Final Report – September, 2008

Project Title:
"Methodologies and Tools to Support Decision-making"

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INTRODUCTION

Natural habitats in South Florida have been under various types of development pressures since the early part of the last century. Next to urbanization, land drainage and water management have had the greatest impact on the ability of these habitats to provide suitable environmental conditions for many local and migrating animal populations. The impairment of these environmental conditions has put the persistent of many of the habitats at risk.

Large scale drainage projects, the most important being the Central and South Florida Project lead by the Army Corps of Engineers beginning in the 1960's, have resulted in the permanent loss of wetlands, changes in seasonal flooding and drought cycles, soil loss (peat), and alternations in the landscape patterns of land forms, vegetation, and topography, especially in areas of tree islands, ridge and sloughs, and marl-forming prairies. As a consequence, various species were now in danger of not being able to sustain their populations; some populations were of such low numbers that they have been given protected status as threatened or endangered species.

The primary goal of this project was to create a decision support system (DSS) to provide the Everglades National Park (EVER) with technical support during the transition phase between assessment and implementation of various civil works projects being proposed by the Comprehensive Everglades Restoration Plan (CERP). This project was funded in full by the Critical Ecosystems Studies Initiative because it was intended to add to the effort of tool development for use by land managers, researchers, and others interested in participating in Everglades restoration assessments.

The original goal was to develop an ArcGIS (ver. 8.+) application that would allow query of existing hydrological and ecological data to permit evaluation of the potential ecological effects of Everglades restoration projects on the animal communities of the Everglades National Park and Big Cypress National Park. This application was originally designed to allow the user to select any run from either of these models, select a year, then select from a list of organisms. Each organism selected would be a query composed of hydroperiod and a list of plant species associations. The goal was to facilitate the display of the potential occurrence of vegetation and animal species under the hydrologic conditions of a given model run over a selected year.

The tool developed by this project was called the Everglades Query Tool. As a result of the unforeseen complexity of original goals of this project, the Everglades Query Tool was completed with the ability to display the hydroperiod for any given day during the period of record of the South Florida Water Management Model (SFWMM) used by the South Florida Water Management District. As an adaptive measure to ensure the effort to pursue the original goal was not in vain, two additional products were developed for this project that were presented as individual interrelated tools. These products in order of their development were the Everglades Species Crosswalk, which was intended to provide ecological data for the Everglades Query Tool, and the EVER-DRTO Permit Tracking Database, to provide a researcher with updates on available field data.

METHODS

Everglades Query Tool

Between August and December, 2001, a conceptual model was designed of the DSS. The design changed various times as it was not clear at the beginning of the project what the regional (beyond EVER boundaries) restoration assessment protocol would be, which was under the direction of the RECOVER group as part of CERP. At the end of this project, the regional assessment protocol question was still unanswered.

It was decided that the most useful tool for EVER would have the most flexibility in application while providing general information and simple queries. The final design of the DSS was a tool that allows the user to query where selected species occur in EVER based on plant and animal inventories conducted by Park staff and the vegetative community classifications delineated on the Florida Gap Map (ver. 6.6, 2001). The development Project Manager (UMESC) determined that ArcGIS 8.1 would be the best choice of GIS program to build the graphical user interface necessary to meet the requirements of the DSS design.

EVER and UMESC reviewed the scope and agreed upon a preliminary design of the DSS that would incorporate the use of output from the SFWMM and the Natural System Model (NSM) to create the base hydrologic conditions of the Everglades restoration area. Much effort was put into resolving how the DSS design would incorporate the use of the model output, which was available only as bin files.

A utility was developed under the guidance of UMESC that reads one day of stage from the hydrological model output. The utility has been named CONVERT as it also converts the data from binary code into an ASCII text file so that the data can be read directly as a grid format in Arcview. The metadata for CONVERT was provided in Appendix A. UMESC wrote initial code for the Everglades Query Tool to develop code in Arcview 8.1, to allow user-friendly controls to access the bin file from the hydrologic model, read it into CONVERT, and display a grid. Samples of how the interface works (as graphics) was given in Appendix B.

Everglades Crosswalk

Tabular data and relationships for the biological components of the project were being developed by EVER. Appendix C gives the cross walk used to compare the vegetative classifications given in the F-Gap map (ver. 6.6) to the habitat definitions provided in the Multi-species Recovery Plan, MSRP, (USFWS, 1999). The codes used to define the potential occurrence of animals species within those habitats was given in Appendix D. This legend was based on information provided in the MSRP and publications on inventory lists (Lenczewski, 1980; Robertson et. al., 1984; Bass and Robertson, 1995; Robert and Kushlan, 1995). In Appendix E the categories used in the descriptive look-up table for the animal species were provided.

In Appendix H, indicator species were listed that were chosen based on their importance in the Everglades ecological system and their sensitivity to seasonal hydrologic conditions. Indicator species were selected so that detailed information (literature based) could be gathered on their life history. Subsequently, decisions will be made as to whether habitat suitability models will be developed for selected species.

