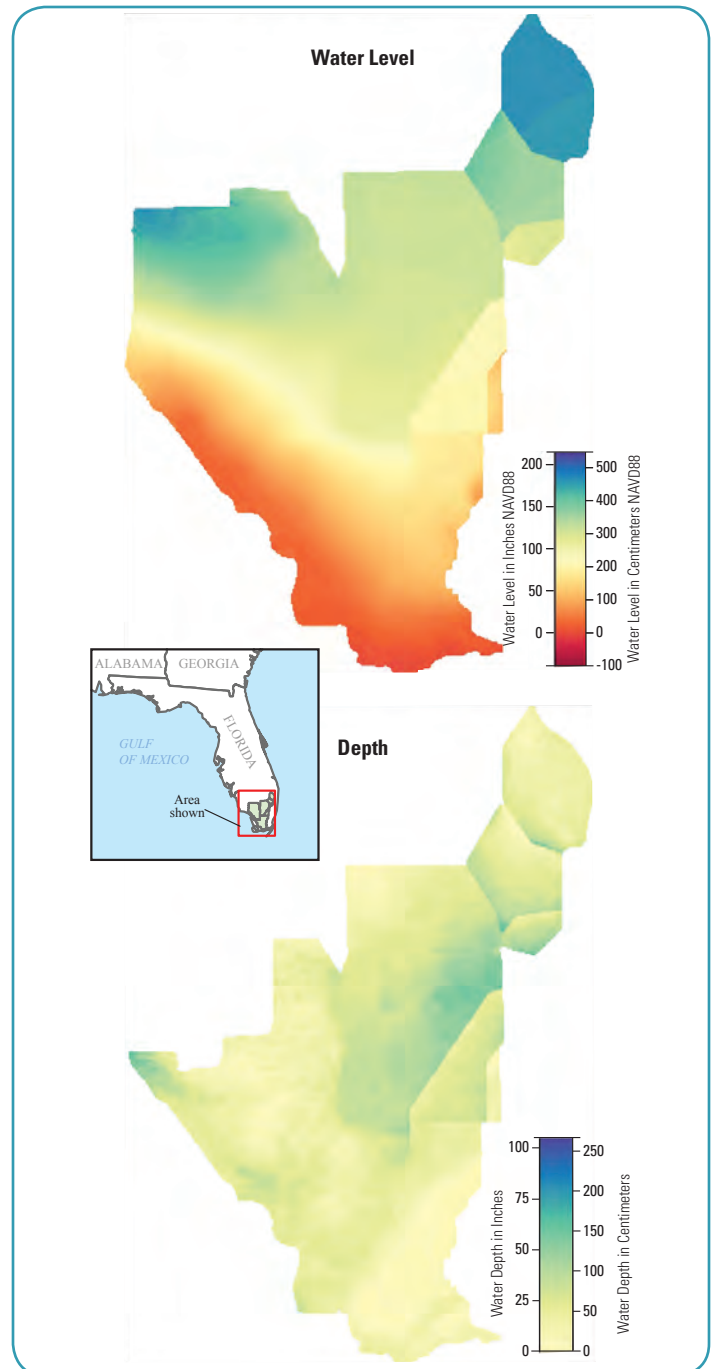# <u>E</u>verglades <u>D</u>epth <u>E</u>stimation <u>N</u>etwork (EDEN)—

