

## **Status Report**

**Period Covered:** October 1, 2008 through September 30, 2009

**Project:** South Florida Surface Water Monitoring Network for Support of MAP Projects

**Agency:** U.S. Geological Survey (USGS)

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**Agreement:** USGS IA#12 under MOA between USGS and USACE

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This annual report for 2009 summarizes the major accomplishments, lists of deliverables, and outlines the work plan for 2010 for the EDEN project. The EDEN's primary deliverable and product continues to be the EDENweb ([sofia.usgs.gov/eden](http://sofia.usgs.gov/eden)); the project website that provides all data, results, documentation, and other project information for EDEN users.

### **I. MAJOR ACCOMPLISHMENTS**

- Real-time, provisional, and final EDEN surfaces are being produced and posted to EDENweb on schedule. Surfaces currently posted on the EDENweb ([sofia.usgs.gov/eden](http://sofia.usgs.gov/eden)) include:
  - Final for 1/1/2000 through 9/30/08
  - Provisional for 10/1/08 through 6/30/09
  - Real-time for 7/1/09 through current
- This year the EDEN project completely reevaluated its data management plan (see issues identified in Section VIII below) to handle the agency data from water-level gages, manage and process the data, and create daily water surfaces more efficiently and, if possible, with more automation. This included some of the following:
  - Developed a data management plan and obtained a review by an outside reviewer who has provided significant recommendations for efficiency and quality control. Implementation of these recommendations is ongoing.
  - Reconfigured the EDEN data management staff to include better mix of skill sets and to provide cross training necessary for consistent daily surfacing and data postings.
- A simple regression gap filling program was developed for filling data gaps in water level data at gages prior to creating daily water level surfaces. Program was automated for use with provisional (quarterly) and final (annual) data sets. Work is ongoing to use the program potentially for creation of real-time surfaces. Currently requires significant manual review based on data received from agencies, however project staff continue to fine tune program and process.
- EDEN continues to evaluate new and additional gages that may help fill in gaps in the network of gages used to create the daily water-level surfaces and potentially improve the surfaces. In 2009, EDEN added 5 gages to the network:
  - BARW4, BARW6A in western Big Cypress National Preserve

- G338\_T and G251\_T in western WCA1
  - SR1 in Everglades National Park
  - TSB replaced TS2, in Everglades National Park
- EDEN DEM was revised and expanded
  - Using methodology for nearest-neighbor grid comparison developed by Florida Atlantic University (FAU) in 2008, the EDEN DEM for WCA1 was revised and improved. Other data used in development of this DEM revision included SFWMD Ken Rutchey's vegetation map (based on the 2004 aerial imagery) and the vegetation data from the USGS aerial height finder data sets.
  - The area south of Big Cypress National Preserve to the mangrove edge (an area not previously included in the EDEN DEM) was added to the EDEN DEM. The DEM was developed using the method documented for the current DEM.
  - Documentation, metadata, and the new DEM are planned for posting online for users in November 2009.
- Expand and improve EDEN surface water interpolation model
  - The surface water interpolation program is being updated for new and revised datasets and expanded to include an area south of BCNP to the mangrove ecotone. The expanded area is interpolated consistent with the existing program. This task has been delayed about 6 months because data quality issues required more time to address than expected. Coordination and integration of multi-agency datasets has proven to be more time intensive than expected at this point in the project.
  - 3 days per water year (2004, 2007, 2008) are used to represent dry, wet, and average conditions for model calibration. 300-400 runs per day have been completed for the selected 9 days with varying parameter values based on EDEN extended daily medians prior to canal file revisions, including 50 runs randomly selected from 255,744 parameter scenarios. The parameter scenarios and resultant SW grids will serve as reference for evaluating canal file revisions.
  - USACE contract is in place to collect water level data at approximately 65 benchmarks through the Everglades in wet season 2009, dry season 2010, and wet season 2010. These data will be invaluable to continue the validation process of the EDEN surfacing model (a seemingly never-ending pursuit).
- EDEN assisted the USACE Survey Section in installation and survey of 34 benchmarks (BMs, surveyed to Class B standards, stainless steel rod driven to refusal) in the Everglades wetland marshes. EDEN compiled the location of BMs, obtained permits where required, and will post all BM elevations and data sheets on the EDENweb. See Figure 1 for proposed BM locations.
- Rainfall and evapotranspiration data continue to be updated regularly for the EDEN gage network and posted to the EDENweb.
- Began pilot data analysis to review data in Shark River Slough for oligohaline zone analysis

- EDEN Newsletter currently has 90 subscribers and is used to notify users of updates or additions to the EDEN website.

## II. SIGNIFICANT MEETINGS/WORKSHOPS/CONFERENCES

- The EDEN team participated in NCER 2009 with 5 posters and oral presentations
  - Conrads, P.A., Petkewich, M.D., Daamen, R.C., Roehl, E.A., Dealing with data realities – Automation of evaluation of data quality and estimation of missing data for the Everglades Depth Estimation Network (EDEN), NCER2009
  - Henkel, H.S., The south Florida information access (SOFIA) system, NCER2009
  - Telis, P.A., and Henkel, H., Assessing Everglades restoration using Everglades Depth Estimation Network (EDEN) , NCER2009
  - Telis, P.A., Henkel, H., McCloskey, B., and Holmes, M., Rainfall and potential evaporation data for Everglades Depth Estimation Network (EDEN) gages, NCER2009
  - Xie, Z., Liu, Z., and Jones, J.W., The development of digital elevation model for the area south of the Big Cypress National Park in the greater Everglades restoration, NCER2009
- UNESCO seminars
  - Liu, Z. and Z. Xie, 2009. Everglades Depth Estimation Network (EDEN) - model application, validation, and revision. 2009 UNESCO Lectures (organized by USGS), June 10- 11, 2009, Davie, FL
  - Conrads, P., 2009. Data mining and neural network modeling. 2009 UNESCO Lectures (organized by USGS), June 10- 11, 2009, Davie, FL
  - Henkel, H., 2009. The South Florida Information Access (SOFIA) System and Everglades Depth Estimation Network (EDEN). 2009 UNESCO Lectures (organized by USGS), June 10- 11, 2009, Davie, FL
- Other conferences
  - Telis, P.A., and Henkel, H., Assessing Everglades restoration using Everglades Depth Estimation Network (EDEN) , USGS Gulf Coast Science Conference and Florida Integrated Science Center Meeting: Proceedings with Abstracts, October 20-23, 2008, Orlando, FL.
  - Liu, Z., F.J. Mazzotti, L.A. Brandt, S.S. Romanach, D.E. Ogurcak, and A.L. Higer. 2009. Relationship between alligator holes and EDEN hydrologic data in Everglades National Park, Florida. Annual Meeting of the Association of American Geographers, Las Vegas, NV.
  - Conrads, P., October 2008. Maximizing data-collection networks by using data-mining techniques – case studies in the Florida Everglades. Water Environmental Federation Technical Conference 2009, Chicago, IL.

## III. ADMINISTRATIVE (Contractual and Budgetary)

- The end date for the existing agreement, USGS IA#12 under MOA between USGS and USACE, is 3/31/10. A new scope and cost estimate for the period 4/1/10 through 3/31/15 has been vetted through the Greater Everglades module leads and is in process for an Economy Act approval with the USACE.

- University of Florida (UF, Aaron Higer, Zhongwei Liu) and Florida Atlantic University (FAU, Zhixiao Xie, Dale Gawlik) were funded by the EDEN project through a CESU agreement in FY09 for:
  - Improvement, expansion, and revision of the EDEN DEM
  - Revision of the EDEN surface water interpolation program

#### IV. SUPPORT FROM OTHER PROGRAMS AND FUNDING SOURCES

- Greater Everglades PES funds continue to support the EDEN project by funding efforts by Paul Conrads (USGS-SC), John Jones (USGS-Reston), Heather Henkel (USGS-FISC), and Aaron Higer (UF). Additionally, PES provides some funds for Pamela Telis (USGS-FISC) in her role as project coordinator and liaison with the USACE.
- ARRA (economic stimulus) funding was offered to the EDEN project for work that could be conducted under the ARRA regulations. Most work by the EDEN team is not allowable under the ARRA regulations, i.e. labor for federal government employees. In 2008, the USGS South Carolina Water Science Center funded Phase 1 of an effort by Advanced Data Mining (ADM), LLC, however, did not have funding for Phase 2 at this time. The project by ADM addresses data quality issues by developing an intelligent software application in order to automate the validation and correction of data, in the case of EDEN, prior to creation of the daily water level surfaces. The ARRA funding is being used in 2009-2010 to fund Phase 2 of this work. Additionally, the ARRA funding partially supports the CESU agreement with Florida Atlantic University and their work to improve the surface water interpolation program.
- As described in the Section I above, USACE funding in excess of \$350,000 was provided to install and survey benchmarks through the Everglades, collect water level data at this network (during wet season 2009, dry season 2010, and wet season 2010), install continuous water level recorders at benchmarks in Everglades National Park, survey elevations to NAVD88 datum at 8 water level gages in Everglades National Park, and collect ground elevation data at 12 water level gages.

#### V. FY09 DELIVERABLES/REPORTS

- EDENweb ([sofia.usgs.gov/eden](http://sofia.usgs.gov/eden)) has been updated throughout the year to provide data, metadata, and documentation to MAP PIs and others.
- Reports (partially funded by USGS PES funds):
  - Conrads, P.A. and M.D. Petkewich, 2009, *Estimation of missing water-level data for the Everglades Depth Estimation Network (EDEN)*: U.S. Geological Survey Open-File Report 2009-1120, 53 p.
  - Telis, P.A. and Henkel, H., 2009, *Everglades Depth Estimation Network (EDEN) Applications: Tools to view, extract, plot, and manipulate EDEN data*: U.S. Geological Survey Open-File Report 2009-3052, 4 p.
  - Liu, Z., Volin, J., Owen, D., Pearlstine, L., Allen, J., Mazzotti, F., and Higer, A., 2008, *Validation and ecosystem applications of the EDEN water-surface model for the Florida Everglades*: *Ecology and Hydrology* Volume 2, Issue 2, p. 182-194 (2009).