The main sources of data for this project will come from the Florida Gap Program, U.S. Fish and Wildlife Service, Everglades and Big Cypress National Parks, and the South Florida Water Management District

Contributions of the Florida Gap Program:

The Florida Gap program produced a map of vegetation over South Florida commonly referred to as the F-Gap map. The latest version of this map (ver. 6.6) was completed in 2001 and includes 71 different land cover classifications. The map was created at a resolution of 28.5 m^2. The F-Gap map provided the base conditions for the spatial distributions of vegetative habitats within the study area

Contributions of the U.S. Fish and Wildlife Service:

In order to organize and plan for the management of Federally and State *listed species*, the U.S. Fish and Wildlife Service has authored a document entitled the Multi-Species Recovery Plan (MSRP). This document also provides habitat associations for each of the *listed species*, which includes mammals, birds, reptiles, invertebrates, and fish. By using aggregated vegetative classifications, the MSRP produced tables that list the habitat types each organism would most likely be found in. Additional tables were constructed in the MSRP making habitat associations for threatened and endangered plant species and exotics using the same vegetative classifications as used for the animal species.

It was not the purpose of this project to create a GIS-interface for visualization or application of the MSRP. Rather, the information on the species-habitat associations contained in the MSRP was used to create the initial tables necessary to associate *listed species* to the vegetation classes in the Florida Gap map.

Contributions of the Everglades National Park and Big Cypress National Park:

In addition to performing some of the tasks required by this project, the most recent inventory of species observed in each park provided additional information as to the potential occurrence of these species in their respective habitats. These inventories added species with no protective status to the tables used by the query tool. Hence, the final tables included a nearly complete list of nearly all species known or suspected to occur in the parks. However, because of the inherent difficulties in conducting field studies for species counts, fish and invertebrate lists included only *listed species*.

Contributions of the South Florida Water Management District:

The South Florida Water Management District developed two hydrologic models to simulate hydrologic conditions in South Florida from 1965-1995. These models were driven by measured rain events over the period of record and topography. One model, known as the SFWMM, distributes water over the landscape based on water management schedules and existing/proposed water control structure designs. The NSM distributes water over the landscape based on the assumption no water control structures were in place and all canals and levees have been removed. The NSM currently serves as

the target for setting future water schedules and deliveries in order to produce historic ecological conditions that should be more suitable for sustaining wildlife populations.

A summary of the spreadsheet information for the Everglades Crosswalk were provided in Appendices D-H.

EVER-DRTO Permit Tracking Database

A classic database design was used including one table of unique attributes associated with each permit and several 'look-up' tables containing additional descriptive attributes common to more than one permit. Consultative assistance for design of the database was provided by Darrell Tidwell, EVER Information Technical Branch, and Kevin Kotun and George Sharpe, EVER Physical Branch.

To make the database as simple to use as possible, only one form was created that can be used to either view or edit all of the information associated with any one permit. New permits can also be easily added to the database using this form. Moreover, this same form allows attributes of the 'look-up' tables to be edited or added.

Four queries and associated reports were created to summarize the permit information. Other queries and reports can be easily added using the design of the tables already included in the database. Additional 'look-up' tables can be added.

RESULTS

Everglades Query Tool

The outcome of the Everglades Query Tool was a functional ArcGIS application designed by UMESC. The tool was able to display visual spatial results of accessing hydroperiod data from the SFWMM output by use of the CONVERT tool. A description of CONVERT was provided in Appendix A.

The Everglades Query tool could not display the Everglades Crosswalk data nor did it provide the anticipated libraries of information about Everglades species similar to the HNA tool libraries of species along the upper Mississippi River basin. Example screen shots can be reviewed in Appendix B.
UMESC built the application framework used only the hydrological data output from the NSM and SFWMM models. The biological data was being prepared; however, the complexity of the hydrologic data was that focusing on programming it into the tool was deemed a priority. A consequence of the decisions made was that the project was on track to have one of the first Decision Support Systems implemented in ArcView 8.2 using the ArcObjects library and Component Object Model programming methodology. The chosen design puts the DSS ahead of the ArcView 3.2 technology and so that the project team can take advantage of the new functionality that exists in the very latest GIS software and development tools.

Everglades Species Crosswalk

A total of ten detailed spreadsheets were populated with habitat information "on-hand" for this subproject. The categories were listed below:

- ✓ Amphibians and Reptiles
- ✓ Birds
- ✓ Exotic animals
- ✓ Exotic plants
- ✓ Fish
- ✓ Invertebrates
- ✓ Landscape Ecosystems
- ✓ Mammals
- ✓ Midges
- ✓ Threatened and Endangered Plants

An additional spreadsheet, Endemic Plants, was not completed as sufficient information was not available to populate the tables with as much detail as the other ten.

Each spreadsheet used a "crosswalk" or legend with the F-Gap landcover categories to enable the user to gain general knowledge of where to find any Everglades species of interest.

EVER-DRTO Permit Tracking Database

This database was meant to be a prototype version of a possible design recognizing that many other designs were possible, but at the current time no other one was readily available to emulate. This project did not present this database as the official EVER/DRTO tracking tool as changes in the design may be required before it would be accepted as such.

