

DATE: December 10, 2021

FILE REF:

TO: Heidi Schmitt Marquez & Nicole Krueger – WDNR Wastewater Program

FROM: Mary Gansberg, Water Resources Management Specialist
Kristi Minahan, Water Quality Standards Specialist

SUBJECT: Geisel Creek and Dunes Lake

Water resources staff monitored both Geisel Creek (WBIC 97400) and Dunes Lake (WBIC 97300) in Door County in 2021. This monitoring was conducted, in part, to support permit reissuance for Sevastopol Sanitary District No.1 Wastewater Treatment Facility (WWTF). This memo summarizes the baseline data collected. All data are entered in the SWIMS, Fish & Habitat, or WATERS database.

1. Geisel Creek
 - Fish survey
 - Water temperature monitoring
 - Aquatic invasive species survey
2. Dunes Lake
 - Water quality monitoring
 - Aquatic plant survey

Geisel Creek

Fish survey – Attachment 1 is the natural community verification form completed for Geisel Creek. A fish survey was conducted on May 13, 2021 above E. Dunn Road (WBIC 97400, Station ID 10047030). The fish community verified as a warm transition headwater which matched the modeled stream natural community. Four species of fish including one intolerant species (Iowa darter) was documented in Geisel Creek. These data suggest that Geisel Creek supports a higher aquatic life community than the current codified classification of limited aquatic life. This stream classification should be updated in Wisconsin Admin Code NR 104.

Temperature monitoring – Attachment 2 is a graph of continuous water temperature collected at E. Dunn Road (WBIC 97400, Station ID 10047030) from May 14 to September 2, 2021.

Aquatic invasive species – Yellow iris (*Iris Pseudacorus*) was documented along the shoreline of Geisel Creek between Haberli Road and Dunes Lake in June 2021.

Dunes Lake

Water quality monitoring - Chlorophyll *a*, total phosphorus (TP), Secchi depth, and dissolved oxygen and temperature profile data were collected at the deep spot in Dunes Lake in the summer of 2021. Trophic status was calculated using chlorophyll data. Note Secchi disc hit bottom during each measurement.

A summary of 2021 results is shown on the next page. It was pulled from the lakes page at:

<https://dnr.wi.gov/lakes/waterquality/Station.aspx?id=10029267>

Lake Water Quality 2021 Annual Report

Dunes Lake
Door County
Waterbody Number: 97300

Lake Type: DRAINAGE
DNR Region: NE
GEO Region: SE

| Site Name | Storet # |
|---------------------|----------|
| Dunes Lake - Center | 10029267 |

| Date | SD (ft) | SD (m) | Hit Bottom | CHL | TP | TSI (SD) | TSI (CHL) | TSI (TP) | Lake Level | Clarity | Color | Perception |
|------------|---------|--------|------------|------|------|----------|-----------|----------|------------|---------|-------|------------|
| 06/09/2021 | 4 | 1.2 | YES | | 26 | 57 | | 53 | | | | |
| 07/08/2021 | 4 | 1.2 | YES | 14.7 | 35.3 | 57 | 55 | 56 | | | | |
| 08/06/2021 | 4 | 1.2 | YES | | | 57 | | | | | | |
| 08/06/2021 | | | | 34.1 | 72.5 | | 61 | 61 | | | | |

| 06/09/2021 | | |
|------------|-----------------|-----------|
| Depth FEET | Temp. DEGREES C | D.O. MG/L |
| 1 | 23.8 | 10.7 |
| 2 | 22.9 | 11.5 |
| 3 | 22.8 | 11.8 |

| 07/08/2021 | | |
|------------|-----------------|-----------|
| Depth FEET | Temp. DEGREES C | D.O. MG/L |
| 1 | 18.6 | 6.8 |
| 2 | 18.7 | 7.3 |
| 3 | 18.9 | 7.5 |

| 08/06/2021 | | |
|------------|-----------------|-----------|
| Depth FEET | Temp. DEGREES C | D.O. MG/L |
| 1 | 22.3 | 6.9 |
| 2 | 22.1 | 6.5 |
| 3 | 22 | 6 |
| 4 | 21.9 | 4.2 |

Dunes Lake - Center 2021 Results



Dunes Lake - Center was sampled 7 different days during the 2021 season. Parameters sampled included:

- water clarity
- temperature
- dissolved oxygen
- total phosphorus
- chlorophyll

The average summer (July-Aug) secchi disk reading for Dunes Lake - Center (Door County, WBIC: 97300) was 4 feet. The average for the Southeast Georegion was 7.4 feet. With this particular lake, it is important to note that the Secchi disc hit the bottom of the lake for 3 of the Secchi readings during the 2021 monitoring season. This indicates that the water clarity was actually greater than the Secchi readings imply.