A Decade of Serving Hydrologic Information to Scientists and Resource Managers

Introduction

The Everglades Depth Estimation Network (EDEN) provides scientists and resource managers with regional maps of daily water levels and depths in the freshwater part of the Greater Everglades landscape (fig. 1). The EDEN domain includes all or parts of five Water Conservation Areas, Big Cypress National Preserve, Pennsuco Wetlands, and Everglades National Park (figs. 2, 3). Daily water-level maps are interpolated from water-level data at monitoring gages (figs. 2, 4), and depth is estimated by using a digital elevation model of the land surface. Online datasets provide time series of daily water levels at gages and rainfall and evapotranspiration data (https://sofia.usgs.gov/eden/). These datasets are used by scientists and resource managers to guide large-scale field operations, describe hydrologic changes, and support biological and ecological assessments that measure ecosystem response to the implementation of the Comprehensive Everglades Restoration Plan (U.S. Army Corps of Engineers, 1999). EDEN water-level data have been used in a variety of biological and ecological studies including (1) the health of American alligators as a function of water depth (Fujisaki and others, 2009), (2) the variability of post-fire landscape dynamics in relation to water depth (Jones and others, 2013), (3) the habitat quality for wading birds with dynamic habitat selection (Beerens and others, 2015), and (4) an evaluation of the habitat of the Cape Sable seaside sparrow (fig. 5).
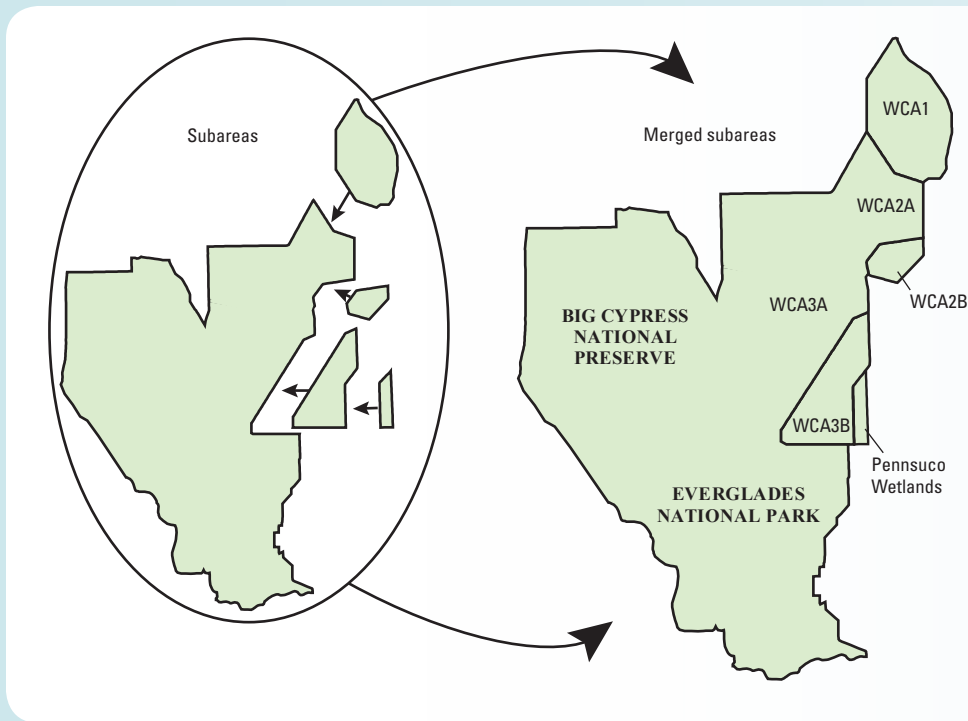
EDEN Water-Level Model

Water levels across the EDEN domain are computed by using the EDEN surface-water model, version 2 (referred to as the V2 model). Input to the model includes continuous water-level measurements at 247 gaging stations, including freshwater-marsh gaging stations, canal stations, and coastal (tidal) stations operated by the Big Cypress National Preserve (BCNP), Everglades National Park (ENP), South Florida Water Management District (SFWMD), and the U.S. Geological Survey (USGS) (fig. 2). The V2 model interpolates the daily median water level from 223 of these 247 stations to generate daily water-level surfaces (Telis and others, 2015). The remaining 24 stations are available for quality-assurance evaluations and estimation of missing or erroneous data. Enhancements of the V2 model relative to the original EDEN surface-water model (Pearlstine and others, 2007) include adjustments to water-level input data, improved understanding