- For the 2009 System Status Report, EDEN provided hydroperiod maps and mean monthly water depth data to assist with hydrologic assessments of component areas of the Everglades and for understanding the total system hydrology:
  - Figures 2 through 6 show maps developed from EDEN daily surfaces of water level. The period of time in increments of a year show areas that have had water surfaces above land surface (based on the EDEN ground elevation model gridded to 400 meters by 400 meters) for the selected date based on data from 1/1/2000 through the selected date. Several observations are noted:
    - The WCAs were the wettest following wet season 2005 and driest following wet season 2007.
    - Everglades National Park was wettest following wet season 2006 and driest following wet season 2008.
    - Areas of southern and southeastern WCA3A that remain wet continuously are easily evident on the maps year after year.
  - Figures 7 through 11 show plots of mean water depth for EDEN grid cells (400 meters by 400 meters) in subareas of the greater Everglades for water years 2004-05, 2005-06, 2006-07, 2007-08, and 2008-09 (partial year). These water depths are computed from EDEN daily water level surfaces and the EDEN ground elevation model. The mean monthly rainfall for subareas is also plotted. Several observations are noted:
    - The storage capacity of the system is quite evident. Initial water depths in the WCAs are relatively high in water year 2005-06, in part, due to the high rainfall and subsequent high water depths the previous year.
    - The longer, drier dry season in water year 2006-07 likely impacted the resulting lower mean depths in water year 2007-08.
    - The short dataset shows extreme ranges of water depth in WCA3N which appears highly linked to rainfall fluctuations.
  - Figures 12 through 17 show plots of mean water depth by month for EDEN grid cells (400 meters by 400 meters) in subareas of Everglades National Park for water years 2004-05, 2005-06, 2006-07, 2007-08, and 2008-09 (partial year). These water depths are computed from EDEN daily water level surfaces and the EDEN ground elevation model. The mean monthly rainfall for subareas is also plotted. Several observations are noted:
    - Water depths in Everglades National Park were highest in water year 2005-06.
    - Water depths in Everglades National Park were lowest in water year 2007-08.
    - Relatively high water depths entering dry season 2008-09 (partial year plot) result, in part, from high rainfall amounts in the previous wet season.
    - The marl prairie system has the lowest mean water depths and large areas go dry in the dry season. The coastal oligohaline system has the highest mean water depths.

**VI. FY10 WORKPLAN (in draft form at this time)**

- Data management and daily water surface creation
  - Create and post daily water surfaces on schedule
  - Continue to improve the data gap fill program
  - Use new datum surveys at gages to revise water level data
  - Add new gages if appropriate
  - Create rules for handling ‘dry’ data at gages and in EDEN surfaces
  - Complete revision of surface-water model
  - Use water level data at benchmarks to evaluate/improve EDEN surfaces
  - Post benchmark data to the EDENweb
- Revise EDEN ground elevation model
- Continue to enhance the EDENweb to provide users with data and information that is user-friendly and easily accessible
- Consider hindcasting water-level data and creation of water surfaces prior to 2000
- Develop protocol for oligohaline zone EDEN
- Update rainfall and evapotranspiration data on schedule
- Participate in GEER 2010
- Make revisions to EDENapps (if staffing resources available)
- Conduct hydrologic assessments for RECOVER
- Continue to document EDEN protocols, research, and data analyses

**VII. UNFUNDED NEEDS IN FY09**

- With construction of the Tamiami Trail bridge approved for construction, the EDEN project would like to focus on the hydrology directly upstream and downstream of the new proposed bridge. EDEN can provide useful baseline data prior to and following completion of the bridge in 2012. EDEN project staff have already begun initial discussions with Leonard Pearlstine, Everglades National Park, regarding collaboration and data support.

**VIII. ANTICIPATED NEEDS OR ISSUES**

- Because the water level data at gages is the foundation of the EDEN surface water interpolation program, the quality of gage data is critical to the resultant EDEN daily water surfaces. Gage data used for EDEN surfaces comes from multiple agencies with varying protocols, schedules, and levels of review. It is a highly ambitious goal to receive hourly data from 230 gages daily (approximately 5520 data values). Even if only 1% (rarely this low) of these data appear bad or are missing, 55 values per day or 5000 values per quarter must be identified and resolved. Monitoring, reviewing, editing (when necessary) and estimating missing and bad data has taken more personnel time than expected. Users see the results as EDEN products when, in fact, they are the result of many others’ work outside of EDEN. It has been a serious challenge for me as the project chief to balance sufficient data quality with adequate results and appropriate use of funds.
- EDEN staff continues to be concerned that datum surveys and water level data is not as accurate as necessary to produce a high-quality interpolated water-level

surface. Independent data sets at gages may look adequate but when surfaced together can show discontinuities and shifts not seen when viewing water level data gage by gage. Continued investigation of data and files suggests that gage data may still have datum inaccuracies. New funding in 2010 may be available to run new datum surveys to the newest standards for many gages in the Everglades. Any significant changes to the water level dataset might require another round of reparameterizing of the surface water model.

**IX. FUNDING STATUS**

- As of 9/30/08, all FY09 funding (\$530,263) has been expended or obligated.
- ARRA (economic stimulus) funding (\$200,000) was received 6/29/09 and is in the process of being obligated for agreement in accordance with ARRA regulations. Funding will be expended by 9/30/10.

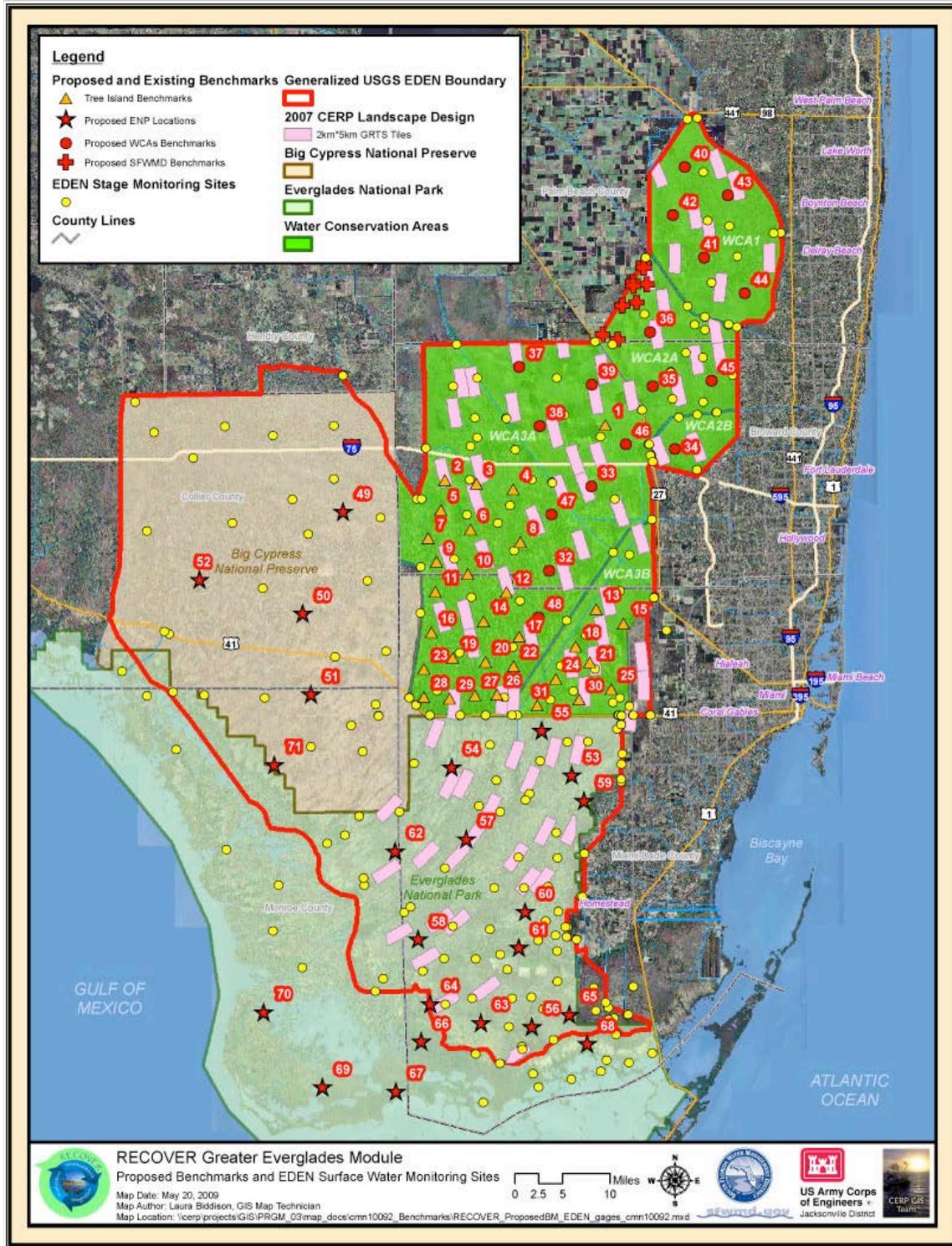


Figure 1.

