PROPOSAL FOR THE VEGETATION AND FUELS MAPPING OF THE SLEEPING BEAR DUNES NATIONAL LAKESHORE

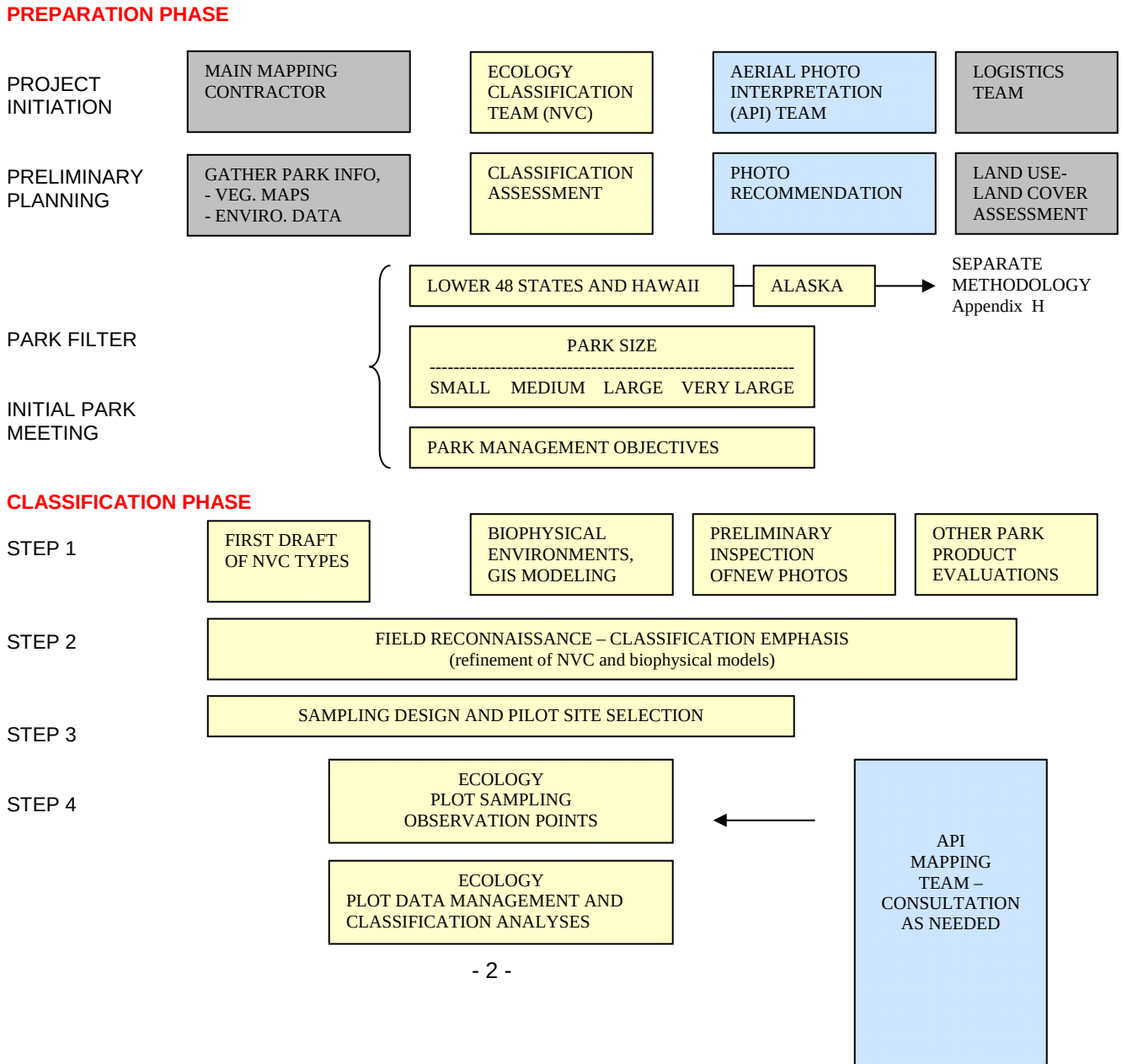
January 2007

PROJECT DESCRIPTION:

