Guidelines for
Opening and Closing the Three Sisters Springs Unit
of the Crystal River National Wildlife Refuge
to Visitor In-water Access,
Manatee Season November 15, 2016 to March 31, 2017

Environmental and biological factors are evaluated daily and considered when determining whether to open or close Three Sisters Springs to in-water access for visitors.

There are three main environmental predictors of manatee presence inside Three Sisters Springs (the Springs): tide, air temperature, and water temperature in the Gulf of Mexico. Generally at lower tides, manatees are absent or in low numbers in the Springs and on an out-going tide leave the Springs through the narrow spring run, often into the sanctuaries at Idiots Delight I and/or II. Conversely, manatees tend to return to the Springs on an in-coming tide and rest or nurse until the tide begins to turn again. While many manatees follow these patterns, some manatees will deviate from the norm.

Ambient air temperature, Gulf water temperature, and tides are key factors in predicting manatee presence in the Springs. Generally, when morning temperatures are below 45^{o}F (7^{o}C) and the Gulf water temperature is below 68^{o}F (20^{o}C), manatees seek thermal refuge in freshwater springs, including Three Sisters Springs, on an incoming or high tide. When the Gulf water temperature measured at a USGS gauge near Shell Island (mouth of Crystal River) is below 60^{o}F (15^{o}C), large numbers of manatees are likely to aggregate in the Springs. Conversely, a measured water temperature above 60^{o}F in combination with falling tides and rising air temperature conditions, generally cause manatees to leave the Springs to forage. When these environmental factors are considered in combination, the U. S. Fish and Wildlife Service can begin to predict the presence or absence of manatees in the Springs.

A flow-chart was designed to use data from the previous evening and forecasted conditions at sunrise to to assist in the determination of whether to open or close the Springs the following morning. The measured variables are used to inform management on the likelihood that manatees will be present in Three Sisters Springs and the need to close the Springs to prevent disturbance. The predictors were based on data obtained during the winter of 2014-15. The flow chart was tested for 104 days from December 19, 2015, to March 31, 2016. The flowchart accurately predicted the Springs' open/closed status 83 times (79.8%) and incorrectly predicted the status only 10 times (9.6%). There were 5 times (4.8%) when the prediction was off by 1 to 2 hours after sunrise and 6 times (5.8%) when the accuracy of the prediction was undetermined due to lack of data. Natural factors that made the prediction inaccurate included wind speed, wind direction, magnitude of tide, and actual high and low tide times (e.g., a strong west wind would keep the tides high, causing manatees to stay in the springs longer).

Biological factors considered when determining open or closed status include observed manatee distribution and specific behaviors. Under a specific suite of environmental conditions that includes a strong or prolonged cold front, manatee numbers in the Springs can be in the hundreds. The Springs may be closed to visitor access especially if the observed distribution of manatees includes the narrow spring run and areas outside of the closed lobes. If temperatures begin to warm before an outgoing tide, this same large aggregation of manatees may begin to leave the Springs through the spring run. Under such conditions, these biological factors may prevent the opening of the Springs. Manatee behavior must also be considered when evaluating spring opening/closing. Observations of mating herds, high numbers of nursing mother/calf pairs, or injured/stressed animals may also warrant the closure of or prevent the opening of Three Sisters Springs to in-water visitors.

As a final consideration, reduced water clarity in the Springs may limit staff ability to fully evaluate the numbers of manatees resting in the Springs, particularly at sunrise when the angle of the light is low. When the water clarity is rated a 3 or 4, low to no visibility (see attached Biological Guidelines flowchart), the Springs may remain closed for manatee and human safety. Visitors may disturb or injure resting manatees by stepping on them or kicking them if they can't see them. Refuge staff may need to keep the Springs closed until they can do an accurate assessment of manatee abundance and distribution. Common causes of reduced water clarity include low light, glare, wind, and turbidity associated with high numbers of manatees in the Springs.

All of these environmental and biological factors are considered in determining the open or closed status of Three Sisters Springs to visitor in-water access (see attached flowcharts).