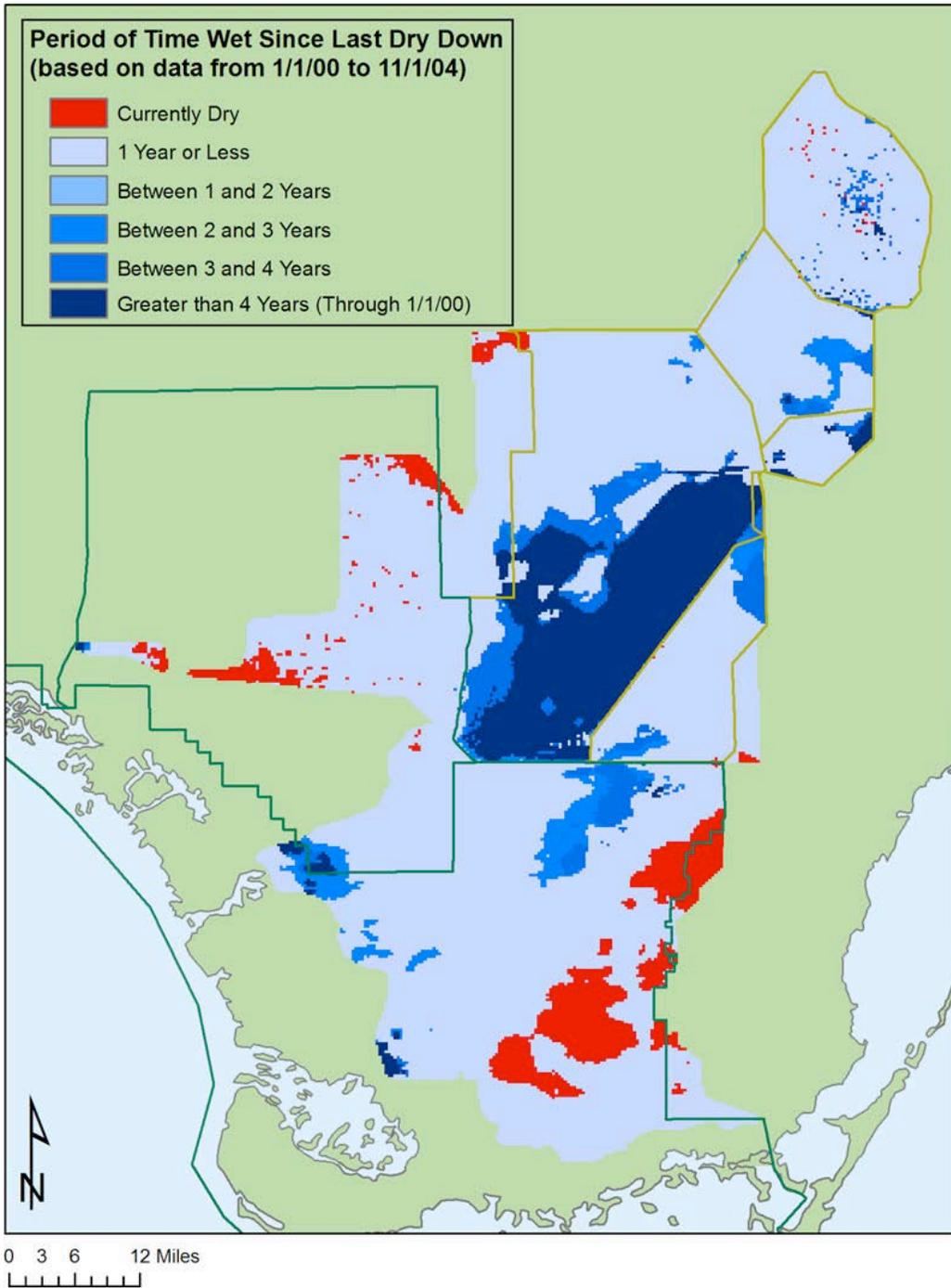


Figure 2. Map showing hydroperiod for greater Everglades for November 1, 2004 based on EDEN daily water surfaces and EDEN ground elevation model.

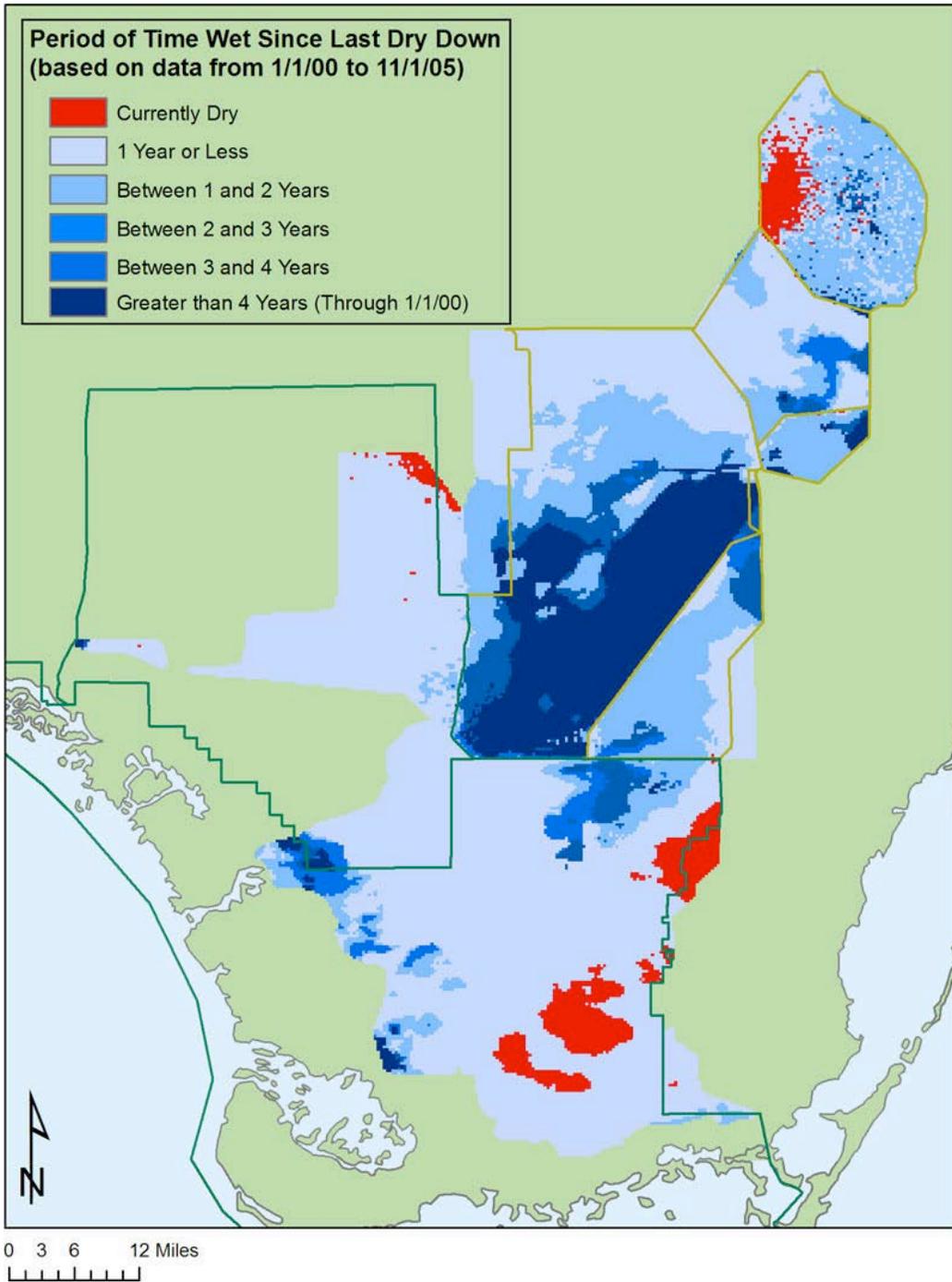


Figure 3. Map showing hydroperiod for greater Everglades for November 1, 2005 based on EDEN daily water surfaces and EDEN ground elevation model.

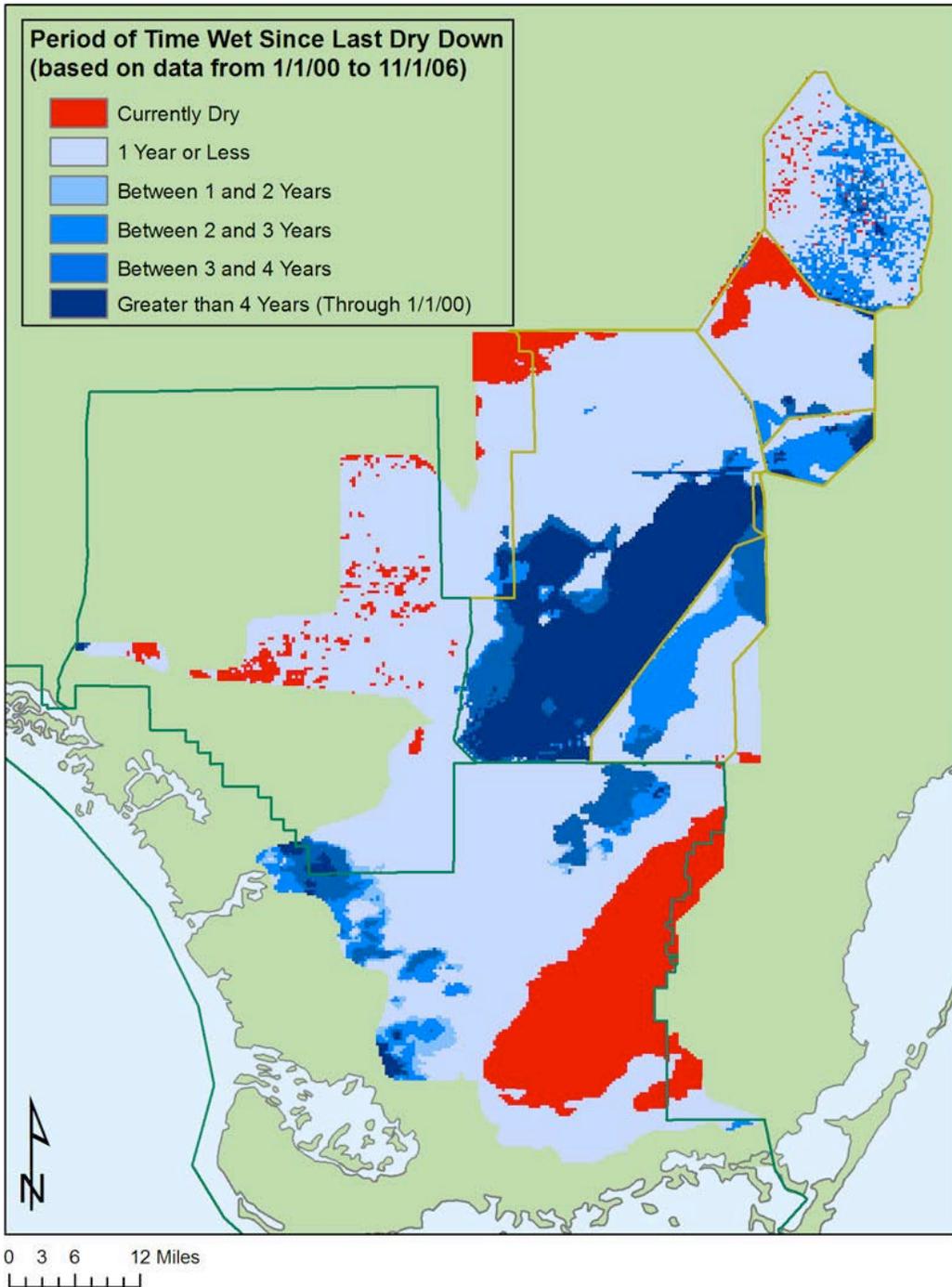


Figure 4. Map showing hydroperiod for greater Everglades for November 1, 2006 based on EDEN daily water surfaces and EDEN ground elevation model.