Not all the tables have populated fields. Some fields were included in the database to suggest the need to have this information available to increase the variety of ways

permits can be effectively sorted given the needs of the permit coordinator and EVER concerns overall.

DISCUSSION AND CONCLUSIONS

Everglades Query Tool

The final product of this project was not useful for direct application to Everglades restoration assessments. An agreed upon final design of the Everglades Query Tool and guidance toward the intended application was slow in coming, which hampered the ability of the Project Manager and USGS partners to produce a usable product "straight out of the box".

The silver lining of this project was that during the development phase of the Everglades Query Tool, many other projects were able to see some of their weaknesses more clearly. The most illuminating one was the consistency of difficulties each and every ecological modeler has with the use of the South Florida Water Management Model (SFWMM) to provide the hydrologic layers necessary for both static and simulated ecological computer models. To my knowledge, this project was the only project that was able to unravel the code the SFWMD enough to allow display of hydrologic information on a daily basis. This was only possible because this project took advantage of the efforts of other CESI funded projects, primarily ATLSS, to create visual decision support tools. Unfortunately, in the case of the Everglades Query Tool, the spatial resolution of the SFWMM was appropriate for many habitats, but the ability to capture the temporal range of time necessary to show seasonal variation in the habitats of Everglades was not possible.

In retrospect, this project would have benefited if it were continued for at least another six months in order to display the species and their habitats closer to design used in the DSS this project was originally modeled after, i.e., the HNA developed by UMESC. The final version of the Everglades Query Tool is functional as it was ultimately designed, and provides and excellent stepping-stone for new similar projects to build upon.

It would have also benefited this project greatly if more coordination was done between the Principle Investigators and Project Manager of this project with those of the ATLSS Viewer project, another CESI funded project. The ATLSS Viewer was being simultaneously designed and developed as the Everglades Query Tool. The difference between the DSSs was that the ATLSS Viewer was intended to visually display output from the ATLSS ecological models known as the Spatial Explicit Species Index models (SESI) and eventually the simulated Individually-Based Models. In contrast, the original intent of the Everglades Query Tool was to create static habitat suitability models based on a database containing all available information outside of the collection of new field data.

At the start of this project purpose of the Everglades Query Tool was intended to compliment not compete with the ATLSS Viewer. However, the ATLSS Viewer had limitations in its design because it completely relied on model output data that could not be updated without extensive collaboration with the model developers. The interim solution was to try to upgrade the expectations of the Everglades Query Tool and try to simulate changes in the habitats with hydrologic conditions, hence the need to try and create seasonal blocks of time in the output from the SFWMM, which without CONVERT was provided to us as annual hydrologic conditions. Again, in retrospect, it probably would have behooved both the ATLSS Viewer project and this project if we had combined our efforts to create one DSS.

The database for this project could have been handed over to them in enable the DSS user to have the choice of either looking at the ATLSS ecological model output or the static conditions of multi-species in Everglades habitats. Though our project advanced the ability to apply higher temporal resolutions of the SFWMM, we lost ground in the likely much easier task of just displaying the ideal habitat conditions of the various species as done in the HNA. UMESC could have guided the ATLSS Viewer Team, the USGS Center in Lafeyette, Louisana, as to how to create advanced HNA features in the same ArcGIS tool designed to display ATLSS model output.

Everglades Crosswalk

The Everglades Crosswalk was completed using an extensive amount of information and was useful if it was kept in mind that none of the data was from long term monitoring programs. Instead, the information came from inventories and grey and published literature. It was not designed to be accessed directly; however, each spreadsheet was designed so that it can be understood once the legend was reviewed.

EVER-DRTP Permit Tracking Database

This project developed an easy to use Access database to meet the needs of the EVER/DRTO permit coordinator. The database was designed to allow more efficient tracking of permits and includes a limited number of descriptive summary queries and reports.

The purpose of this subproject was to assist the long-term use of the DSS and associated decision making tools to be used by EVER. In Appendix I, the meta data was provided for the Everglades-DRTO Permitting database written in Access. This database will allow those working on environmental assessments to check the current permits on species or areas of the Park of interest for reference as to what research was being conducted that might support their topic. They can also see the gaps in research and make recommendations of what needs to be studied to assist in defining their conclusions of the potential for restoration success.

Coordinates and descriptions of research projects not requiring a permit, such those conducted by EVER staff, could be added to the database. This would increase the ability to track research sampling conducted in the EVER and DRTO overall.

As the database was designed now (absolutely no bells or whistles included), it will easily upgrade to Access 2000.

References and Metadata sources for Everglades Crosswalk

**makes sure to include MSRP for those that apply – check online if not sure

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Threatened and Endangered Plants

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Complete citations for the following Everglades Crosswalk spreadsheets have been lost:

- ✓ Invertebrates (believed from CESI MON99-1, 3, and 4, Lenczewski, et. al., and field guide)
- ✓ Midges (believed from notes provided by CESI MON99-1, 3 and 4)
- ✓ Exotic animals (believed from publication and/or notes from Sonny Bass, EVER Biologist and William Loftus, USGS)
- ✓ Exotic plants (believe from Florida Exotic Pest Plant Council Invasive Plant Lists 2001 – see http://www.fleppc.org/list/list.htm)
- ✓ Amphibians and Reptiles (believe from internet, CESI projects, field guide)

Appendix A

NAME
convert - convert data from SFWMM format to ASCII grid format.