Chemistry data was collected on Dunes Lake - Center. The average summer Chlorophyll was 24.4 µg/l (compared to a Southeast Georegion summer average of 21 µg/l). The summer Total Phosphorus average was 53.9 µg/l. Lakes that have more than 20 µg/l and impoundments that have more than 30 µg/l of total phosphorus may experience noticeable algae blooms.

The overall Trophic State Index (based on chlorophyll) for Dunes Lake - Center was 59. The TSI suggests that Dunes Lake - Center was **eutrophic**. This TSI usually suggests decreased clarity, fewer algal species, oxygen-depleted bottom waters during the summer, plant overgrowth evident, warm-water fisheries (pike, perch, bass, etc.) only.

Phosphorus - Table 1 contains TP results for 2021 and 2013. The TP criterion for Dunes Lake, classified as a shallow drainage lake, is 40 ug/L. The mean for 2021 is 41 ug/L, exceeding the criterion and much higher than the mean in 2013 at 19 ug/L. Values in 2021 were higher overall than in 2013, with one particularly high value of 72.5 ug/L. It appears an increasing trend may be occurring, and an additional year of data collection is recommended for a new attainment determination using 6 samples.

- For purposes of limit calculation, the 2021 mean phosphorus concentration exceeds the criterion, but we recommend collecting a second year of data to complete the dataset before making a final determination.
- For purposes of waterbody assessment and impairment listing, we typically gather 3 samples for each of 2 years (6 total) and compare the lower confidence limit (CL) to the criterion. If the lower CL exceeds the criterion, then it is considered “clearly exceeding” (i.e. we are 90% sure its “true mean” is exceeding the criterion) and it is listed as impaired for phosphorus*.
- We give preference to the most recent 5-year period but may use up to 10 years if we don’t have 6 samples in the most recent 5 years and if the older data is still considered to be representative of conditions. If the last 10 year period is calculated using both 2013 and 2021 data, the grand mean is 27 ug/L, which is below the criterion, but since there is a sizeable difference in the concentrations between the two years and a lengthy time between the samples, it may not be appropriate to combine samples as conditions may be changing.

*For permit limit calculation, the mean (for lakes) is compared to the criterion rather than the lower CL.

Table 1. Total phosphorus (TP, ug/L) assessment results for 2021, 2013, and combined. The TP threshold is 40 ug/L.

| | TP (ug/L) | | |
|--------------------------|------------|---------------|---------------|
| | 2021 | 2013 | 2013+2021* |
| Upper CL | 72 | 23 | 38 |
| <i>Mean</i> | 41 | 19 | 27 |
| Lower CL | 23 | 15 | 20 |
| Attainment determination | May exceed | Clearly meets | Clearly meets |

*The calculation of this grand mean is not exact; the 2021 data are not yet available in our automated statistical package, so these values were run by hand in a manner that differs slightly from the statistical package.

Chlorophyll *a* - Table 2 shows chlorophyll *a* concentrations from 2021 and 2013. The chlorophyll *a* threshold to protect aquatic life is 27 ug/L. Dunes lake is below 27 in both years, though in 2021 the standard deviation is very wide because there are only 2 samples instead of 3.

Table 2. Chlorophyll *a* (ug/L) Aquatic Life assessment results for 2021, 2013, and combined. The chlorophyll *a* threshold for aquatic life is 27 ug/L.

| | Chlorophyll <i>a</i> (ug/L) | | |
|--------------------------|-----------------------------|---------------|---------------|
| | 2021* | 2013 | 2013+2021 |
| Upper CL | 82 | 5 | 15 |
| <i>Mean</i> | 22 | 3 | 5 |
| Lower CL | 6 | 0 | 2 |
| Attainment determination | May meet | Clearly meets | Clearly meets |

* 2021 had only 2 values instead of 3 so had a wide standard deviation.