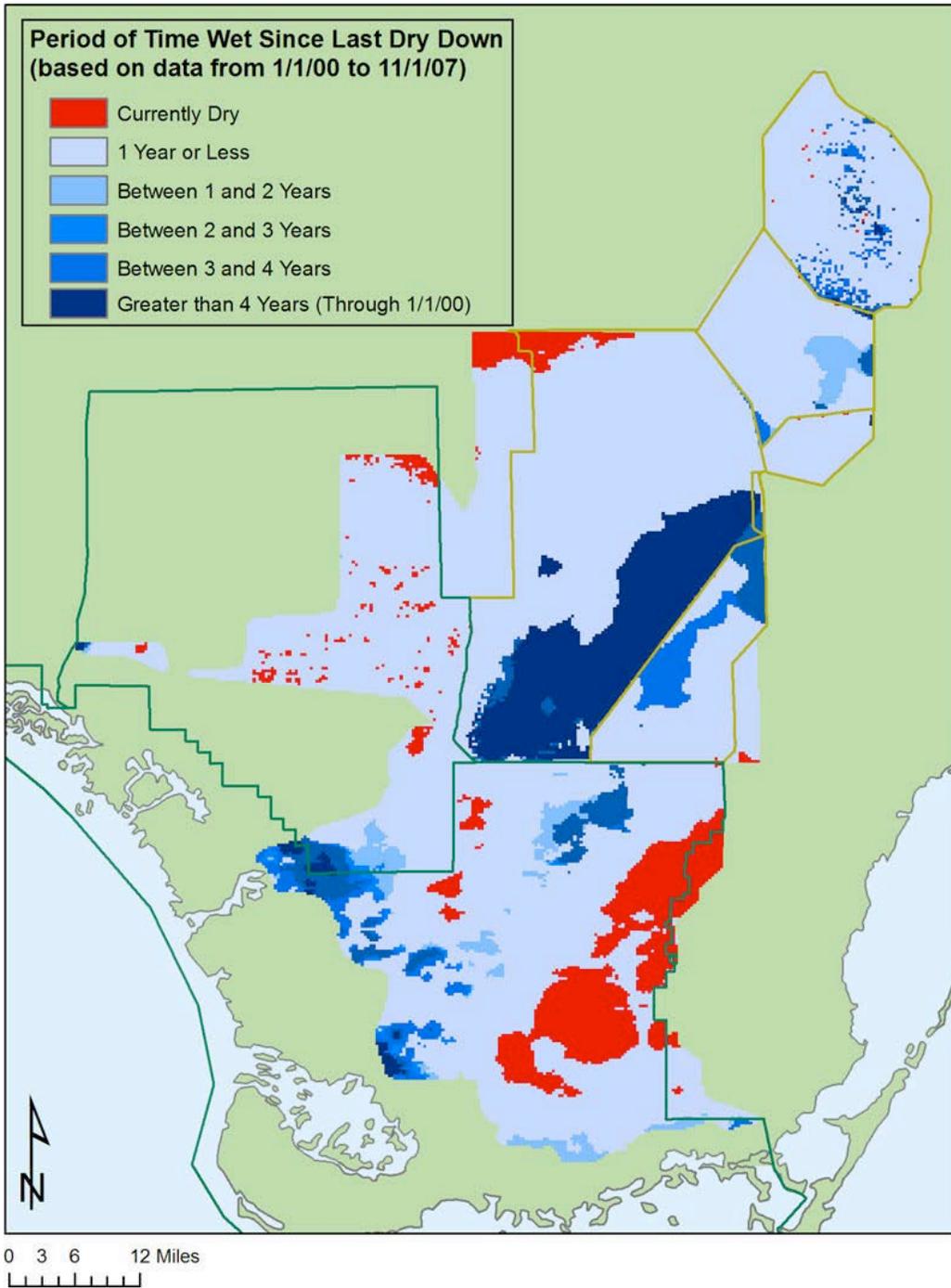


Figure 5. Map showing hydroperiod for greater Everglades for November 1, 2007 based on EDEN daily water surfaces and EDEN ground elevation model.

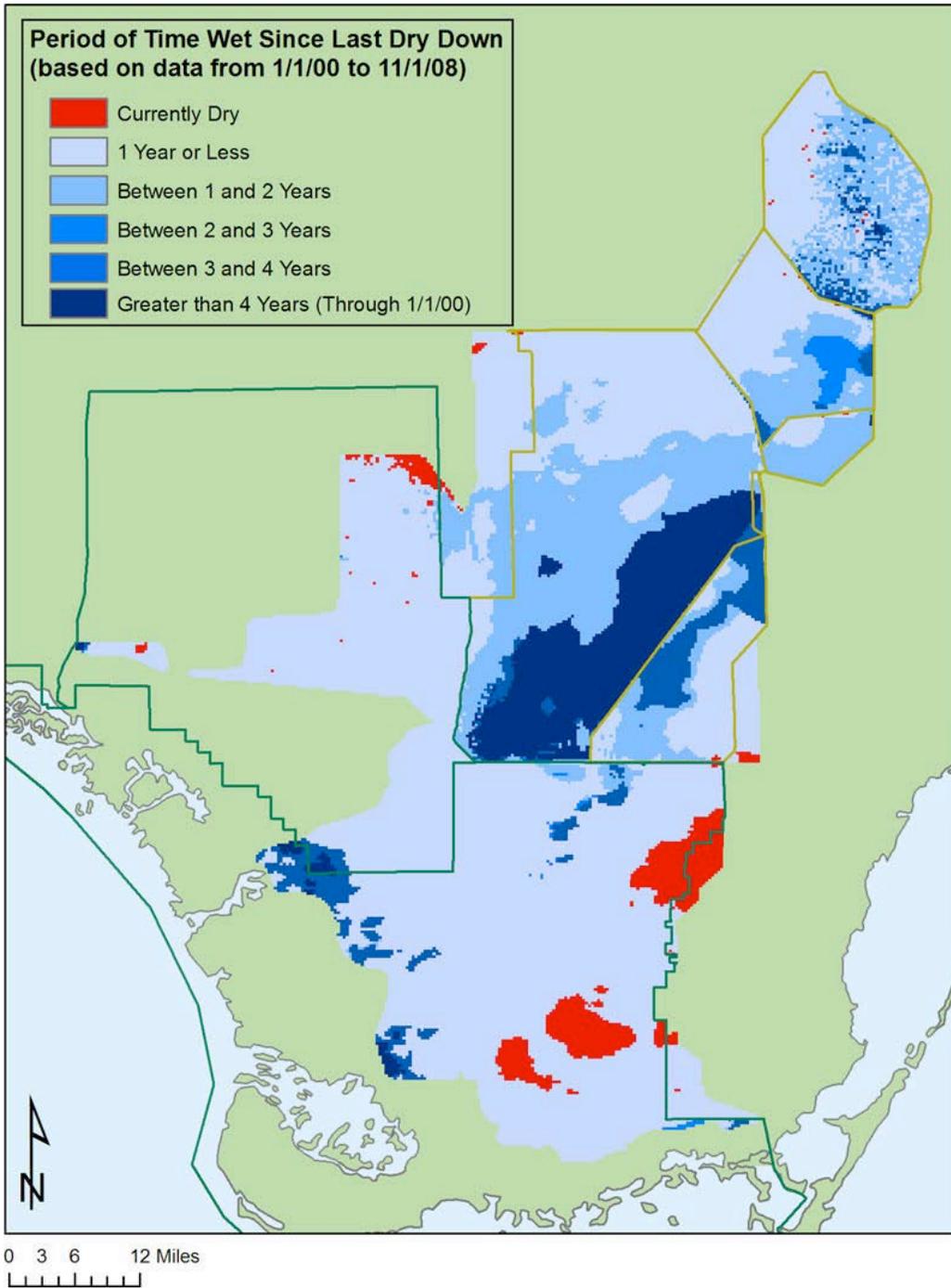
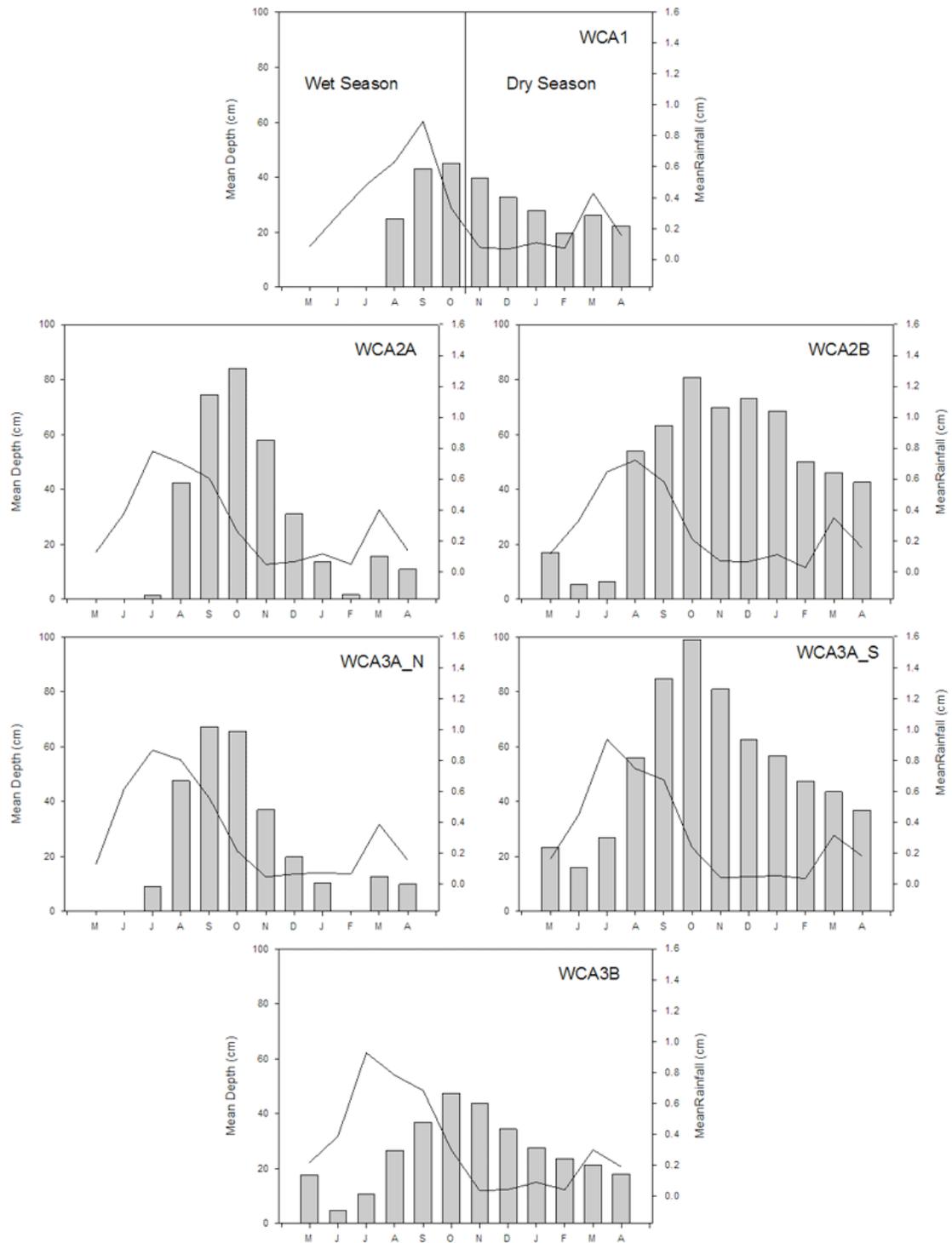
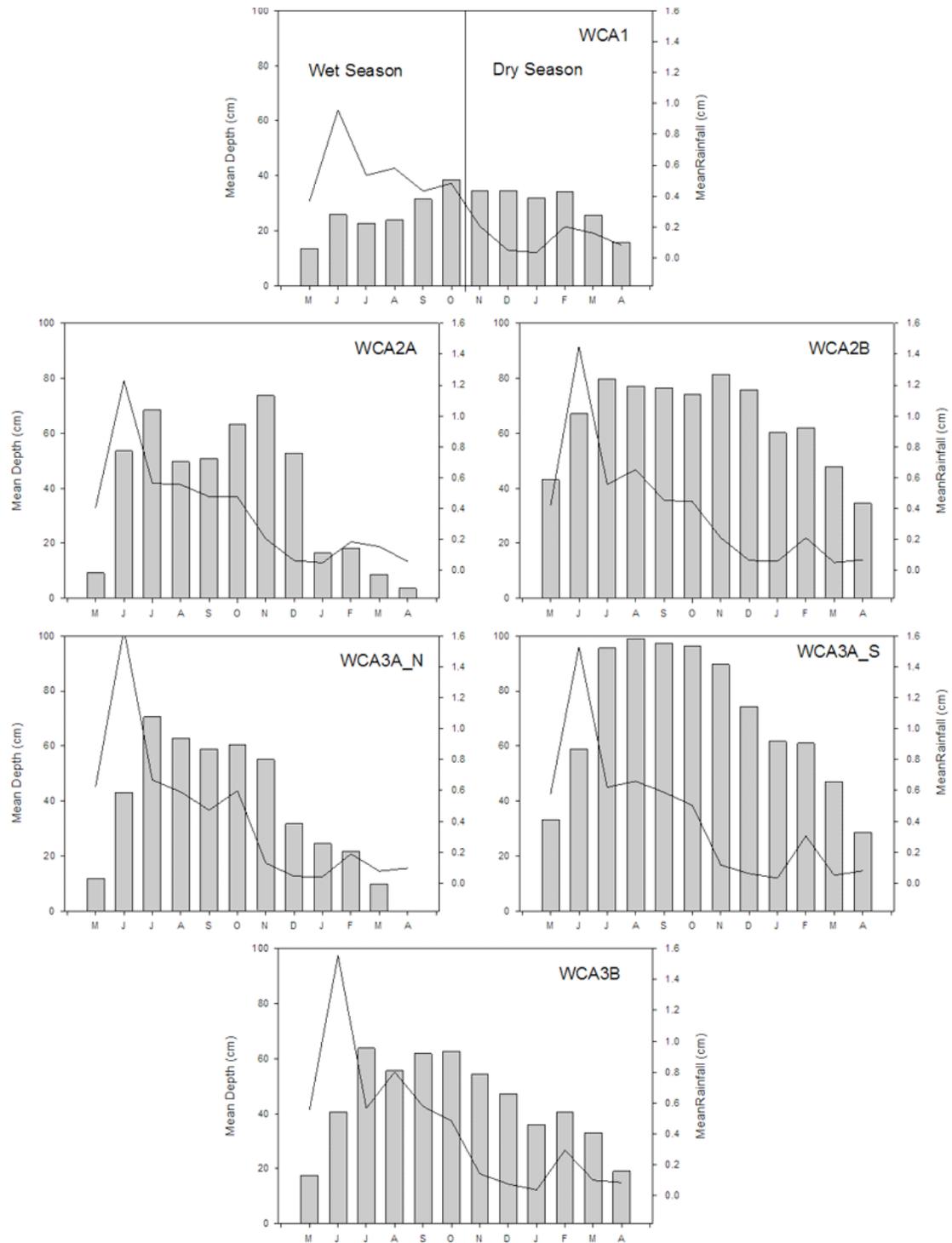


