Hydrological Monitoring

Background

It is difficult to overstate the importance of water as a resource. Amplifying the importance of water on Cape Cod is the fact that our fresh water comes from a one-source supply that is recharged soley through precipitation. With this in mind, the Cape Cod National Seashore (CACO), in collaboration with the United States Geological Survey, has developed a standardized, long-term methodology of monitoring water levels on the Lower Cape. As local populations continue to grow, so too does the burden placed on water resources. Climate change, sea-level rise, and increased withdrawal rates from groundwater all have the potential to significantly impact the fresh water resources critical to the human population and the sensitive coastal ecosystems of the Lower Cape. CACO's long-term hydrological monitoring program will provide a better understanding of the effects of both natural and human-induced change on groundwater levels of the Cape Cod aquifer.

Long-Term Monitoring

A systematic protocol has been developed and implemented to monitor groundwater over the long-term at CACO. Park Service scientists began collecting data in 1999. Currently, the effort includes collecting data from 30 observation wells and 10 ponds on a regular basis (Figure 1). In addition, a prioritization process for future stream gauging is currently under way with the intent to begin collecting data in the fall of 2009. This comprehensive approach has been implemented to provide an integrated assessment of water resources. The network of sampling locations has been established taking into account a variety of different factors including spatial distribution, anticipated changes to hydrodynamics, and impacts of development within all four of the ground-water-flow cells, or lenses, in the Seashore area. The monitoring protocol was developed with the intent of being used as a standard throughout the region at other coastal parks and refuges. A long-term approach is essential in order to understand the complex dynamic of hydrological change on aquatic, terrestrial, and estuarine ecosystems and on water supplies.

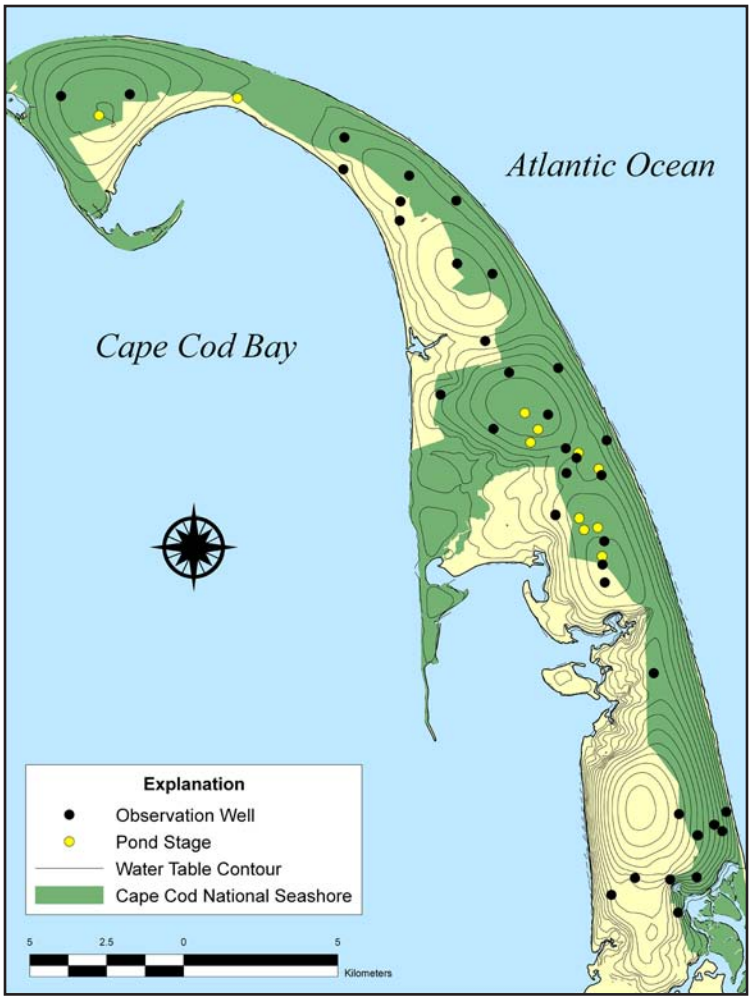

Figure 1. Past and current sampling sites for the CACO hydrological monitoring program. Observations wells are used to measure groundwater level. Pond stage is used to measure pond surface levels. These sites were selected by taking into account spatial distribution, anticipated changes to hydrodynamics, and impacts of development within all four ground water flow-cells in the Seashore area.