Chlorophyll *a* also has thresholds to protect recreation. The threshold specifies that shallow lakes may not have a concentration above 20 ug/L chlorophyll *a* for over 30% of summer days. For 2013, the mean chlorophyll *a* value was zero, with a lower CL of zero and an upper CL of 9, clearly meeting this threshold. The 2021 recreation results are not yet available in the statistical package, which is required for running these calculations. The recreation threshold is a more stringent threshold than the aquatic life threshold, so obtaining these results and sampling for an additional season to complete the dataset is recommended.

Aquatic plant survey – A survey of the entire lake aquatic plant community was completed July 21-22, 2021 in Dunes Lake. See Attachment 3 for a map of the survey points and Attachment 4 for a memo report of the survey results.

Attachment 1

Natural Community Verification Report

Waterbody Name (WBIC): GEISEL CREEK (97400)

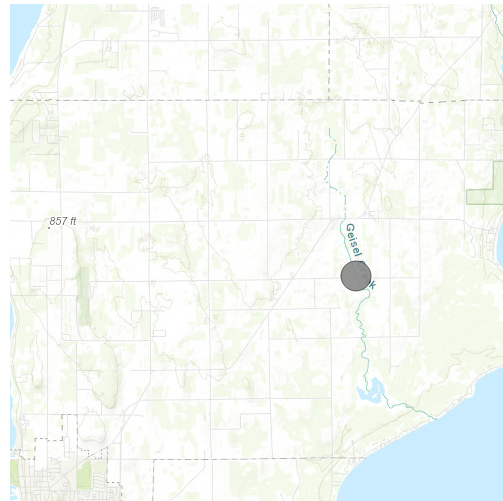
Swims Station ID: 10047030

Survey Sequence Number: 515094628

This NC Verification Report was run on Geisel Creek-East Dunn Rd., (10047030), located in DOOR County with fish Survey Sequence Number 515094628 sampled on May 13, 2021. The Natural Community for this station was verified by Andrew Hudak on September 20, 2021.

The Natural Community was modeled *Warm Transition Headwater* and is now Verified as *Warm Transition Headwater* .