Figure 6. Map showing hydroperiod for greater Everglades for November 1, 2008 based on EDEN daily water surfaces and EDEN ground elevation model.



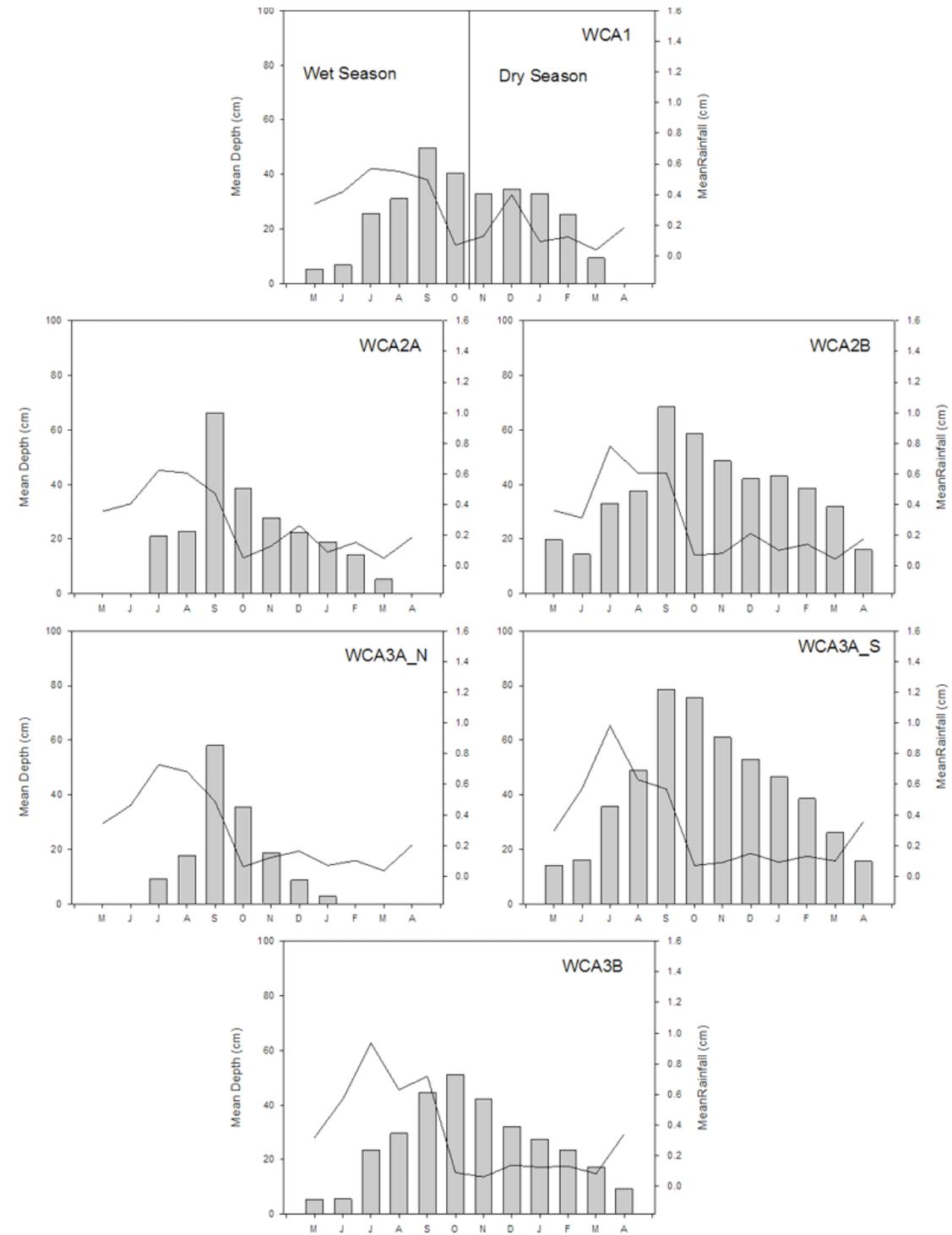
Water year 2004-2005

Figure 7. Plots of mean water depth by month for subareas of the greater Everglades based on EDEN daily water surfaces and ground elevation model for water surfaces and ground elevation model for water year 2004-2005 (May 1 – April 30). Mean monthly rainfall for subareas also plotted.