Figure 1. Everglades Depth Estimation Network-generated water-level and water-depth surfaces for August 1, 2017.
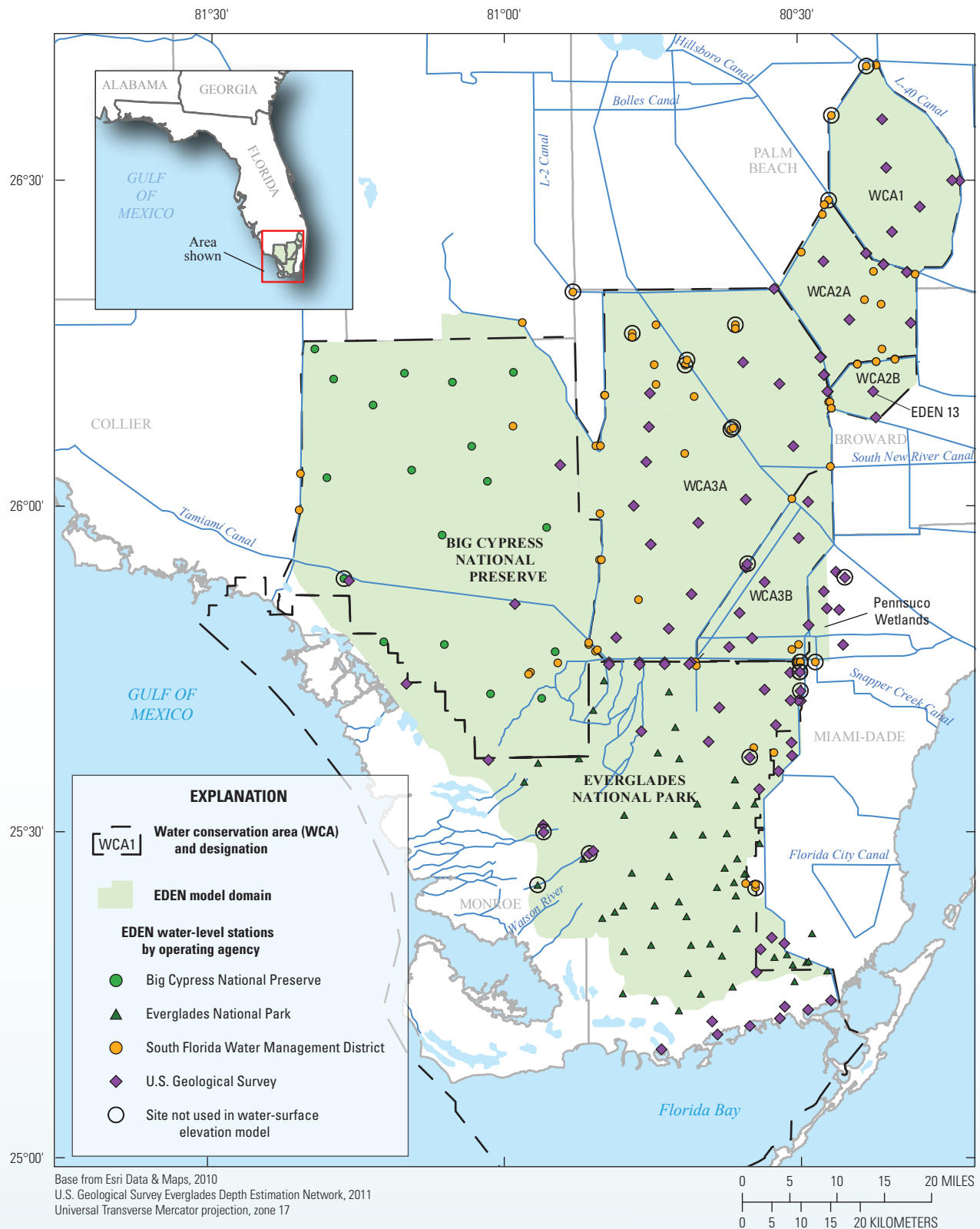
Figure 2. Everglades Depth Estimation Network model domain and location of monitoring gages (modified from Petkewich and others, 2016).

Figure 3. Five subareas merged to represent the entire Everglades Depth Estimation Network model domain (modified from Telis and others, 2015).