Survey location



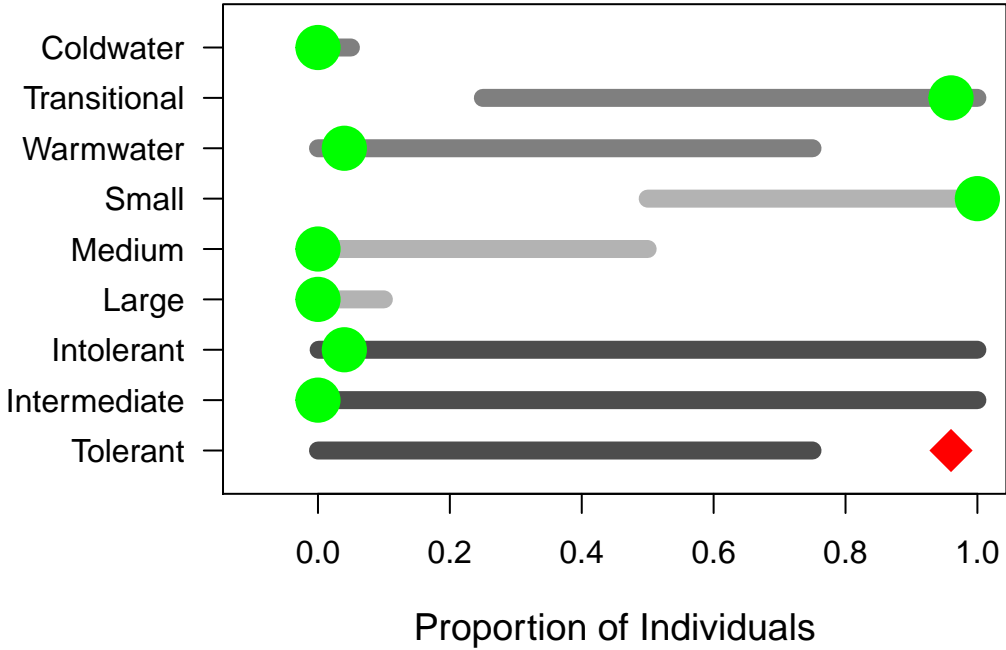
Fish captured

| Species | Count |
|-------------------|-------|
| BROOK STICKLEBACK | 1 |
| CENTRAL MUDMINNOW | 22 |
| CREEK CHUB | 1 |
| IOWA DARTER | 1 |

Guild percentages

| Thermal | Percent.Indiv. | Size | Percent.Indiv. | Tolerance | Percent.Indiv. |
|--------------|----------------|--------|----------------|--------------|----------------|
| Coldwater | 0 | Small | 100 | Intolerant | 4 |
| Transitional | 96 | Medium | 0 | Intermediate | 0 |
| Warmwater | 4 | Large | 0 | Tolerant | 96 |

Warm Transition Headwater Guild Test



Comments from WR Biologist:

Fish community was consistent with that of a Warm Transition Headwater. No weather extremes.

Attachment 2

Designated Use: LAL

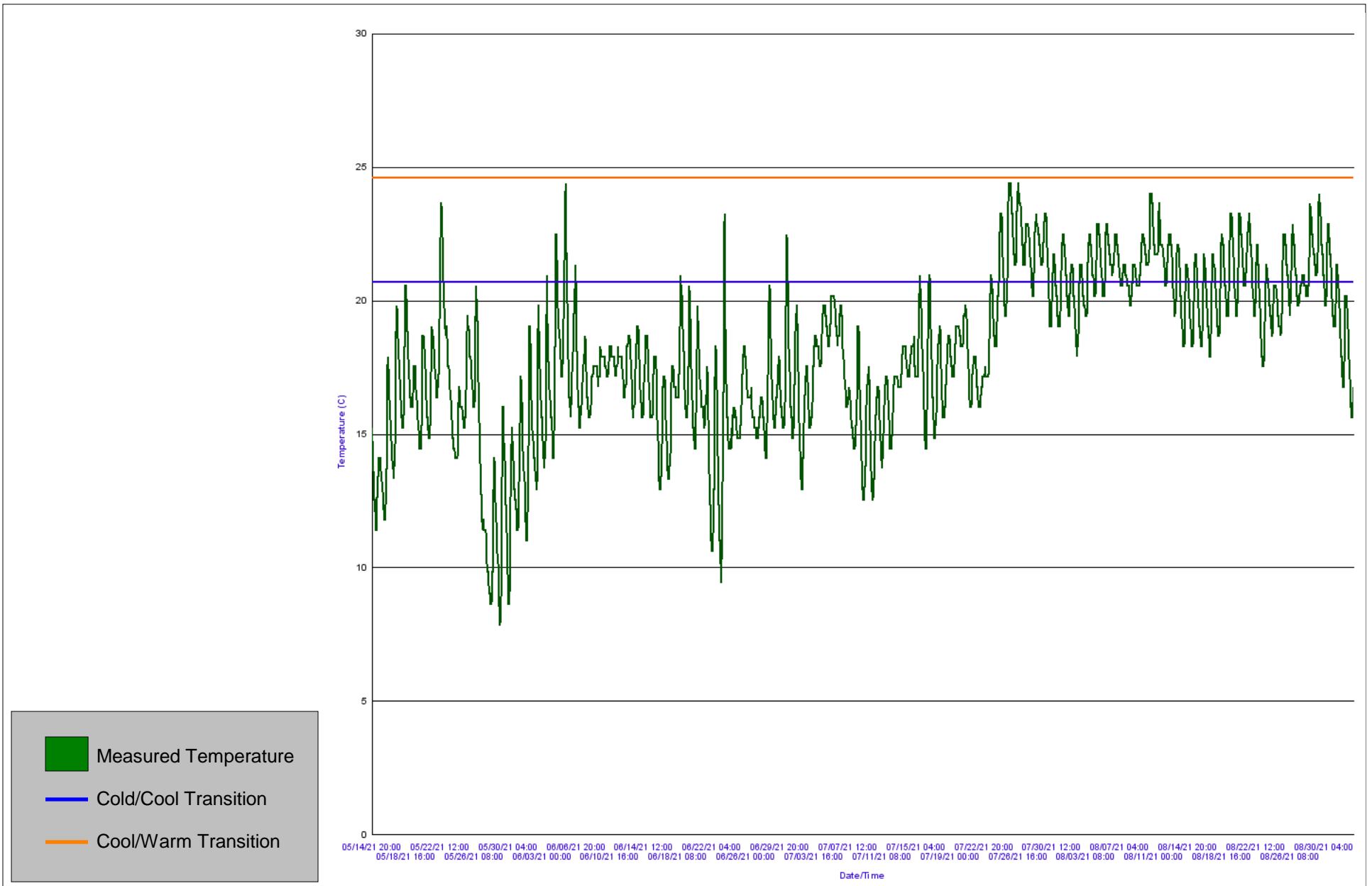
Natural Community: Cool-Warm Headwater, Macroinvertebrate, Warm Headwater