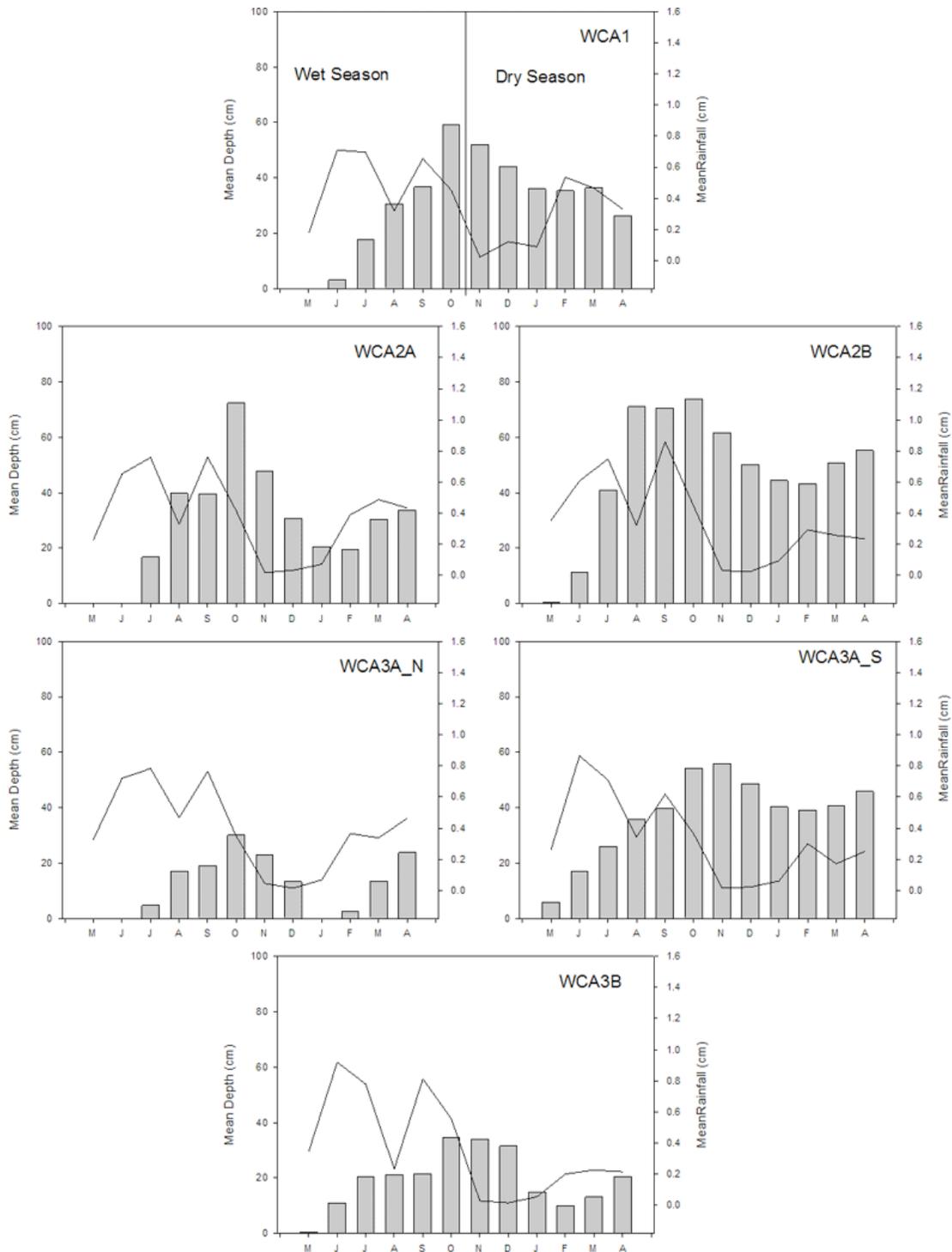
Water year 2005-2006

Figure 8. Plots of mean water depth by month for subareas of the greater Everglades based on EDEN daily water surfaces and ground elevation model for water surfaces and ground elevation model for water year 2005-2006 (May 1 – April 30). Mean monthly rainfall for subareas also plotted.



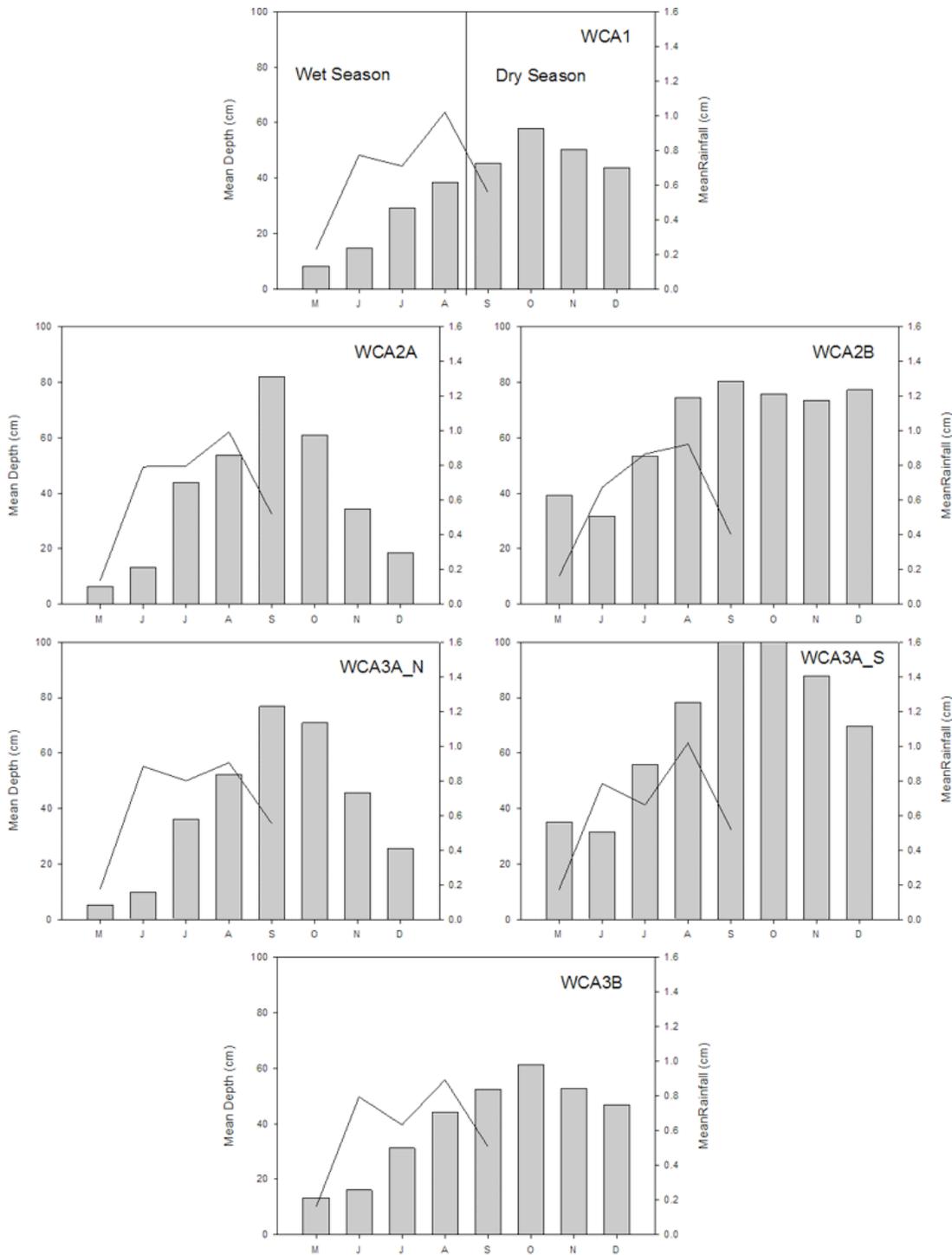
Water year 2006-2007

Figure 9. Plots of mean water depth by month for subareas of the greater Everglades based on EDEN daily water surfaces and ground elevation model for water surfaces and ground elevation model for water year 2006-2007 (May 1 – April 30). Mean monthly rainfall for subareas also plotted.



Water year 2007-2008

Figure 10. Plots of mean water depth by month for subareas of the greater Everglades based on EDEN daily water surfaces and ground elevation model for water surfaces and ground elevation model for water year 2007-2008 (May 1 – April 30). Mean monthly rainfall for subareas also plotted.



Water year 2008-2009

Note that rainfall data extends through September 2008 and water depth data extends through December 2008

Figure 11. Plots of mean water depth by month for subareas of the greater Everglades based on EDEN daily water surfaces and ground elevation model for water surfaces and ground elevation model for water year 2008-2009 (May 1 – April 30). Mean monthly rainfall for subareas also plotted.