The primary objective of this project is to develop a spatially referenced vegetation database map, supported with ecological and vegetation data, for use in geographic information systems (GIS) and in support of the management of park natural resources. The project will provide an inventory of vegetation communities at SLBE, providing descriptive botanical and ecological information that can be referenced to locations as provided by the vegetation map. Along with the vegetation map will be a fuels model, keyed to the vegetation types as determined by quantifying dead and downed fuels and herbaceous layer characterization relative to Stereo Photo Series for Quantifying Natural Fuels. The vegetation map's footprint will cover all of the SLBE with a 400-meter buffer beyond the park boundary.

CLASSIFICATION AND MAPPING PROCESS:

The general vegetation mapping procedure for the USGS-NPS VMP is outlined in Figure 1 below. No one park-mapping project necessarily follows this schematic exactly. Nevertheless, the classification and mapping procedures for SLBE vegetation mapping, as outlined in this proposal, follow this schematic diagram for the most part.



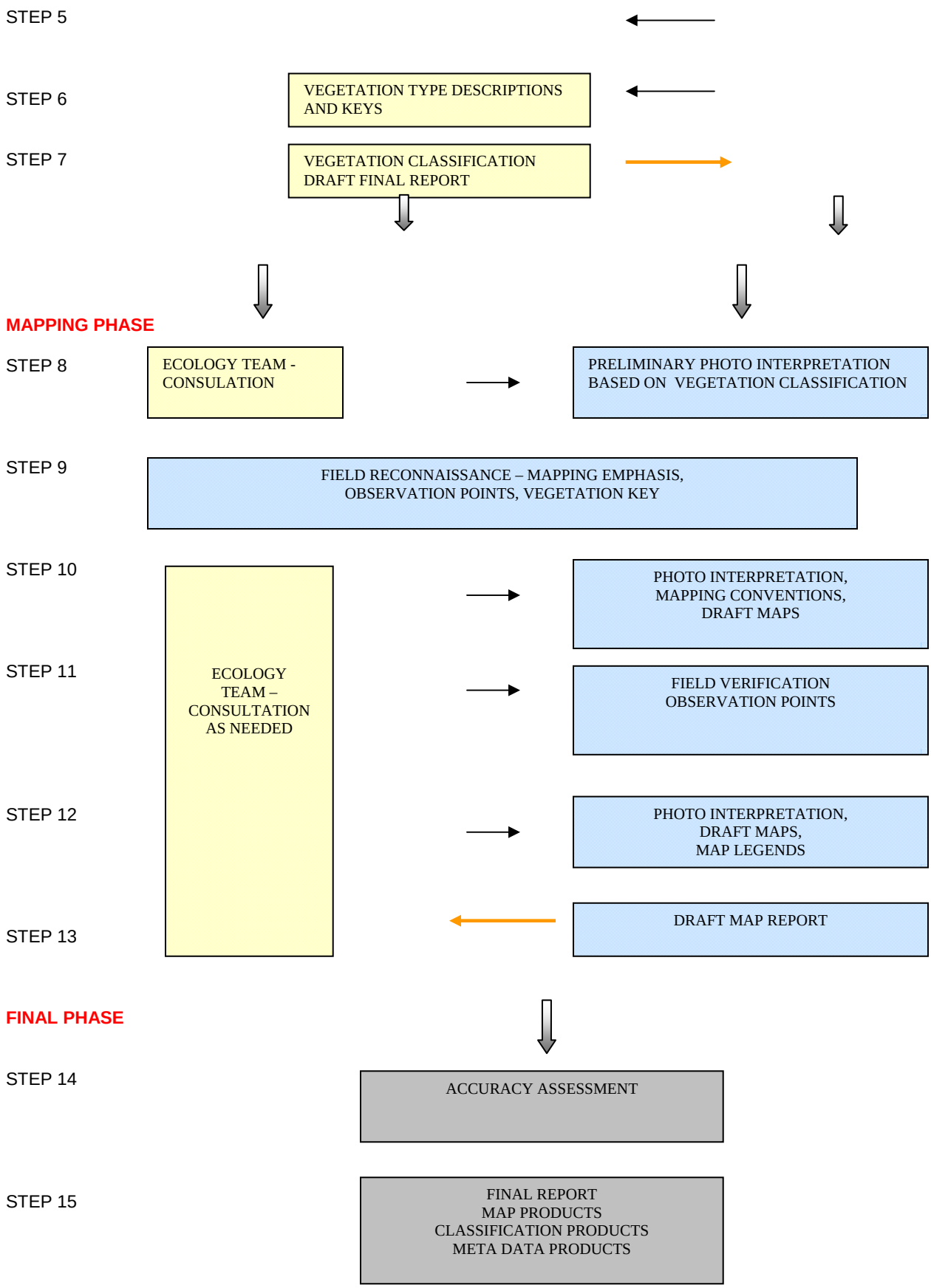

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Figure 4. Flow diagram for completing the classification and mapping of a national park.

Aerial Photography Acquisition

Color infra-red aerial photography is contracted for SLBE, but the narrow window of peak leaf color in fall of 2006, drought and wind conditions, conspired to prevent the flight from being completed. The Great Lakes Network is planning on acquiring a spring, leaf-off natural color flight at 1:12,000-scale in early 2007, with completion of the color infra-red, peak leaf color change flight anticipated in fall 2007. Both flights will be completed with standard 60% endlap, 30% sidelap for complete stereo coverage (Figure 2). Products for the CIR flight is 2 sets of prints, 1 set of diapositives, scans of imagery at 15 micron, and ortho-photography. The spring flight will not include diapositives. The resulting sets of imagery will have a ground pixel of roughly 0.15 meters. This orthophotography will significantly improve the efficiency and accuracy of geo-referencing the raw polygon overlays during the mapping phase.