Figure 4. Field water-level monitoring gage EDEN 13. Photograph by Michael Oliver, U.S. Geological Survey.

Figure 5. The Cape Sable seaside sparrow in Everglades National Park. Photograph by David A. La Puma, New Jersey Audubon, from Wikimedia Commons, https://commons.wikimedia.org/wiki/File:CSSS1.jpg, licensed under the Creative Commons Attribution 3.0 Unported license.

of flow dynamics, the installation of an elevation benchmark network, the expansion of the EDEN domain to cover a part of southern BCNP and northwestern ENP, and the development of subdomain models. The subdomain models were developed for five subareas (fig. 3) to better simulate the discontinuities of water-surface levels among Water Conservation Areas. The resulting water-level surfaces are merged to generate the final water-level surface for the entire EDEN domain (fig. 1) (Telis and others, 2015). Many of the gages in the current network were not in operation prior to 2000 and required hindcasting to estimate past water levels. Water levels and depths for these gages were hindcasted to 1991 by using 214 empirical models (Conrads and others, 2014).
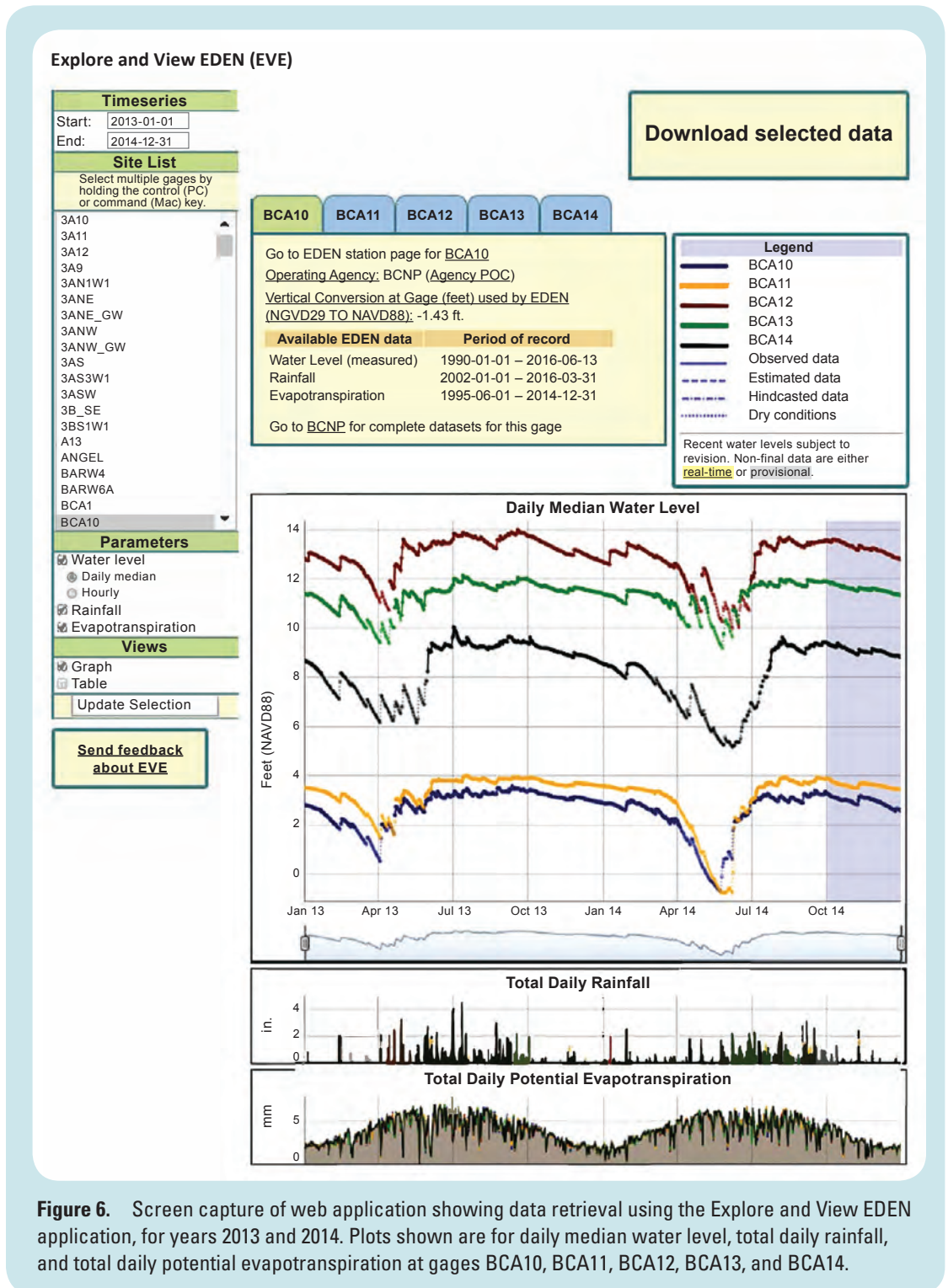
EDEN Web Applications