SYNOPSIS
convert [input file] [output file] yyyy mm dd

DESCRIPTION
convert extracts a single days worth of data from a file specified by the first argument [input file] and writes to another file specified by the second argument [output file]. The input file should be in the format used by the South Florida Water Management Model (SFWMM). Data sets known to be in this format were those created by the SFWMM and the Natural Systems Model (NSM). The output file will be written in ASCII grid format. The third, fourth and fifth arguments specify the day which should be extracted from the input file.

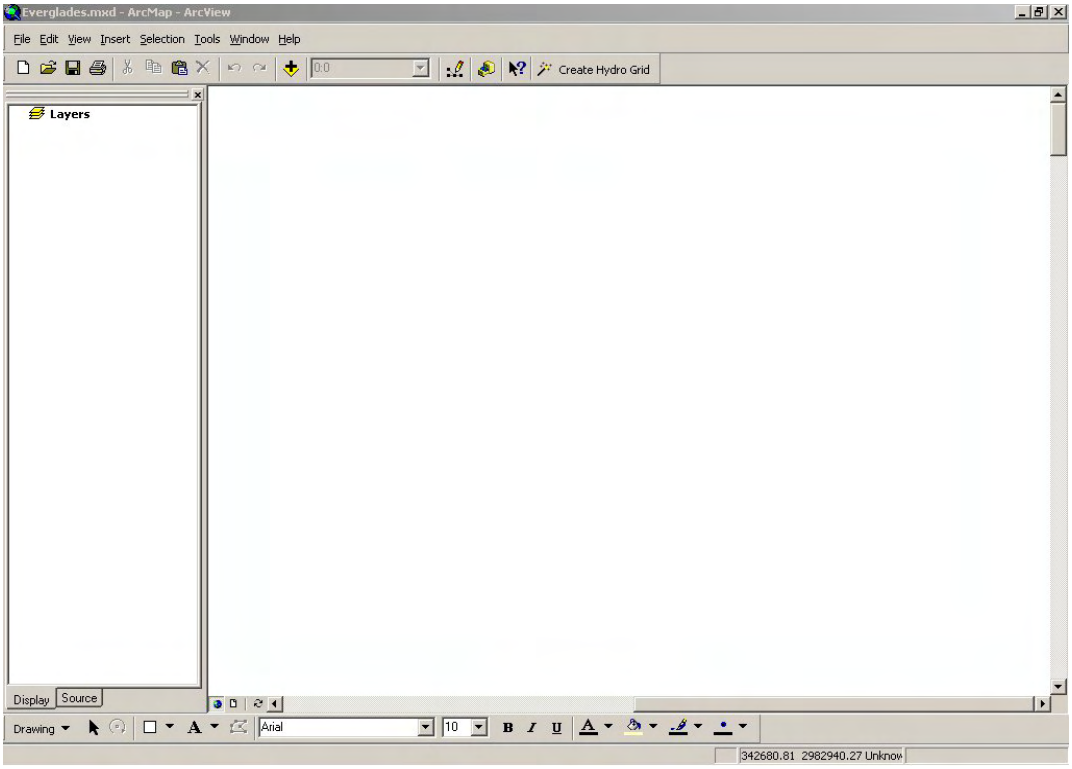
yyyy specifies the year, which must be between 1965 and 1995.
mm specifies the month, which must be between 1 and 12.
dd specifies the day. The day must be between 1 and [28, 29, 30, 31]. The largest valid day value depends on the month and year. SFWMM data structure includes leap days.