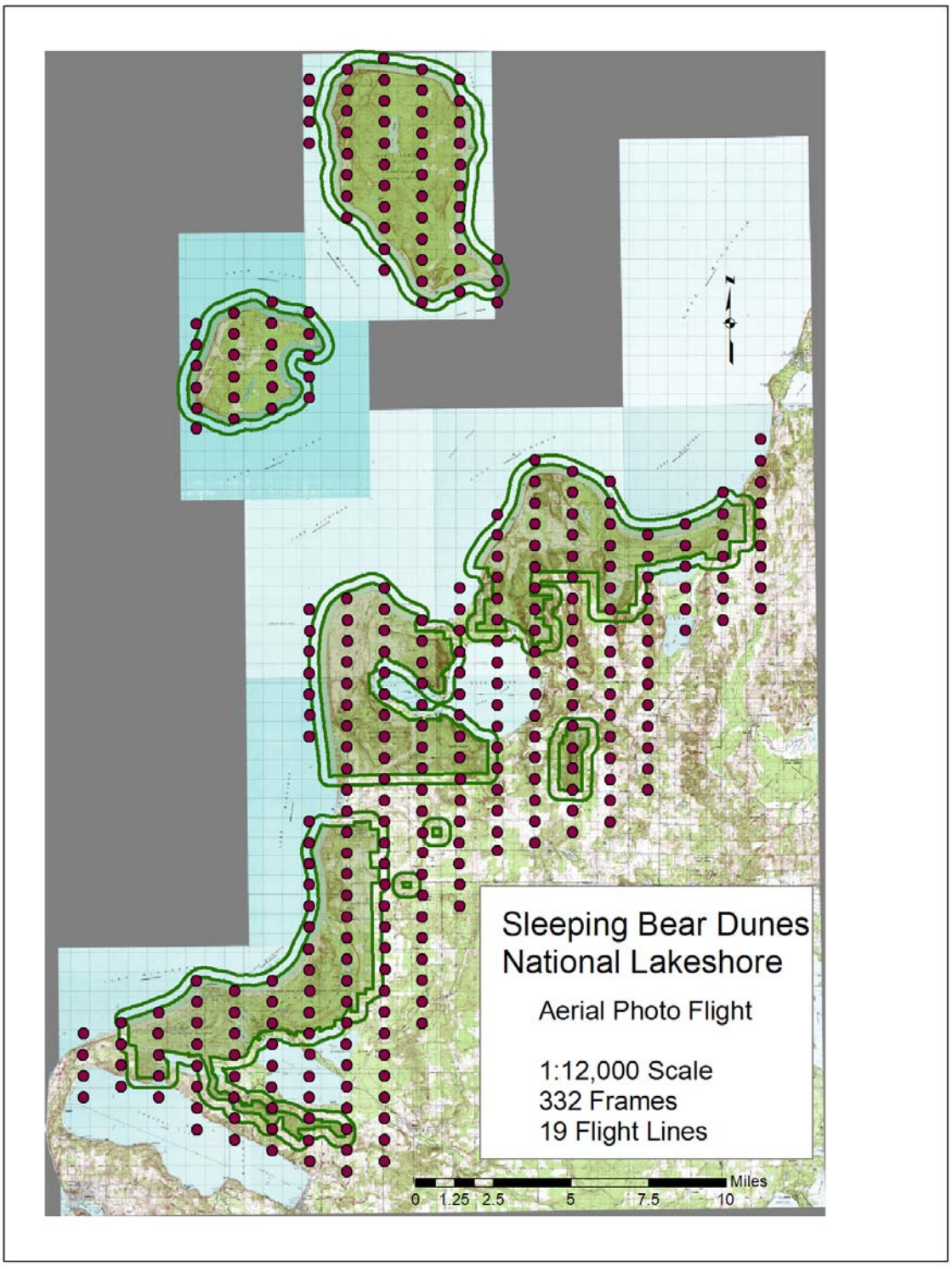

Figure 2. Aerial Photo Acquisition Area for PIRO NL Vegetation Mapping Project

Vegetation and Map Classifications

The US National Vegetation Classification (NVC, Grossman et al. 1998, & FGDC 1997), managed by NatureServe (available online at http://www.natureserve.org/explorer/index.htm) and the Federal Geographic Data Committee (FGDC) Vegetation Subcommittee, will be used for the classification of natural and semi-natural vegetation at SLBE. The hierarchy of the classification is presented in Table 1. Vegetation associations will be defined and described based on analysis of vegetation data collected for this project and other compatible existing data and comparison and evaluation of the results in a regional/national context using NVC units. Part of the classification process will include writing new descriptions or revising existing descriptions of each of the natural/semi-natural vegetation associations from both a global (rangewide) and local (park-specific) perspective.

Vegetation map classes will be developed by the UMESC, and will link (crosswalk) to the vegetation types and their descriptions as defined by NatureServe. Map classes will be determined based on photographic signatures as they relate to the NVC types identified at SLBE.

Non-vegetative map classes (e.g., open water, roads & railroads, industrial lands, residential lawns) will be developed based on a modification to a land use and land cover classification system, such as Anderson et al. (1976).

Table 1. The USNVC's Physiognomic-floristic Hierarchy for Terrestrial Vegetation (from Grossman et al. 1998)

Level	Primary Basis For Classification	Example
Class	Growth form and structure of vegetation	Woodland
Subclass	Growth form characteristics, e.g., leaf phenology	Deciduous Woodland
Group	Leaf types, corresponding to climate	Cold-deciduous Woodland
Subgroup	Relative human impact (natural/semi-natural or cultural)	Natural/Semi-natural
Formation	Additional physiognomic and environmental factors, including hydrology	Temporarily Flooded Cold-deciduous Woodland
Alliance	Dominant/diagnostic species of uppermost or dominant stratum	Populus deltoides Temporarily Flooded Woodland Alliance
Association	Additional dominant/diagnostic species from any Strata	*Populus deltoides – (Salix amygdaloides) / Salix exigua* Woodland

Vegetation Mapping

IMPORTANT: The vegetation mapping phase will begin once the vegetation classification phase is complete, providing mappers with a draft vegetation classification.