Station ID: 10010240

Fieldwork Event Start: 05/14/2021 18:00

Station Name: Geisel Creek - Geisel Creek at Dunn Road

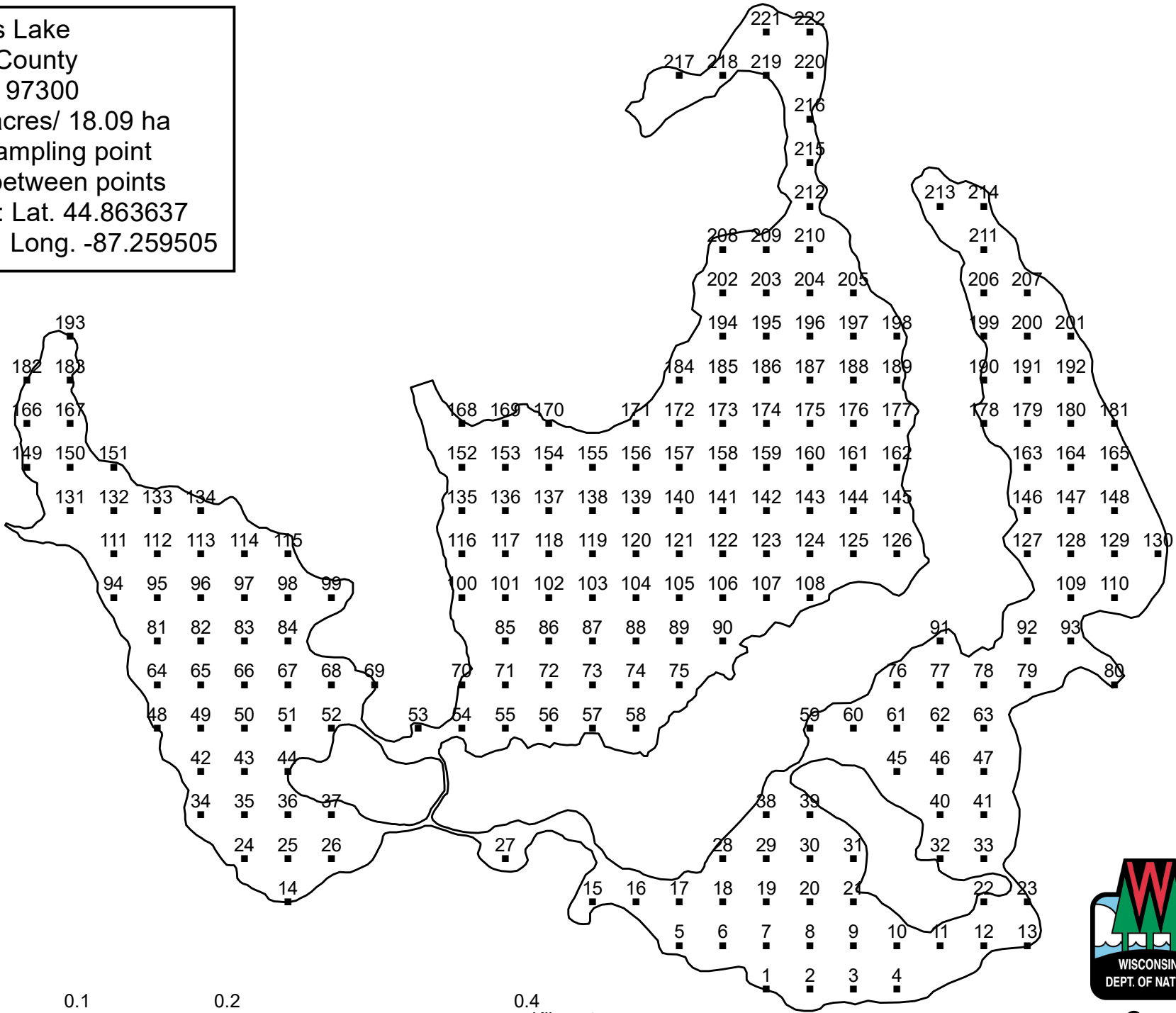
Fieldwork Event End: 09/02/2021 11:00



SWIMS: Temperature for a Selected Fieldwork Event

Attachment 3

Dunes Lake
Door County
WBIC 97300
44.7 acres/ 18.09 ha
222 sampling point
29m between points
Site 1: Lat. 44.863637
Long. -87.259505



Created: 2021

Attachment 4

State of Wisconsin
DEPARTMENT OF NATURAL RESOURCES
2984 Shawano Avenue
Green Bay WI 54313-6727

Tony Evers, Governor
Preston D. Cole, Secretary
Telephone 608-266-2621
Toll Free 1-888-936-7463
TTY Access via relay - 711



December 10, 2021

To Whom it May Concern:

An aquatic plant survey was completed on Dunes Lake (WBIC 97300) in Door County in July 2021. This memo summarizes the results of that survey. Prior dredging of lake sediment was completed as part of a lake restoration effort. Approximately two acres were dredged in 2016 as a demonstration project and another approximately 10 acres was completed in 2020. Dredging occurred in the northeast portion of the largest lake basin (outlet of Geisel Creek). Disturbance of the lake sediment may have slightly impacted the 2021 aquatic plant survey results.

Importance of Aquatic Plants

Aquatic plants form the foundation of healthy lake ecosystems. They not only protect water quality, but also produce life-giving oxygen. Aquatic plants are a lake's own filtering system, helping to clarify the water by absorbing nutrients like phosphorus and nitrogen that could stimulate algal blooms. Plant beds stabilize soft lake bottoms and prevent shoreline erosion by reducing the effect of waves and currents. Healthy native aquatic plant communities help prevent the establishment of invasive non-native plants such as Eurasian water milfoil and curly-leaf pondweed. Native aquatic plants also provide important habitat for reproduction, food, and cover for fish, invertebrates, and wildlife.