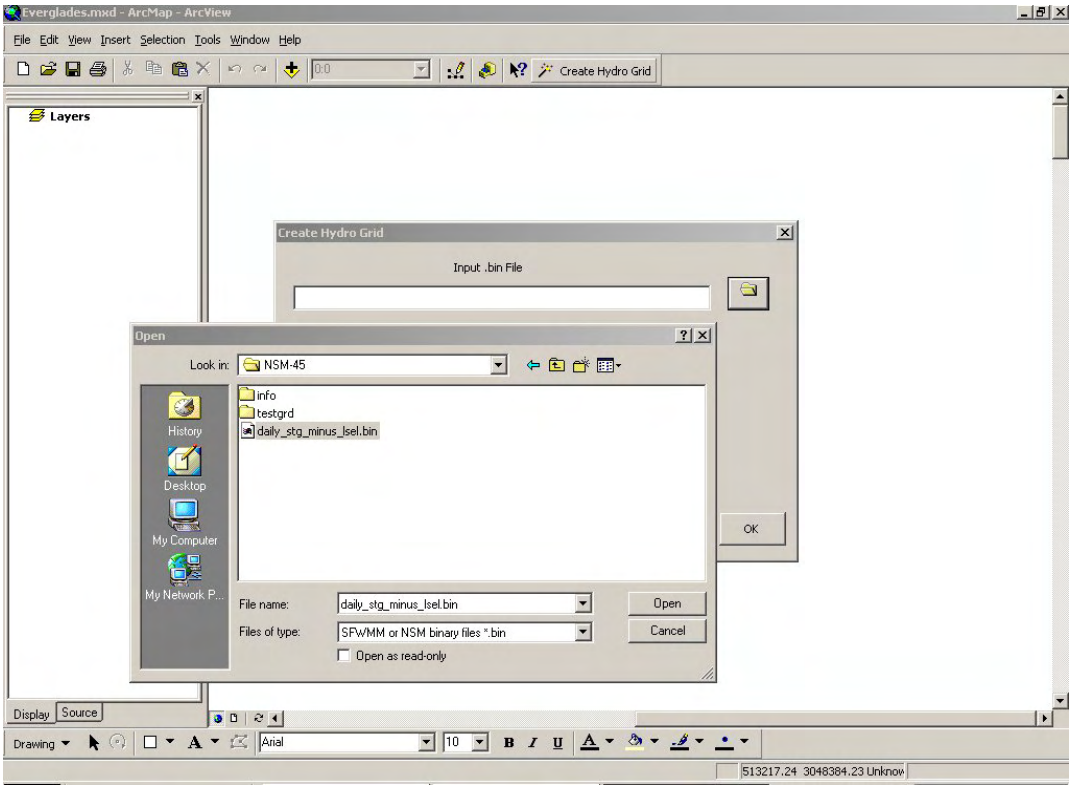
INPUT DATA
As stated above, the input data should be in the format used by the SFWMM. This format was used by most outputs from the SFWMM as well as the NSM. The exception was outputs from the Calibration/Verification (Cal/Ver) Runs of the SFWMM. Cal/Ver runs of the SFWMM differ from other data sets primarily in the time span covered. While the SFWMM and NSM cover Jan. 1, 1965 to Dec. 31, 1995 inclusive, a Cal/Ver run covers only Jan. 1, 1979 to Dec. 31, 1995.

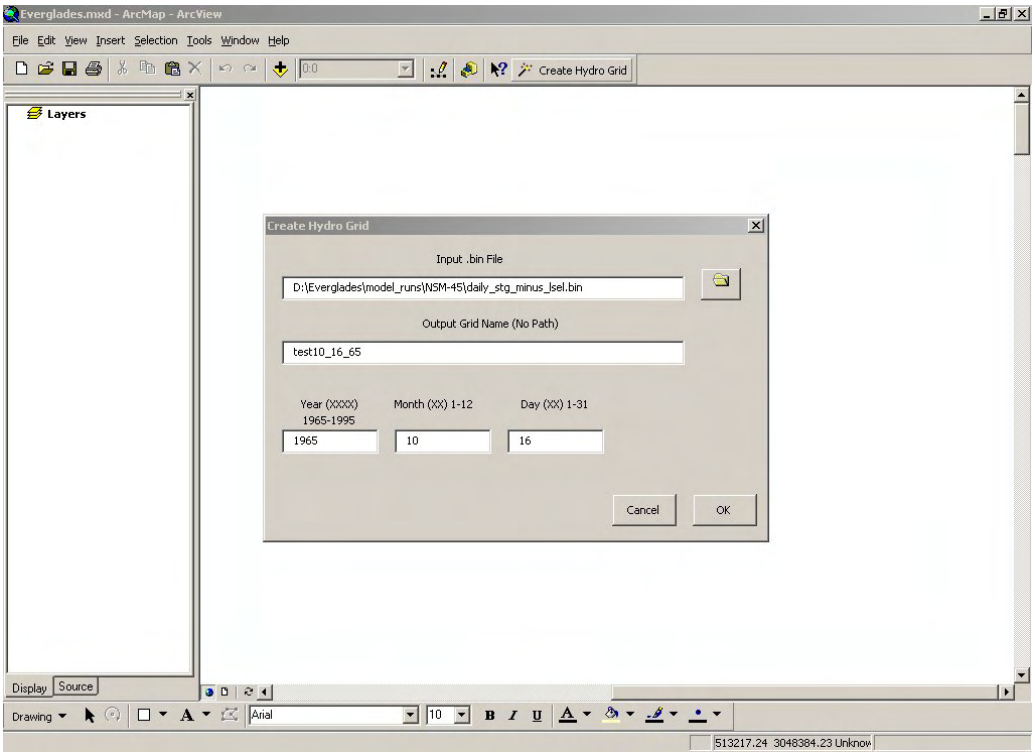
SOURCE CODE:
The source code for convert, convert.cpp, was ment to be compiled with a C++ compiler. It was know to compile on MicroSoft(tm) Windows2000(tm) systems, using MicroSoft(tm) Visual C++(tm). The resulting binary was known to function correctly on Windows2000(tm), Windows98(tm) and Windows95(tm) environments. The source code contains several print statements which output the state of many internal variables which can be useful at times. To gain access to this output the program needs to be recompiled with the #define VERBOSE line in convert.cpp uncommented.