Vegetation types will be mapped to the lowest hierarchical level of the NVC possible based on photo limitations (the limit in which the photo provides vegetative distinctions for accurate and confident interpretation). Additional environmental factors can be tested and applied (if proven accurate) to the interpretation to increase classification detail beyond what the photography itself can provide.

Prior to vegetation mapping, sufficient field reconnaissance will be performed to learn, test, and verify photo signatures as they relate to NVC vegetation communities. Map classification and

mapping conventions (rules) will be developed which will coincide with the vegetation community concepts.

Photo interpretation will be performed with the aerial photo diapositives using stereoscopes (with optical magnification) over light tables. Interpretive data and attributes will be applied to overlays registered to the photograph. Photo signature and ecological concepts will be used to interpret the vegetative data. Polygons will be delineated defining the boundaries of vegetation types and will be attributed with map classes that define the vegetation types.

In addition to map classes, each polygon representing vegetation will receive additional attribute information relating to the physiognomic structure of the vegetation. Coverage density, coverage pattern, and height will be additional polygon information where applicable.

Geo-referencing the interpreted data and digital automation methods will depend upon available base map layers and the resolutions and positional accuracies they provide. ArcGIS software will be the parent data automation tool used to produce the spatial vegetation coverage. The coverage will be converted to a geodatabase. The projection of the geodatabase will be in Universal Transverse Mercator (UTM), Zone 16, and North American Datum of 1983 (NAD83).

Accuracy Assessment

A thematic accuracy assessment will be performed on the vegetation map to validate the vegetation map classes. Map classes representing NVC Natural/Semi-natural types will be assessed. Accuracy requirement for the USGS-NPS Vegetation Mapping Program requires a minimum of 80% accuracy for each map class that is assessed. Field observation data will be collected and compared to the vegetation map. An analysis will be performed producing a contingency table of the results.

END PRODUCTS

The following is a list of end products in regards to this proposal:

- A final report, including methodologies, results, descriptions of vegetation types, vegetation key, map accuracy assessment results and contingency table, map classification descriptions;
- Spatial database, (coverage and/or geodatabase), which includes the vegetation map, vegetation field plots, accuracy assessment sites, flight line index, project boundary, and other supportive GIS data (e.g. fuels associated data);
- Digital data files and hard copy data sheets of field work including, vegetation field plots and accuracy assessment sites;
- Aerial photographs of the project area (1 diapositive set and 2 contact print sets) and their corresponding interpreted overlays;
- Orthorectified photo mosaicks of the aerial photograph sets;
- Representative ground photos of vegetation types;
- Digital graphics of all spatial database coverages;
- Hard copy & digital map composition of the vegetation map;
- FGDC compliant metadata for all spatial database coverages and geodatabase. In addition, NBII will be provided for all biological data sets;

- CD-ROM containing reports, metadata, vegetation key, classification lists, fieldwork data, spatial data, map composition, graphics, and ground photo.

ACTION ITEMS

Scoping Meeting – (USGS-NPS VMP, NatureServe, & UMESC facilitated)
Spring 2007

- Introductions of all parties involved
- Presentations of the USGS-NPS VMP (VMP), Vegetation Classification (NatureServe), Mapping Process, Accuracy Assessment Process, and Final Products (UMESC), and Park Overview (SLBE)
- Discuss Park specific interests and issues (fire, exotics, forest management, etc.)
- Discuss possible partnerships with adjacent land managers and mapping programs
- Discuss classification and mapping issues; confirm project boundary and minimum mapping unit (mmu) application
- Discuss field effort logistical issues (land access, etc.)
- Review of SLBE data inventory – contacts, existing aerial photography, base cartographic data, thematic data, bibliography info (vegetation & fire related), specific vegetation info, soils, fire fuels, fire history, fire effects (SLBE & USGS)
- Tour of Park and vegetation
- Review or assign project task responsibilities of all parties. Some tasks, specifically who will hire field crews, need to be decided earlier to allow time to locate qualified personnel – partially done
- Discuss staffing requirements for all parties
- Review project schedule and logistics; update as necessary

Aerial Photography Acquisition – (USGS-NPS VMP, SLBE, NPS/USGS, & UMESC)
Fall 2005 and Spring 2004
Spring and Fall aerial photography, flown at 1:12,000-scale, have been acquired for SLBE. The Great Lakes Network funded the Spring, natural-color, leaf-off flight in 2004 (5/11/2004), and has an agreement with Michigan Tech University tto produce orthophotography. The NPS Vegetation Mapping Program funded acquisition of the Fall, peak leaf color imagery in 2005 (10/9/2005). Orthophotography is being produced by the vendor,, with product delivery expected before end of 2005.