Point-Intercept Sampling Method

Based on area and depth specific to Dunes Lake, we mapped a 222-point sampling grid over the entire lake surface. Using a GPS, we navigated by canoe to each of the pre-determined grid points. At each point we used a two-sided rake to sample approximately 1 foot along the bottom. After pulling the plants to the surface, the overall rake as well as individual species on the rake were assigned a fullness rating of 1, 2 or 3 to estimate density of plant growth. We also recorded visual sightings of species within six feet of the sample point, as well as any additional species seen in the lake during a general boat survey. For more detailed information on the point-intercept sampling method and how data were collected please visit:

<http://www.uwsp.edu/cnr-ap/UWEXLakes/Documents/ecology/Aquatic%20Plants/PI-Protocol-2010.pdf>

Summary Statistics and Results

Summary statistics and plant survey results are shown in Tables 1- 4.

- Species frequencies of occurrence reflect the percentage of points at which a species was found out of the total number of points sampled. Littoral frequency of occurrence indicates how often a species was found considering only areas of the lake that are capable of supporting plant growth (known as the “littoral area or zone”).
- The maximum depth of plant growth is the deepest depth at which plants were found in the lake.
- Species richness is a count of the total number of different plant species found in a lake.
- The Floristic Quality Index (FQI) is a metric that evaluates the closeness of the flora in a lake to that of an undisturbed condition. The higher an FQI value, the closer that plant community is to an undisturbed ecosystem.