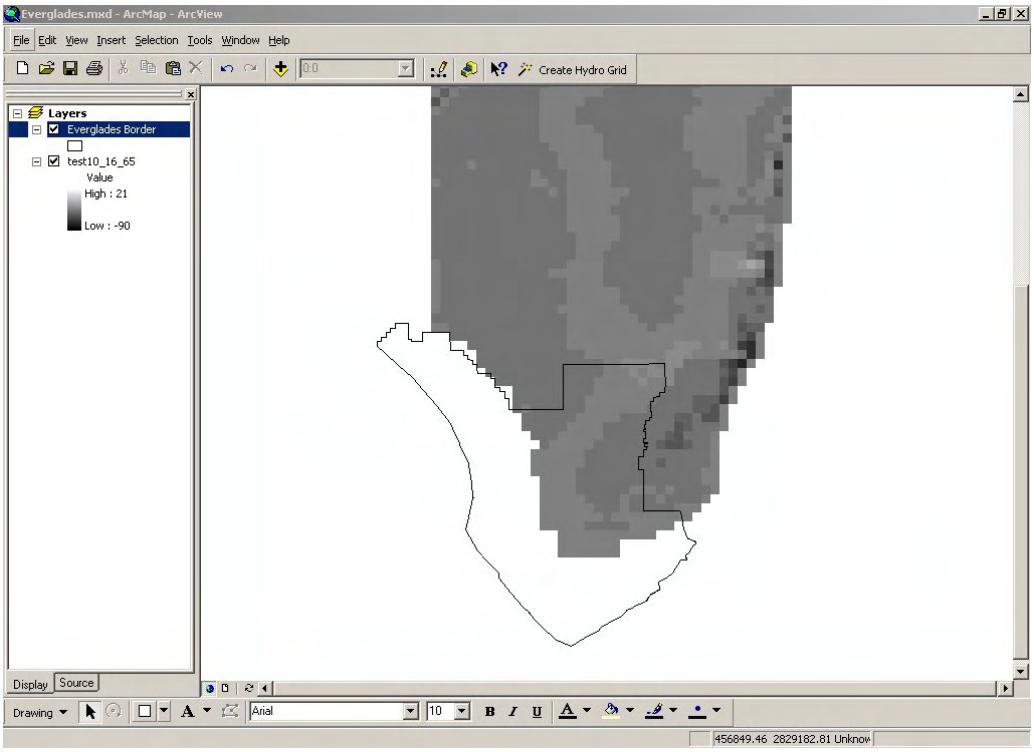
Source code and documentation for convert written by Scott M. Duke-Sylvester, University of Tennessee.

Appendix B


Everglades.mxd - ArcMap - ArcView
File Edit View Insert Selection Tools Window Help
Create Hydro Grid
Layers
Display Source
Drawing
Arial
10
342680.81 2982940.27 Unknow


Everglades.mxd - ArcMap - ArcView
File Edit View Insert Selection Tools Window Help
Create Hydro Grid
Layers
Create Hydro Grid
Input .bin File
OK
Open
Look in: NSM-45
info
testgrd
daily_stg_minus_lsel.bin
History
Desktop
My Computer
My Network P...
File name: daily_stg_minus_lsel.bin
Files of type: SFWMM or NSM binary files *.bin
Open as read-only
Open
Cancel
Display Source
Drawing
Arial
10
513217.24 3048384.23 Unknow


Everglades.mxd - ArcMap - ArcView
File Edit View Insert Selection Tools Window Help
Create Hydro Grid
Layers
Create Hydro Grid
Input .bin File
D:\Everglades\model_runs\NSM-45\daily_stg_minus_lsel.bin
Output Grid Name (No Path)
test10_16_65
Year (XXXX)
1965-1995
Month (XX) 1-12
Day (XX) 1-31
1965
10
16
Cancel
OK
Display
Source
Drawing
Arial
10
513217.24 3048384.23 Unknow


Everglades.mxd - ArcMap - ArcView
File Edit View Insert Selection Tools Window Help
Create Hydro Grid
Layers
Everglades Border
test10_16_65
Value
High : 21
Low : -90
Display
Source
Drawing
Arial
10
456849.46 2829182.81 Unknow

Appendix C

Cross Walk Between the Florida Gap Map Vegetative Classifications and Habitats Defined in the Multi-species Recovery Plan (Synonyms to EVER Habitats were being defined)