(NatureServe/MNFI SLBE, NPS/USGS, & UMESC)
Spring – Summer 2007

- Determine who will be responsible for hiring, training, and supervising the data collection crews.
- Set up contracts as necessary with NatureServe/MNFI (Michigan Natural Features Inventory) for data collection support. NatureServe will be involved in some or all of the following steps,
    - Determine field-sampling strategy and plan including number of field samples to be collected and method for determining location (i.e. gradsect)
    - Conduct site reconnaissance trip with the photo interpreters
    - Gather existing vegetation data previously collected in and around the park
    - Perform an initial stratification of vegetation types
    - Schedule and organize field crews
- UMESC provide NatureServe with general support (in-field and/or sample polygons) on an as needed basis.

Vegetation Classification Design – (NatureServe/MNFI, & SLBE, & NPS/USGS)
Spring – Summer 2007

- Develop Task Agreements with NatureServe to develop vegetation classification for the SLBE project area at the association level
- Provide for review of the initial classification by SLBE, NatureServe, and subject matter experts
- Develop classification decision rules for photo interpreters

Vegetation Plot Sampling (+ Fuels Data) – (NatureServe/MNFI, & SLBE, & NPS/USGS)
Summer 2007

- Train field crews in the sampling procedures and project area vegetation identification. This also includes information for fuel model classification
- Deploy crews to the selected plot locations created in the Sampling Design Phase
- Ensure that the photo interpreters accompany the field crews to at least 20% of the sample plots. The plots they visit must be representative of all of the vegetation types described for the project area
- The characteristics of the site are recorded, including site location, plant association, and plant community

- In forested areas, the data gathered to support the needed information to characterize fuels will include the following:
    - Tree Species – by individual
    - Tree Height – by individual or size class
    - Tree Diameter – by individual or size class
    - Trees per acre – by species
    - Stand age class.

- In all areas, evaluate fuels by estimating percent dead and downed fuels, height to live canopy and herbaceous fuels based on Stereo Photo Series for Quantifying Natural Fuels

- Make provisions to back up and secure all of the data collected by the field crews

- Make provisions for quality control on the fieldwork

- Make provisions for the distribution and analysis of the fieldwork

Fuel Model Classification – (SLBE & NPS/USGS)
Summer 2006 (2007?)

- Generate the fuel load themes needed to link the vegetation classification to the fuel models (NatureServe will consult)

Orthorectified Aerial Photo Mosaic – (GLKN)
Winter 2006/2007 (2006/2007)

- Scan, geo-referenceorthorectify, and mosaic the entire 1:12,000-scale aerial photo set (~240 aerial photos)

- Provide orthorectified aerial photo mosaic in MrSID® image format and individual photos in TIFF format

- FGDC compliant Metadata for both combined photo mosaic sets

Geo-referenced Aerial Photo Index – (GLKN)
Winter 2006/2007

- Produce an aerial photo index of the 1:12,000-scale photo set

- Projection in UTM, Zone 16 with datum in NAD83

- Provide geo-referenced aerial photo index in ArcInfo & Shapefile formats

- FGDC compliant Metadata

Vegetation Classification, Descriptions, & Key – (NatureServe/MNFI)
Winter 2007/2008

- Draft Vegetation Classification Report including methodology, local vegetation community descriptions, and a dichotomous key to vegetation associations

- Provide draft Vegetation Report to UMESC Team prior to Mapping Phase (March 2007)

