014171	1.31
21	Spruce-Paper Birch-Quaking Aspen Forest	20314839	4517817	18283355	7.93
25	Willow Shrub	4996155	1111095	4496540	1.95
26	Alder Shrub	2648277	588950	2383449	1.03
27	Alder-Willow Shrub	25082536	5578105	22574282	9.80
29	Birch-Willow Shrub	3813246	848028	3431921	1.49
31	Sweetgale-Graminoid Bog	7771884	1728389	6994696	3.04
32	Ericaceous Shrub	367251	81673	330526	0.14
33	Mixed Shrub-Sedge Tussock Tundra-Bog	44629598	9925176	40166638	17.43
34	Birch-Ericaceous Shrub	33352709	7417309	30017438	13.03
35	Ericaceous-Birch Shrub Bog	809539	180033	728585	0.32
36	Willow-Sedge Shrub Tundra	3257	724	2931	0.00
37	Willow-Graminoid Shrub Bog	159119	35386	143207	0.06
41	Dryas/Lichen Dwarf Shrub Tundra	12506836	2781395	11256152	4.88
42	Mtn Heath-Cassiope Dwarf Shrub Tundra	925684	205863	833116	0.36
43	Crowberry Dwarf Shrub Tundra	730522	162461	657470	0.29
48	Bluejoint-Shrub-Herb	157119	34942	141407	0.06
50	Tussock/Lichen Tundra	1813478	403299	1632130	0.71
51	Mesic Sedge-Grass-Herb Meadow-Tundra	72559	16136	65303	0.03
52	Sedge-Willow-Dryas Tundra	13642047	3033855	12277842	5.33
54	Wet Meadow Tundra	1920989	427209	1728890	0.75
55	Wet Sedge-Grass Meadow-Marsh	6022368	1339314	5420131	2.35
56	Wet Sedge Bog-Meadow	21093738	4691036	18984364	8.24
62	Halophytic Wet Meadow	46725	10391	42053	0.02
63	Wet Bryophyte (Moss)	882013	196151	793812	0.34
67	Foliose and Fruticose Lichen - Ridge	300968	66932	270871	0.12
68	Aquatic Herbaceous	4725619	1050930	4253057	1.85
69	Snow-Ice	79448	17668	71503	0.03
70	Water	174013483	38698858	156612135	0.00
71	Rock-Talus-Glacial	7329879	1630092	6596891	2.86
72	Sand-Gravel-Mud	1698184	377659	1528366	0.66
73	Recent Burn	29262	6508	26336	0.01
74	No Data (Imagery Bad)	377450	83941	339705	0.15

Summary and Recommendations

An AKEVT map and digital data set was generated for the western and northern sections of the WALCC region, covering over 70 million acres and is available at [http://akevt.gina.alaska.edu]. The main limitation to the analysis was the quality of the field data. It caused roughly an order of magnitude increase in the effort required to complete the EV modeling phase of the analysis. The field data needs to be fixed, the locations need to be matched against at least Landsat resolution data and the best possible vegetation call made from the available field data, hopefully to AVC level IV or V classes. A class level QA/QC of the field data is needed. Most importantly, new field data needs to start being collected to fill in the gaps in existing coverages, both between and within project areas, and secondly, to start fixing the existing field vegetation information data base. Collecting new field data is an expensive and lengthy process. An approach is needed similar to the one used in the 1980's land cover mapping projects, where well stratified and distributed field plots were used to quickly collect basic descriptions of the vegetation (Fleming, 1987). Also, some approach needs to be developed to add to the data base when people visit field plots for other applications.

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