EDEN has evolved from primarily serving water-level and water-depth maps to also providing scientists and resource managers with analysis and presentation tools that describe and analyze environmental response to hydrologic changes and assess system-wide management strategies. This evolution includes hindcasted datasets, statistical analyses, and visualization tools. Two of these applications are described below.

Explore and View EDEN (EVE) Application

The Explore and View EDEN (EVE) application (https://sofia.usgs.gov/eden/eve/index.php) allows users to view and download water-level, rainfall, and potential evapotranspiration data in graphical or tabular formats. Up to five gaging stations are selected by the user from the list of EDEN stations provided in the application (fig. 6). The selected timescale for water-level data can be daily (1991 to present) or hourly (2000 to present). Daily rainfall data and evapotranspiration data also are available. For more information on rainfall and evapotranspiration data, refer to Pathak (2008) and Jacobs and others (2008), respectively.

Cape Sable Seaside Sparrow (CSSS) Viewer Application

The endangered Cape Sable seaside sparrow (CSSS; fig. 5) is one of eight remaining subspecies of seaside sparrow. The most current, known distributions of the CSSS are restricted to seven separate subpopulation areas (A–F and AX) in the ENP (fig. 7). Previous studies have shown clear correlations between water depth and CSSS population densities, with successful nesting depending on specific hydrologic conditions (Dong and others, 2006). The EDEN CSSS Viewer application (https://sofia.usgs.gov/eden/csss/index.php) was developed to evaluate water depths at CSSS habitat on a historical and real-time basis.