- Counsel UMESC Team about the Vegetation Classification and how to implement it for the development of Map Classification and Mapping Conventions (both on-going dialogue & field efforts)

Aerial Photo Preparation – (UMESC)
Fall 2007 – Winter 2007/2008

- Prepare diapositive aerial photographs for receiving photo interpretation data (attach acetate overlay and register to photo fiducials, register photo information, & delineate work area boundaries)

- Organize prepared aerial photos for interpretation phase

GIS Data Acquisition – (UMESC)
Fall 2007 – Winter 2007/2008

- Acquire and prepare necessary base map data for the production of spatial data products (project boundary and vegetation map)

- QC and organize newly acquired aerial photography

Preliminary Map Classification – (UMESC & NatureServe/MNFI)
Spring 2008

- Draft the preliminary Map Classification; Vegetation map classes link to Vegetation Classification based on the Vegetation Classification Report and NVC Team guidance; Land use and land cover (LUC) map classes link to a modified version of an existing LUC classification developed by Anderson et al. (1976).

Photointerpretation Field Work – (UMESC, NatureServe/MNFI, & SLBE, & NPS/USGS)
Summer 2007(2008?)

- Perform a Field Reconnaissance trip consisting of the UMESC Team, NVC Team, and SLBE Team to learn, test, and verify vegetation classification as they relate to photo signatures (appearance of vegetation types on aerial photographs)

- Verify preliminary map classes; continue to develop and adjust map classes based on aerial photo limitations and/or environmental modeling

- Perform subsequent ground truthing trip to enhance photointerpreter's confidence in mapping vegetation types; report new vegetation types and variances to NVC Team

- Adjust Map Classification accordingly based on ground truthing results; begin building Mapping Conventions (photointerpretive rules)

- Photointerpret select aerial photos throughout the project area to test the Map Classification and Mapping Conventions

- If necessary, perform a Map Validation trip to test and validate interpretive decisions (both polygon & attribute) and Mapping Conventions

- Update Map Classification and Mapping Conventions as necessary

- Finalize link between Map Classification and Vegetation Classification

Photo Interpretation Mapping – (UMESC)
Fall 2008 – Spring 2009

- Use the Vegetation Plot Sampling data as "virtual" ground truth data to enhance mapping and interpretive decisions

- Interpret, delineate, and attribute vegetation and LUC types of the entire proposed project area (SLBE & environs) using the diapositive aerial photographs and stereoscopic equipment (magnified optics) over light tables

- Base interpretive decisions of vegetation on established Map Classification and Mapping Conventions (founded on Vegetation Classification and photo/modeling results)

- Consult with NVC Team as needed to discuss vegetation concepts

- Consult with SLBE NPS/USGS Team with "trouble shooting" difficult areas; SLBE Team spot visit areas as needed and report back to UMESC Team

- Map to 0.5 ha mmu for lands within SLBE, and outside SLBE (buffer environs)

- Perform QA/QC of all interpreted data; Prepare interpreted data for digital automation phase

Transfer, Digitize, and GIS Database Creation – (UMESC)
Fall 2008 – Spring 2009

- Transfer and orthorectify photo interpreted data producing a digital spatial coverage for GIS

- Transfer and orthorectify photo interpreted data using Orthomapper software (raster phase), and ArcGIS software (vector phase); **NOTE:** spatial accuracy of orthorectified vegetation data dependent upon resolution of base maps (e.g. 3.75-minute digital orthophoto quadrangles, 7.5-minute digital elevation models)

- Provide orthorectifyied Vegetation Map in ArcInfo, SDTS, Geodatabase, & Shapefile formats

- FGDC NBII compliant metadata

Some Special Notes about Thematic Accuracy Assessment of the Vegetation Map:

- Thematic Accuracy Assessment (AA) of the Vegetation Map is performed using the vegetation map classes representing NVC Natural/Semi-Natural Alliance and Association types
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- The number of field sites is dependent first on the number of applicable Map Classes and second, on a formula taking into account a combination of frequency occurrence and area, as outlined in VMP methods documentation (FGDC 1997 and FGDC 2006)