Fgap Code	MSRP Code	Fgap Vegetative Class	MSRP Habitat Type
0	2	Background	Background*
1	26	Water	Water*
2	24	Tropical Hardwood Hammock Formation	Tropical hardwood hammock
3	23	Semi-Deciduous Ecological Complex Tropical/Subtropical Swamp Forest	Seepage swamp
4	15	Xeric-Mesic Live Oak Ecological Complexological Complex	Mesic temperate hammock
5	15	Mesic-Hydric Live Oak, Sabal Palm Ecological Complex	Mesic temperate hammock
6	19	Bay/Gum/Cypress Ecological Complex	Pond swamp
7	23	Lobolly Bay Forest	Seepage swamp
8	7	Cajeput Forest CG	Exotics*
9	13	Mixed Mangrove Forest Formation	Mangrove
10	13	Black Mangrove Forest	Mangrove
11	13	Red Mangove Forest	Mangrove
12	7	Casuarina Compositional Complex	Exotics*
13	16	South Florida Slash Pine Forest	Hydric Pine Flatwoods
14	15	Mexic-Xeric Mixed Pine/Oak/Hickory Forest Ecological Complexological Complex	Mesic temperate hammock
15	22	Sand Pine Forest	Scrub
16	14	Mesic-Hydric Pine Forest CG	Mesic Pine Flatwoods
17	9	Swamp Forest Ecological Complexological Complex	Flowing water swamp
18	19	Cypress Forest CG	Pond swamp
19	15	Mixed Evergreen-Cold Deciduous Ecological Complex Hardwood Forest	Mesic temperate hammock
20	13	Buttonwood Woodland	Mangrove
21	13	Mixed Mangrove Woodland	Mangrove
22	13	Black Mangrove Woodland	Mangrove
23	13	Red Mangrove Woodland	Mangrove
24	15	Live Oak Woodland	Mesic temperate hammock
25	18	South Florida Slash Pine Woodland	Pine rocklands
26	12	Sandhill Ecological Complex	High Pine
27	4	Broad Leaved Evergreen and Mixed Evergreen Cold-Deciduous Ecological Complex Shrubland Compositional Group	Broad Leaved Evergreen and Mixed Evergreen Cold-Deciduous Shrubland*
28	8	Flooded/Saturated Broad leafed Evergreen/Mixed Evergreen Cold-Deciduous Ecological Complex Shrubland	Flooded/Saturated Broad leafed Evergreen Shrubland Ecological Complex*
29	6	Dry Prairie Ecological Complex	Dry Prairie

Fgap Code	MSRP Code	Fgap Vegetative Class	MSRP Habitat Type
30	11	Gallberry/Saw Palmetto CG	Gallberry/Saw Palmetto/Titi Compositional Group/Hydric Pine Flatwoods*
31	7	Brazilian Pepper Shrubland	Exotics*
32	13	Dward Mangrove Ecological Complex	Mangrove
33	3	Coastal Strand	Beach dune/Coastal strand
34	22	Groundsel-tree/Marsh Elder Tidal Shrubland	Scrub
35	22	Xeric Scrubland	Scrub
36	10	St. Johns Wort Shrubland	Freshwater marsh
37	21	Saturated-Flooded Cold Ecological Complexiduous Shrubland	Saturated-Flooded Cold Ecological Complexiduous Shrubland /Freshwater Marsh*
38	20	Saltwort/Glasswort Ecological Complex	Salt marsh
39	3	Graminoid Dry Prairie Ecological Complex	Beach dune/Coastal strand
40	3	Sea Oats Dunes Grassland	Beach dune/Coastal strand
41	6	Wiregrass Grassland	Dry Prairie
42	27	Graminoid Emergent Marsh	Wet prairie
43	10	Sawgrass Marsh	Freshwater marsh
44	10	Spikerush Marsh	Freshwater marsh
45	27	Muhly Grass Marsh	Wet prairie
46	10	Cattail Marsh CG	Freshwater marsh
47	20	Salt Marsh Ecological Complex	Salt marsh
48	27	Sand Cordgrass Grassland	Wet prairie
49	20	Black Needle Rush Marsh	Salt marsh
50	20	Saltmarsh Cordgrass Marsh	Salt marsh
51	20	Saltmeadow Cordgrass/Salt Grass Marsh	Salt marsh
52	27	Sparsely Wooded Wet Prairie CG	Wet prairie
53	10	Dwarf Cypress Prairie	Freshwater marsh
54	27	Temperate Wet Prairie	Wet prairie
55	10	Maidencane Marsh	Freshwater marsh
56	10	Forb Emergent Marsh	Freshwater marsh
57	10	Water Lily or Floating Leaved Vegetation	Freshwater marsh
58	10	Perihyton	Freshwater marsh
59	3	Sand, Beach	Beach dune/Coastal strand
60	25	Bare soil/Clearcut	Urban*
61	25	Pavement, Roadside	Urban*
62	25	Urban	Urban*
63	25	Urban Residential	Urban*
64	25	Urban Open/Others	Urban*
65	1	Agriculture	Agriculture*
66	1	Pasture/Grassland/Agriculture	Agriculture*
67	1	Ag/Groves/Ornamental	Agriculture*
68	1	Ag/Confined Feeding Operation	Agriculture*
69	17	Extractive	Mining*
70	25	Recreation	Urban*
71	5	Cloud	Cloud*

Appendix D

Legend Used for Potential Occurrence Category of Animal-Habitat Tables

Code	Description
1	not present
2	hypothetical (or less than 10 observations)
3	rare (very low population or transient)
4	uncommon (low population or migratory)
5	locally common (often found in patches within habitat type)
6	common (individuals often sighted throughout habitat type)
7	presence unaccounted for (developed areas, water, clouds)

Notes:
Potential occurrence was based on observation (supporting field data) and/or suspected range of animal given available habitat (no supporting field data).
Mammal, bird, reptile, and amphibian lists contain both T&E species and unprotected species. The invertebrate and fish lists include T&E species only.
Exotic species were not listed (except for maybe some birds that escaped the purging exercise.) Exotic and invasive animals will appear in future table along with plants.
I'd probably like to add more species (such as unprotected fish, known butterflies..many endemic), but perhaps...I should apply the mantra "after the prototype".