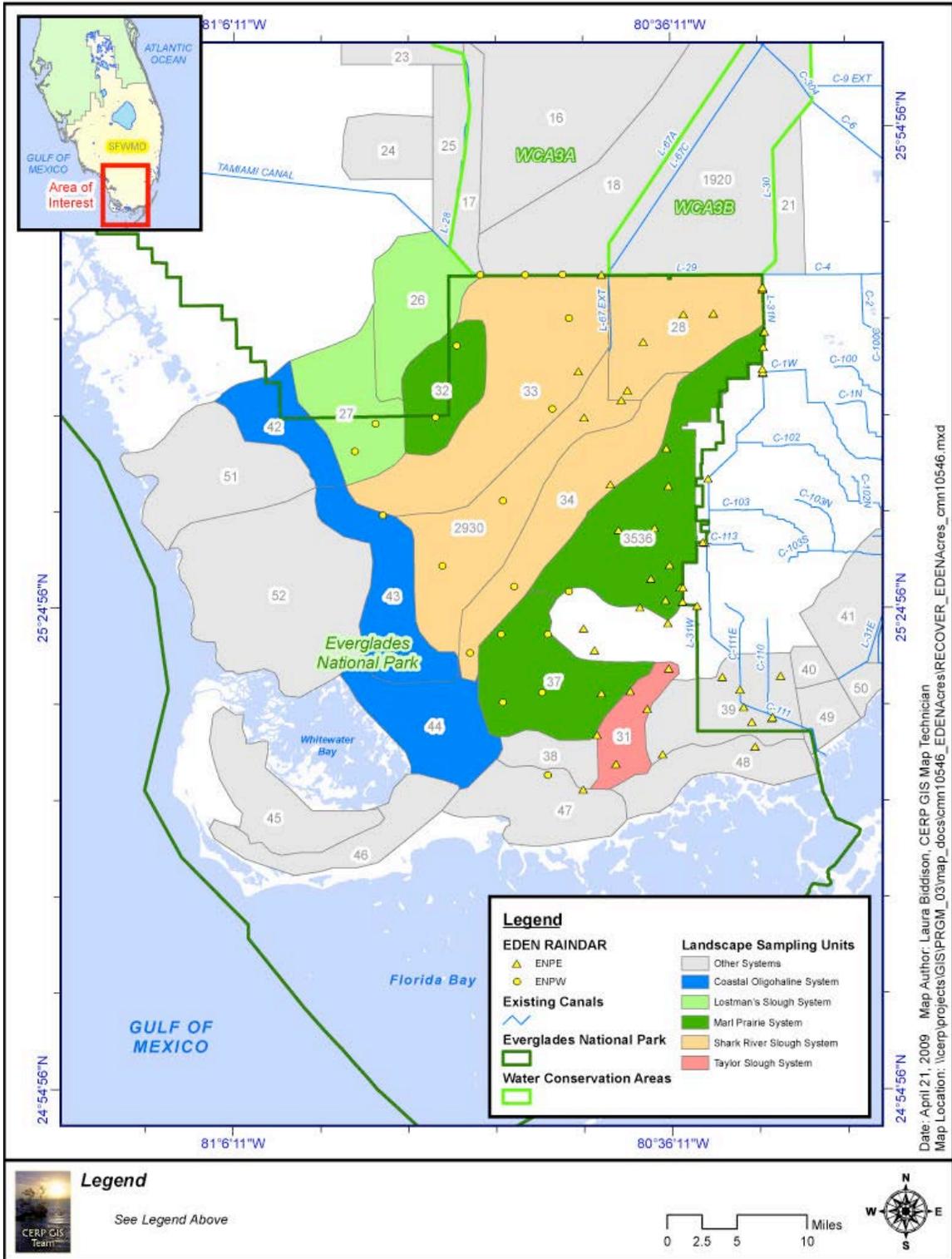
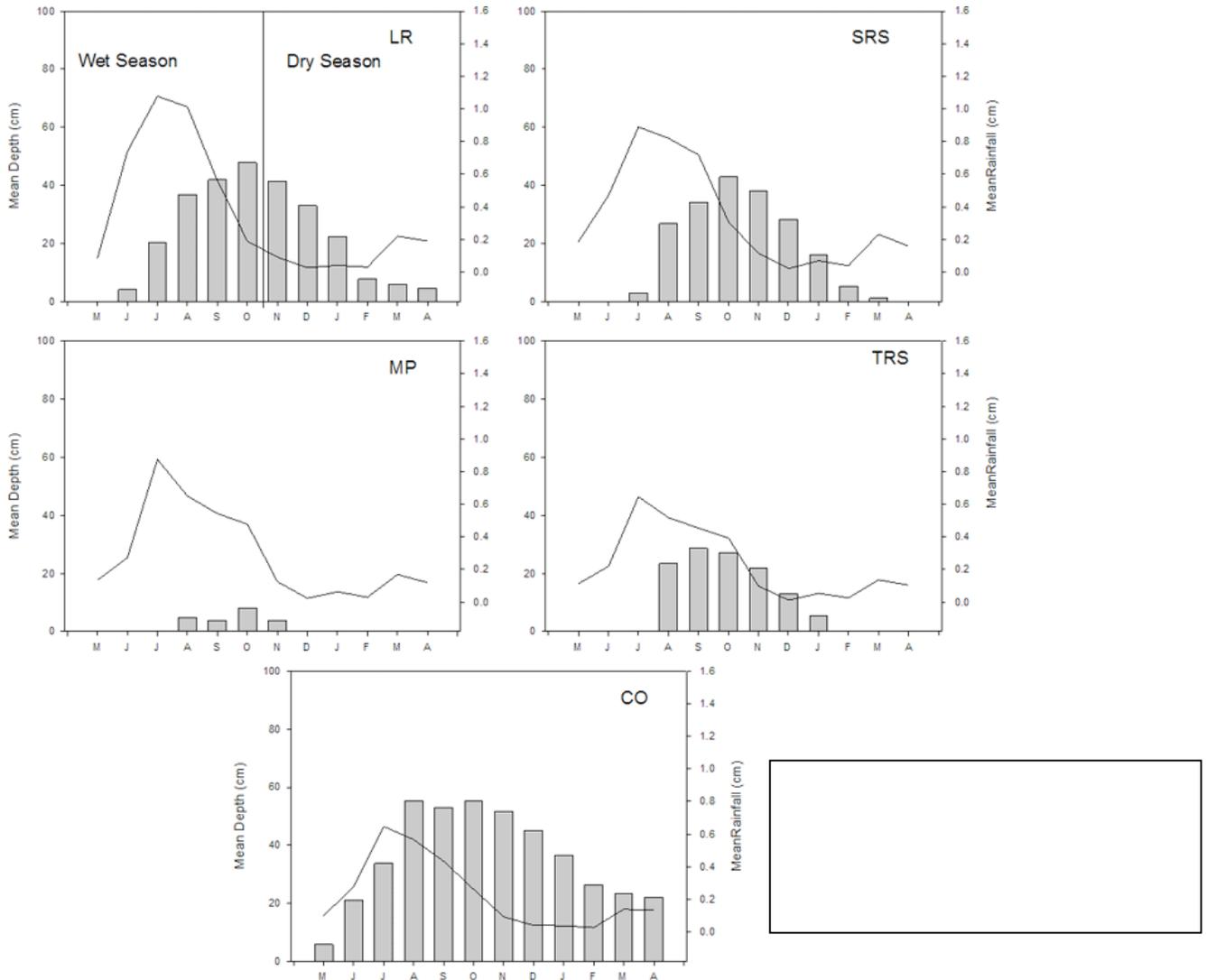
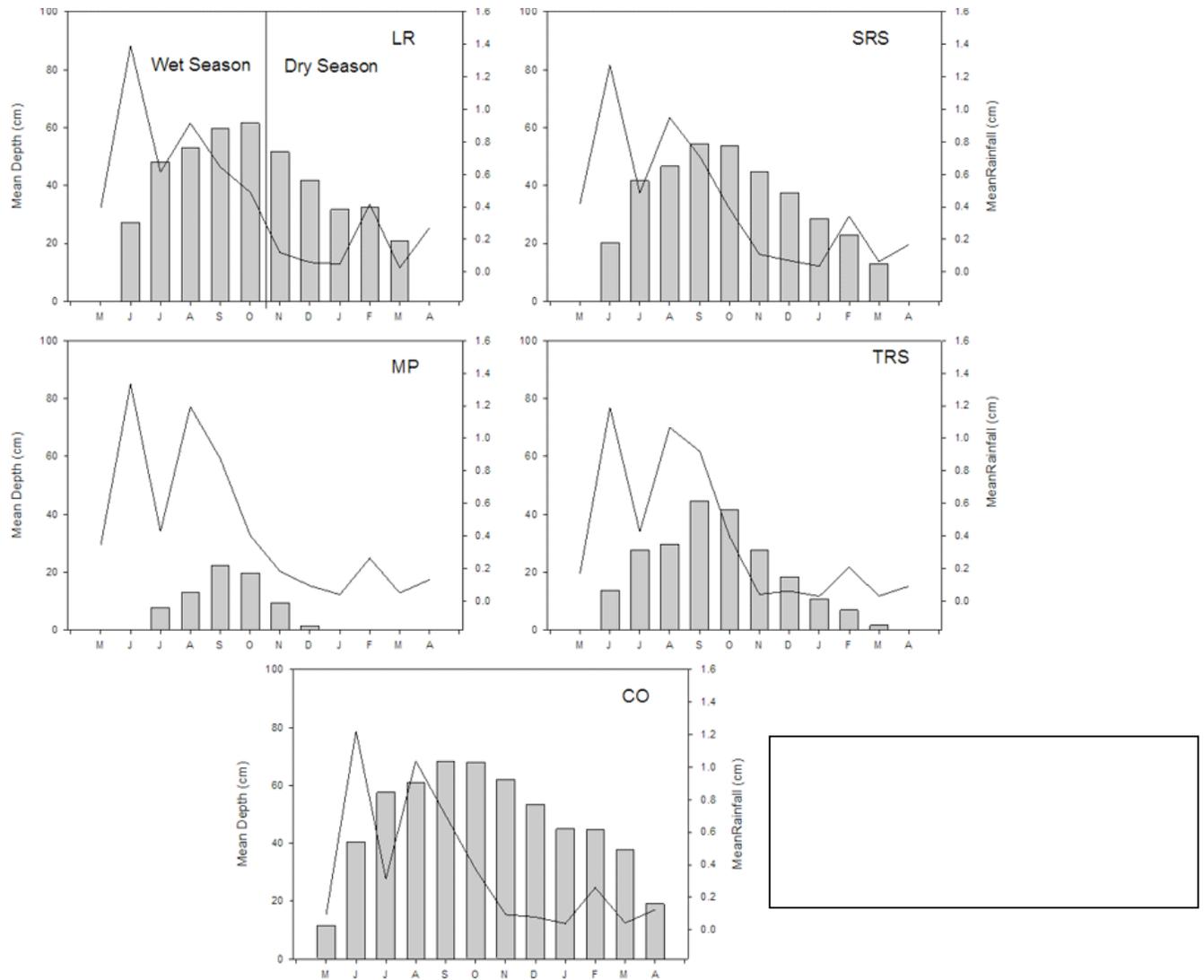


Figure 12. Landscape sampling units grouped by subareas of Everglades National Park.