- Field assessment is performed to the NVC association and cross-walked back to the Map Class using the established vegetation/map classification link

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Thematic Accuracy Assessment Preparation – (UMESC)
Spring 2009

- Determine and develop an approach strategy to the AA field data collection (determine which map classes are applicable for assessment, number of sites per map class, site selection methods, and GPS methods & equipment)

- Select AA sites and produce database of field coordinates for GPS uploading (UTM, Zone 16 in NAD83)

- Produce a series of DOQ maps with theme overlay of the Vegetation Map polygon data (for field navigation purposes)

- Review AA field data sheet and update as necessary

Thematic Accuracy Assessment Field Data – (NatureServe/MNFI, & SLBE, & NPS/USGS)
Summer 2009

- NatureServe provide oversight, training, and instruction to the AA field data collection team (NatureServe/MNFI & SLBE)

- Collect field assessment data

Thematic Accuracy Assessment Analysis – (UMESC & NatureServe)
Fall 2009 – Winter 2009/2010

- Database entry of AA field data & QA/QC (NatureServe)
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- Preliminary analysis of field data to the Vegetation Map
- Review field – map discrepancies, determine nature of discrepancy, and take appropriate action
- Revise draft Vegetation Map if necessary to meet VMP standards
- Re-run analysis of field data to the Vegetation Map
- Develop an AA Contingency Table of results
- Draft documentation explaining results to be included in the Project Report

End Products Production, Compilation, & Distribution – (UMESC, NatureServe, & GLKN)
Winter 2009/2010 – Spring 2010

- Compile, draft, and finalize a Project Report including background, methods, results, discussions, references, dichotomous vegetation key, vegetation community descriptions, and map class descriptions;
- Produce six spatial data sets, all projected in UTM Zone 16, and datum in NAD83:
    - Vegetation Map – ArcInfo, SDTS, & Shapefile formats
    - Vegetation Plots – ArcInfo & Shapefile formats
    - Accuracy Assessment – ArcInfo & Shapefile formats
    - Aerial Photo Mosaic – TIFF and MrSID® image formats
    - Aerial Photo Index – ArcInfo & Shapefile formats
    - Project Boundary – ArcInfo
- Produce geodatabase with SLBE data layers, including the vegetation map, vegetation plots, accuracy assessment site, and other ancillary data sets.
- Write NBII Metadata reports for all five spatial database sets (Vegetation Map, Locations of Vegetation Plots “Physical Descriptions”, Locations of Accuracy Assessment Observations, Aerial Photo Mosaic, & Aerial Photo Index) and non-spatial Vegetation Plots “Species List.”
- Produce export tables (Dbase format) of Vegetation Plots “Physical Descriptions” and of “Species List” from master PLOTS Database

- Produce Classification Tables showing the crosswalk between Map Classification and Vegetation Classification

- Produce graphic files of all spatial data sets, a map composition with legend of the Vegetation Map, and representative ground pictures of vegetation communities;
- Produce and deliver on CD-ROM all digital data products listed above; print and deliver hard copies of reports and maps

REFERENCES

Anderson, J. R., E. Hardy, J. Roach, and R. Witter. 1976. A land use and land cover classification system for use with remote sensor data. Geological Survey Professional Paper 964, U.S. Government Printing Office, Washington.

FGDC. 1997. Vegetation Classification Standard. FGDC-STD-005. Vegetation Subcommittee, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey. Reston, VA. 58p.

FGDC. 2006. National Vegetation Classification Standard, Version 2 – Working Draft. FGDC-STD-005 (version 2), November 30, 2006. Vegetation Subcommittee, Federal Geographic Data Committee, FGDC Secretariat, U.S. Geological Survey. Reston, VA. 57p (+ Appendices).

Grossman, D. H., D. Faber Langendoen, A. W. Weakley, M. A. Anderson, P. Bourgeron, R. Crawford, K. Goodin, S. Landaal, K. Metzler, K. D. Patterson, M. Pyne, M. Reid, and L. Smeddon. 1998. International Classification of Ecological Communities: Terrestrial Vegetation of the United States. Volume 1