Appendix E

Look-up Table Categories

Native Animal Species	Exotic Animal Species
Species Code	"
Common Name	"
Scientific Name	"
Main Category	"
Species Category	"
Federal Status	"
State Status	"
Habitat Use	"
Breeding Potential	"
Vulnerability to Hydrologic Change	"
Population Pressures	"
Existing Management Plans	"

Protected Plant Species	Exotic Plant Species
Species Code	"
Scientific Name	"
Common Name	"
Family	"
Group	"
Main Category	"
Species Category	"
On MSRP List	"
Federal Status	EPPC Category
State Status	Government Listing
Federal Wetland Category	"
State Wetland Category	"
Duration	"
Origin	"
Mode of Dispersal	"
Flowering/Fruiting Seasons	"
Maintenance Method	Eradication Method
Known Occurrence in EVER	"
Wunderlin Habitat	"
Wunderlin Occurrence	"
Wunderlin Regional Occurrence	"
Additional Information	"
References	"

Appendix F

Categories and Number in Species Currently Included in the DSS Database

Category	# Species
Birds	365
Bitterns, Herons, Egrets & Allies	13
Blackbirds & Orioles	14
Boobies & Gannets	2
Cardinals & Buntings	6
Cranes	2
Creepers & Wrens	6
Cuckoos & Anis	4
Darters & Cormorants	3
Ducks, Geese & Swans	32
Falcons, Grouse & Ptarmigans	6
Finches	2
Flamingos	1
Frigatebirds	1
Goatsuckers	4
Grebes	3
Hummingbirds	1
Ibises & Spoonbills	4
Jaegers, Gulls, Terns & Skimmers	21
Jays & Crows	4
Kingfishers	1
Limpkins	1
Loons	2
Mockingbirds & Thrashers	3
Old World Warblers & Thrushes	9
Osprey, Kites, Eagles & Harriers	20
Owls	7
Oystercatchers	1
Pelicans	2
Pigeons & Doves	7
Pipits	1
Plovers	8
Rails, Gallinules & Coots	11
Sandpipers & Phalaropes	31
Shearwaters & Petrels	2
Shrikes	1
Sparrows	22
Starlings	1
Stilt & Avocets	2
Storks	1
Swallows	7
Swifts	1
Tanagers	4
Titmice & Nuthatches	3
Tyrant Flycatchers	15
Vireos	10

Category	# Species
Mammals	41
Mink and Weasles	4
Fox	1
Bats	7
Bears	1
Big Cats	2
Deer	1
Manatee	1
Otters	1
Rabbits	2
Raccoon and Skunks	3
Rats and Mice	9
Shrews and Moles	4
Squirrels	5
Reptiles	243
Alligators and Crocodiles	1
Fish	188
Turtles, Tortoises, and Terrapins	5
Snakes, Lizards, and Skinks	46
Sirens and Newts	3
Invertebrates	91
Snails	3
Crabs	1
Flies and Skippers	52
Beetles	10
Blenny	1
Frogs and Toads	23
Spiders	1
Vultures	2
Waxwings	1
Weavers	1
Wood Warblers	50
Woodpeckers	9

Appendix H

Indicator Species List for Use by the Habitat Restoration Interface DSS
at the Everglades National Park

Marl Prairie/Rocky Glades
alligator
Cape Sable seaside sparrow
wood stork
rosette spoonbill
white Ibis
great egret
limpkin
hispid cotton rat
rice rat
roundtail muskrat
flagfish
marsh killifish
least killifish
dollar sunfish
apple snail
crayfish (P.alleni)
amphibians

Florida Bay
ducks
bay anchovy
common snook
spotted sea trout
pink shrimp
pin fish
rain water killifish
mojarra

Tree islands
rice rat
roundtail muskrat
alligator
deer
wading birds

Ridge and Slough
crayfish (P. fallax)
bluefin killifish
sheepshd minnow
bluespotted sunfish
Florida gar
lake chubsucker
warmouth sunfish
alligator

Mangrove/Estuary
ducks
bay anchovy
common snook
spotted sea trout
pink shrimp
pin fish
rain water killifish
mojarra

Refugia
flagfish
marsh killifish
least killifish
dollar sunfish
apple snail
crayfish (P.alleni)
amphibians

Upland
panther
deer
amphibians
roundtail muskrat
turkey
bluebird
nuthatch