- The mean coefficient of conservatism (mean C) is a number assigned to each species reflecting its tolerance to disturbance.
- Statewide and ecoregion averages for all lake types are calculated from a subset of approximately 2,373 lakes across Wisconsin.

Voucher specimens have been sent to an Herbarium; therefore, all species identifications are subject to change pending verification. Dunes Lake has a very high frequency of occurrence in the littoral zone when compared to other lakes throughout the state and ecoregion. This can partly be attributed to the lake's bathymetry with the maximum depth of Dunes Lake at only 5.5 feet. The two most common species were Chara and Coontail. The species richness is below the statewide but above the ecoregion averages. The FQI and mean C values show an overall good aquatic plant community (Table 4).

Table 1. Species Present

| Common Name | Scientific Name | Growth Form (Floating, free floating, submerged, emergent) | % Frequency of Occurrence |
|------------------------|-----------------------------------|--|------------------------------|
| Muskgrass | <i>Chara sp.</i> | Submerged | 18.9 |
| Coontail | <i>Ceratophyllum demersum</i> | Submerged | 12.3 |
| Forked Duckweed | <i>Lemna trisulca</i> | Free Floating | 10.6 |
| Sago Pondweed | <i>Stuckenia pectinata</i> | Submerged | 9.3 |
| Slender naiad | <i>Najas flexilis</i> | Submerged | 8.2 |
| Small Duckweed | <i>Lemna minor</i> | Free Floating | 8.2 |
| Common Bladderwort | <i>Utricularia vulgaris</i> | Submerged | 7.5 |
| White Water Lily | <i>Nymphaea odorata</i> | Floating | 7.0 |
| Whorled water-milfoil | <i>Myriophyllum verticillatum</i> | Submerged | 5.9 |
| Hardstem bulrush | <i>Schoenoplectus acutus</i> | Emergent | 3.5 |
| Leafy Pondweed | <i>Potamogeton foliosus</i> | Submerged | 3.3 |
| Spatterdock | <i>Nuphar variegata</i> | Floating | 1.6 |
| Small Bladderwort | <i>Utricularia minor</i> | Submerged | 1.3 |
| Common Waterweed | <i>Elodea canadensis</i> | Submerged | 0.9 |
| Large Duckweed | <i>Spirodela polyrhiza</i> | Free Floating | 0.7 |
| Cattail | <i>Typha sp.</i> | Emergent | 0.4 |
| Creeping Bladderwort | <i>Utricularia gibba</i> | Submerged | 0.2 |
| Nitella | <i>Nitella sp.</i> | Submerged | 0.2 |
| Floating-leaf pondweed | <i>Potamogeton natans</i> | Submerged | Boat survey |