Status and Trends

CACO scientists have accumulated a large amount of data since 1999. Interannual data has shown that there is a limited amount of variability within individual wells. Seasonal trends are apparent with groundwater levels falling in the summer months, likely due to decreased precipitation and increased human withdrawal during this period. Ongoing monitoring will likely yield more insight into how the hydrology of the Lower Cape is changing over time. Such long term data is necessary to reveal how groundwater responds to persistent (e.g. sea level rise) and short term (e.g. summer drawdown) stresses.

Management Applications

The comprehensive approach to data collection that the hydrological monitoring program provides will allow for the integration of analysis with other monitoring programs at CACO. For example, the monitoring of wells in known eastern spadefoot toad (Figure 2) breeding habitat has led to insight regarding the influence that groundwater plays on the timing of large-scale emergences of these amphibians that spend the majority of their lives buried in the soil. Spadefoot toads emerge in large numbers to breed only when the groundwater table is at the higher end of its range (Figure 3) and when weather conditions are suitable. Information such as this can help scientists and managers understand past emergences and predict future ones. It is the responsibility of CACO to protect threatened wildlife (e.g. spadefoot toads) and one measure taken is to close down certain roads on warm, rainy nights when amphibian activity levels are high. Enhanced predictive ability that incorporates hydrological data would allow for the more efficient

Photo Credit Brad Timm
Figure 2. A pair of spadefoot toads in amplexus. Spadefoots are a Massachusetts state-listed threatened species. They breed only on relatively warm nights, usually during or immediately following heavy rains. Hydrological monitoring has revealed the relationship between the animal's emergence and groundwater levels.

Another application of hydrologic monitoring will be to gauge the effects of expected sea-level rise. Sea-level rise has the potential to greatly alter the dynamic of the coastal hydrology of Cape Cod and it is essential to document the degree of these changes as they occur. This monitoring program will allow for the identification of areas of the Lower Cape that are most vulnerable to alterations in hydrology and what agents of change (i.e., withdrawal, climate change, sea-level rise) are most influential to groundwater and pond stage levels.

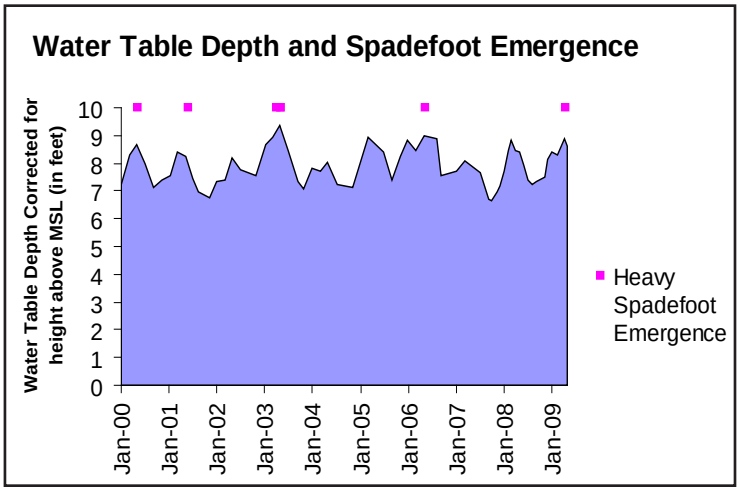

Figure 3. The graph above shows the fluctuation in water table depth at an observation well (PZW-78) in Provincetown, MA in the years 2000-2009. The water level is expressed in feet above mean sea level. The points above the line have no quantitative value associated with the y-axis, but merely represent the points in time (along the x-axis) where large emergences of spadefoot toads were observed in areas near the well.

More Information

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