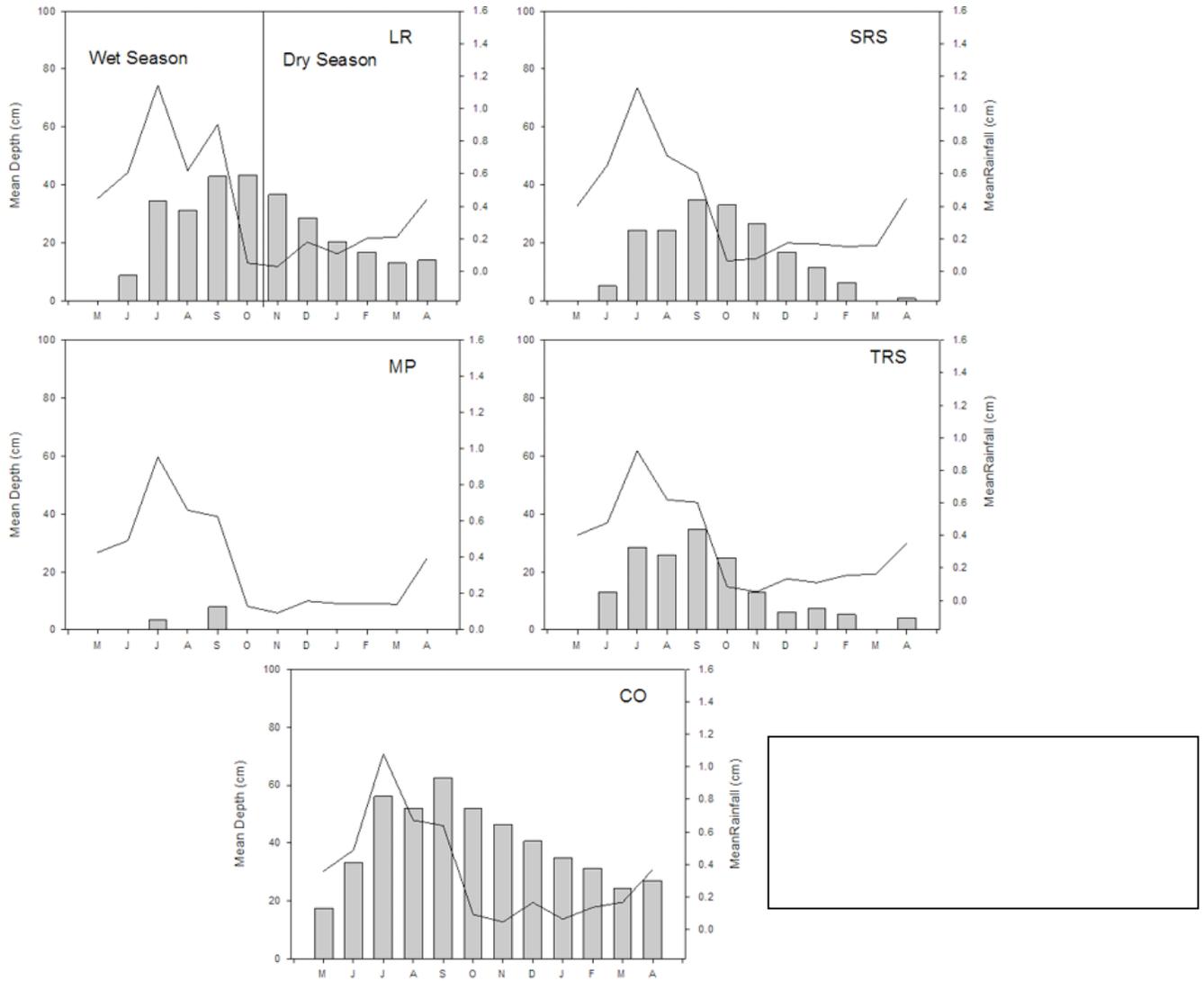
Water year 2004-2005

Figure 13. Plots of mean water depth by month for subareas of Everglades National Park based on EDEN daily water surfaces and ground elevation model for water year 2004-2005 (May 1 – April 30). Mean monthly rainfall for subareas also plotted.



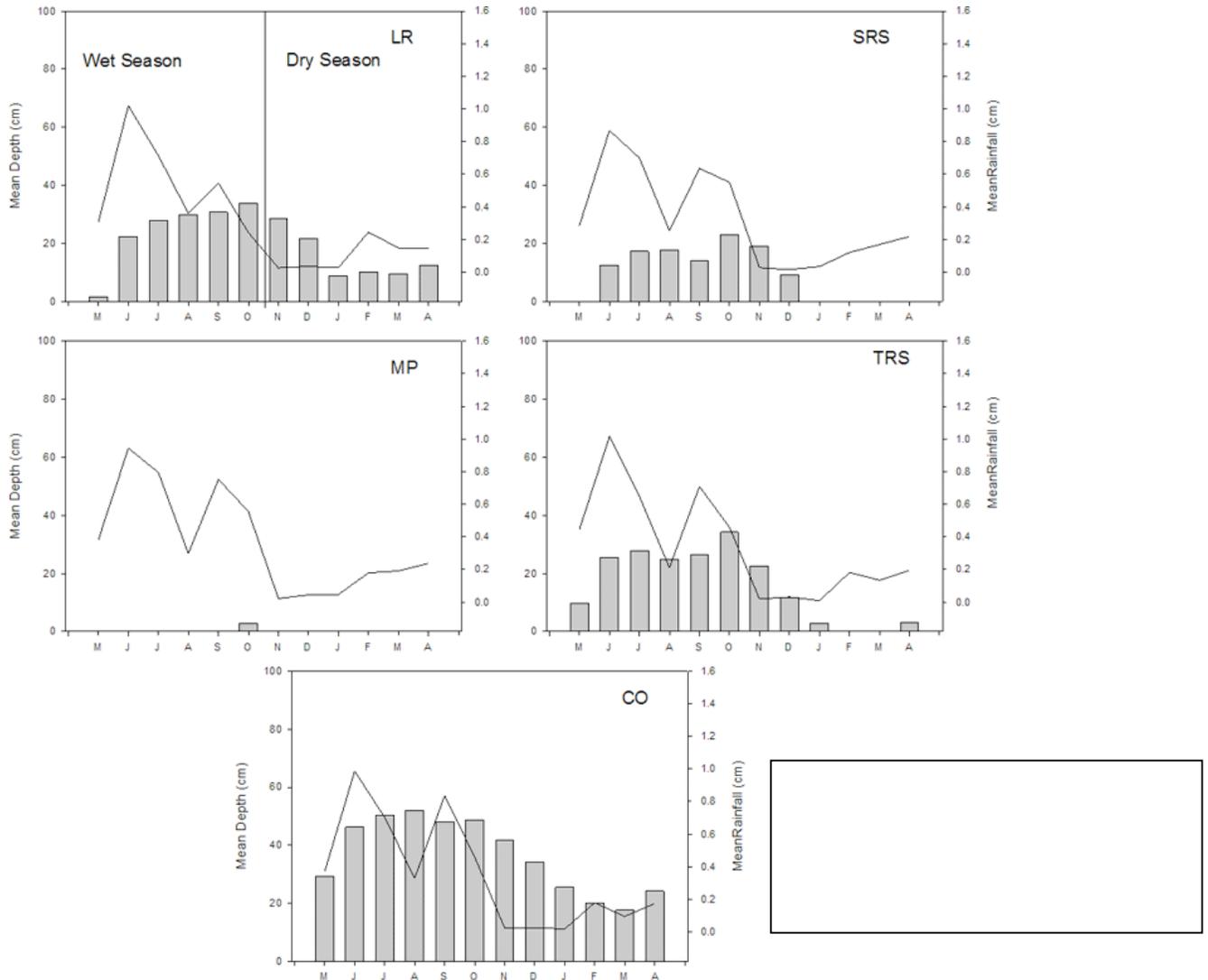
Water year 2005-2006

Figure 14. Plots of mean water depth by month for subareas of Everglades National Park based on EDEN daily water surfaces and ground elevation model for water year 2005-2006 (May 1 – April 30). Mean monthly rainfall for subareas also plotted.



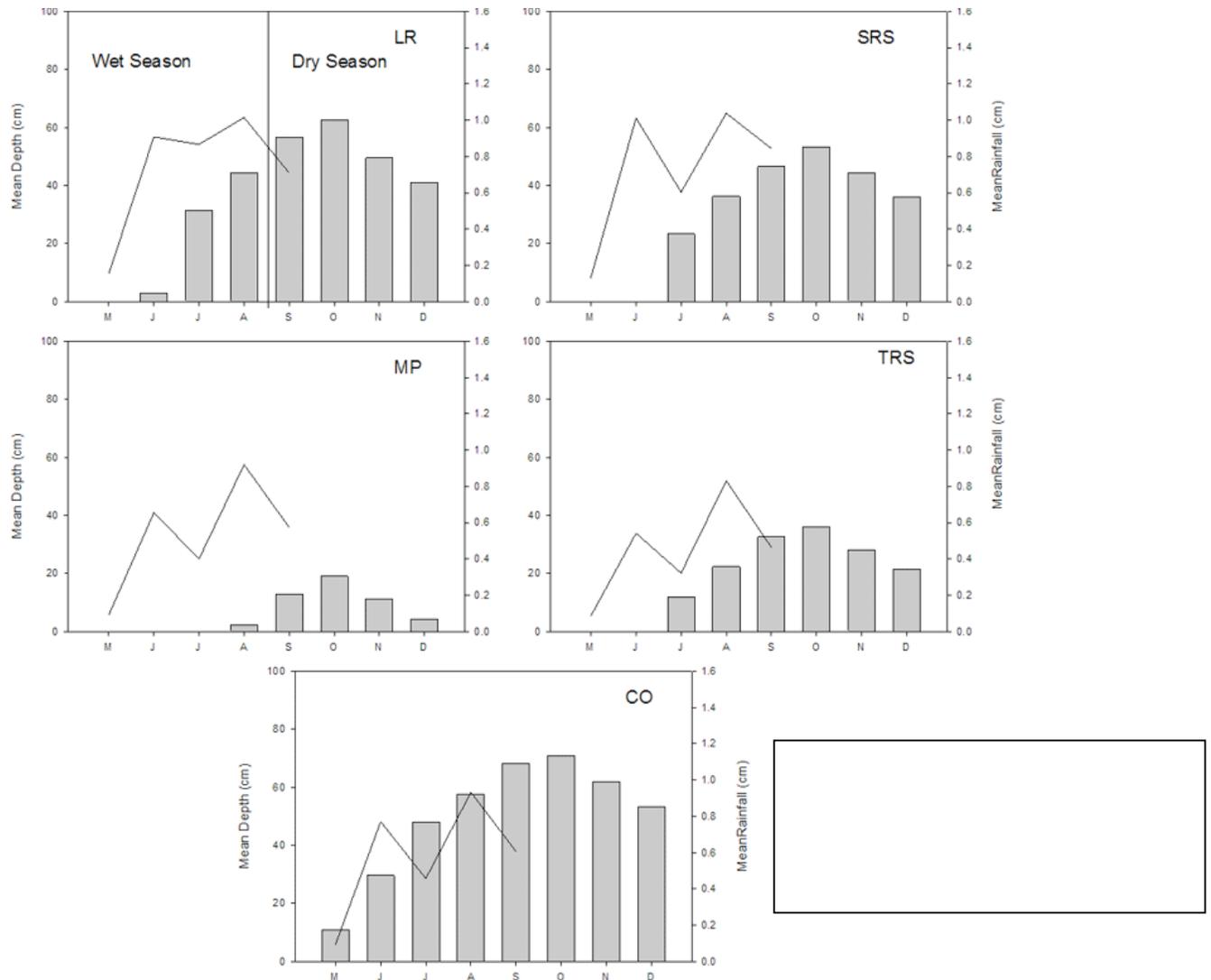
Water year 2006-2007

Figure 15. Plots of mean water depth by month for subareas of Everglades National Park based on EDEN daily water surfaces and ground elevation model for water year 2006-2007 (May 1 – April 30). Mean monthly rainfall for subareas also plotted.



Water year 2007-2008

Figure 16. Plots of mean water depth by month for subareas of Everglades National Park based on EDEN daily water surfaces and ground elevation model for water year 2007-2008 (May 1 – April 30). Mean monthly rainfall for subareas also plotted.



Water year 2008-2009

Note that rainfall data extends through September 2008 and water depth data extends through December 2008

Figure 17. Plots of mean water depth by month for subareas of Everglades National Park based on EDEN daily water surfaces and ground elevation model for water year 2008-2009 (May 1 – April 30). Mean monthly rainfall for subareas also plotted.