Figure 6.   Screen capture of web application showing data retrieval using the Explore and View EDEN application, for years 2013 and 2014. Plots shown are for daily median water level, total daily rainfall, and total daily potential evapotranspiration at gages BCA10, BCA11, BCA12, BCA13, and BCA14.
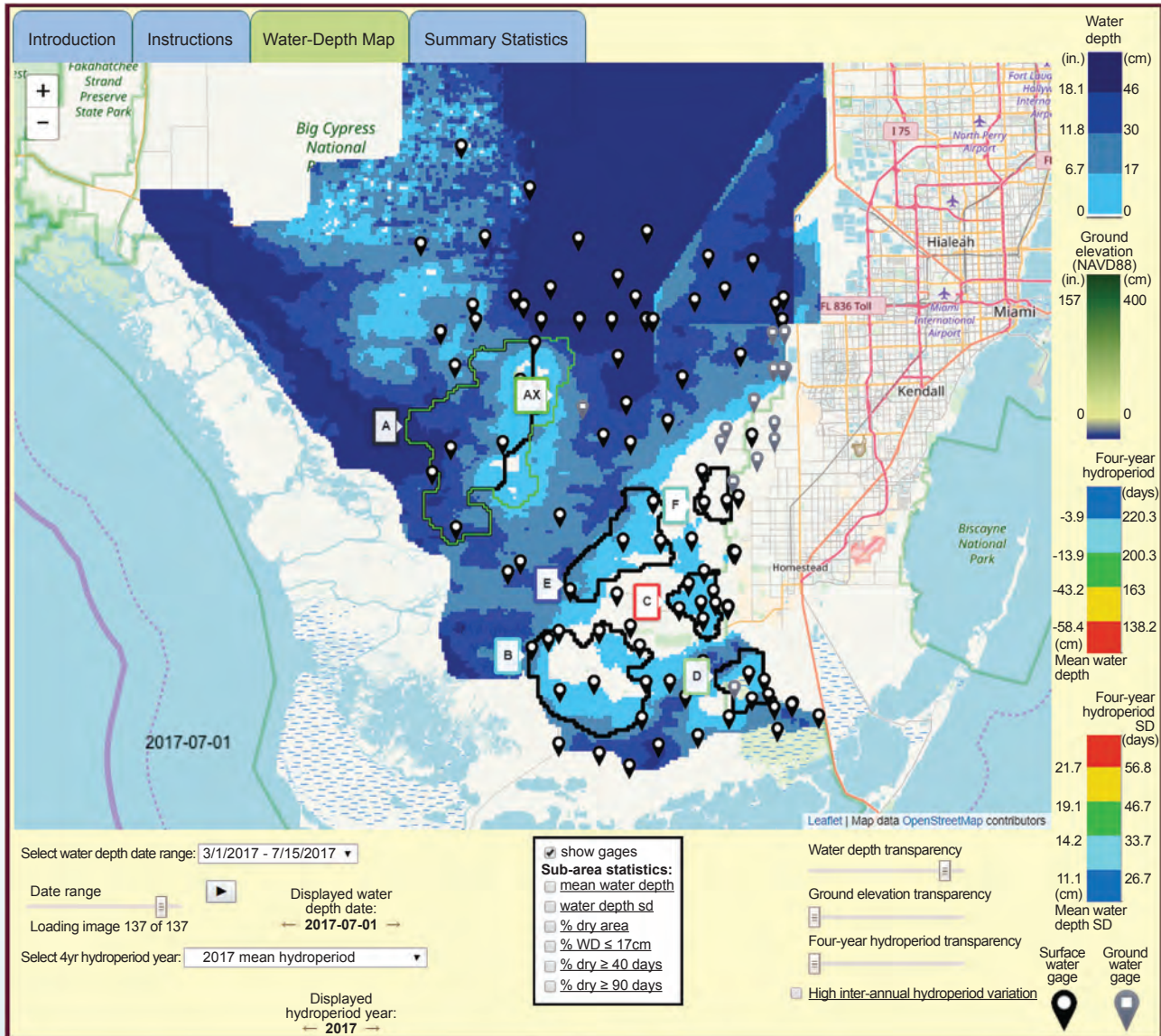
Figure 7. Screen capture of the Cape Sable Seaside Sparrow Viewer application for July 1, 2017, showing the seven subpopulations (A–F and AX) and nearby monitoring gages in Everglades National Park.

The animated viewer shows flooded and dry areas and calculates (1) the percentage of area that is dry, (2) the percentage of area with water depth less than or equal to 17 centimeters (a critical depth for CSSSs), and (3) the percentage of area that has been dry for 40 and 90 days or more for each subpopulation area (fig. 7). The CSSS Viewer application allows scientists and resource managers to access hydrologic information, evaluate potential effects of water depths on nesting success, and guide management strategies on a daily basis.

Looking Forward to the Next Decade

In addition to serving water-level and water-depth maps to scientists and resource managers, the EDEN project will continue exploring the development of innovative real-time analytical and visualization tools to help further the understanding of ecological response to hydrologic changes and evaluate system-wide management strategies. Ongoing research into predictive tools includes the forecasting of water-level conditions by using statistical and numerical methods. The development of specialized applications, such as the CSSS Viewer, will continue in response to the needs of the scientific community and will continue to support biological and ecological assessments.

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Special Acknowledgment

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https://www2.usgs.gov/water/caribbeanflorida/
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