Table 3. Dunes Lake Aquatic Plant Survey Analysis Descriptions

| Parameter | Description | Dunes Lake Results |
|------------------|--|--------------------------------|
| Survey_ID | [Primary key] Unique identifier for each survey to link survey data to sample point and species information; one-to-many relationship with Joined_Long. | 2620 |
| Lake | The name of the surveyed location from ROW, excluding the word "lake". For partial surveys, list the primary location name first, followed by the portion surveyed (i.e. Redstone, Eagle Bay). | Dunes Lake |
| WBIC | Waterbody identification code from ROW of the location surveyed. | 97300 |
| County | Wisconsin county or counties containing the location surveyed. If location is within >1 county, list counties in alphabetical order separated by "/". | Door |
| Region | Part of assessment group, designates a grouping within which plant-based ecological condition assessments are conducted. Indicates whether waterbody is South (S) or North (N) of 44.84707N Latitude. Based on work performed for Mikulyuk et al. 2011. Canadian Journal of Fisheries and Aquatic Sciences 68:1778-1789. | N |
| centLat | Centroid of waterbody (Latitude). | 44.86616469 |
| centLon | Centroid of waterbody (Longitude). | -87.26014108 |
| Hydrology | Part of assessment group, designates a grouping within which plant-based ecological condition assessments are conducted. Lake type, extracted from the ROW natural community type and interpreted after examining the spatial hydrology if necessary. Drainage, Impoundment, Reservoir, or Seepage. | DRAINAGE |
| Year | Date the survey was conducted- mm/dd/yyyy. End survey date | 7/22/2021 |
| MaxPlantDepth | Maximum colonization depth of plants. Max plant depth reported is actual depth closest but not greater than the 99th percentile. 99th percentile calculates ordered depths with plants present, does not count filamentous algae, moss, sponge or free floating species in littoral. | 5 |
| LittoralPoints | Points with plants present, does not count filamentous algae, moss, sponge or free floating species in littoral. | 186 |
| PctLittoral | Numerator: sampled litt points + unsampled but likely littoral points ('Non-Navigable (Plants)', 'Shallow', 'Non-Navigable (Swim Area)', 'Non-Navigable', 'Non-Navigable (Rocks)', 'Dock') Denominator: total points - unsampled points with uncertain status ('Terrestrial', 'No Information', 'Temporary Obstacle', 'Other', 'Non-Navigable (Dam)'). | 1 |
| PctLittVegetated | Numerator: sampled litt points with plants present. Denominator: littoral points sampled. | 0.989247312 |
| PctM | GenM: Percent of vegetated points that have at least one species moderately tolerant of general disturbance. | 0.983333333 |
| PctS | GenS: Percent of vegetated points that have at least one species sensitive to general disturbance. | 0.283333333 |
| PctT | GenM: Percent of vegetated points that have at least one species tolerant of general disturbance. | 0.65 |
| PctTPS | TPS: Percent of vegetated points that have at least one species sensitive to total phosphorus. | 0.833333333 |
| PctTPT | TPT: Percent of vegetated points that have at least one species tolerant of total phosphorus. | 0.755555556 |
| MACassess | Assigns plant communities to ecological condition tiers based on the abundance of species that are sensitive, moderately tolerant, or tolerant of disturbance. Here, disturbance included 20 different variables associated with anthropogenic activity. | Attained |
| TPassess | Assigns plant communities to ecological condition tiers based on the abundance of species that are sensitive, moderately tolerant, or tolerant of total phosphorus. Here, total phosphorus response was the only factor considered. | Attained |
| MACassess_all | MACassess; Includes surveys outside of sampling window. | Attained |
| TPassess_all | TPassess; Includes surveys outside of sampling window. | Attained |
| Richness | Species richness, count of n= species listed (includes visuals) | 22 |
| N.FQI | Species richness, count of n= species listed with an assigned c-value. Used to calculate FQI. (includes visuals) | 19 |
| meanC | Mean C value. C value used are from Bernthal 2003/Gibson 2016. Chara sp, Nitzella sp, and Riccia fluitans are assigned values from Nicholls 1999 per M. Gibson's recommendations. | 5.842105263 |
| FQI | Bernthal 2003/Gibson 2016 CofC values used. FQI divide mean C by N, where N = number of species observed with C values, any species without C values discarded. | 25.46514646 |
| Ecoregion | Omernik 2000 Ecoregions of Wisconsin. | North Central Hardwood Forests |
| Cluster_ID | Community cluster prediction based on Justin Poinsett's work with 2017 NLA data Random Forest model. | Mixed Characid |

Table 4. Overall Survey Summary

| | Dunes Lake | Statewide Average | SWTP Ecoregion Average |
|--------------------------------------|------------|-------------------|------------------------|
| Littoral Frequency of Occurrence (%) | 98.9 | 76.8 | 82.9 |
| Maximum Depth of Plant Growth (ft) | 5.5 | 14.4 | 15.8 |
| Species Richness | 22 | 23.7 | 21.3 |
| Floristic Quality Index (FQI) | 25.5 | 26.7 | 24.4 |
| Mean Coefficient of Conservatism | 5.84 | 5.89 | 4.98 |

Macrophyte Assessment of Condition-General (MAC-Gen)

Lake-dwelling aquatic plants, or macrophytes, are sensitive to multiple forms of anthropogenic disturbance and can be used as a metric to signify ecological impairment. Accordingly, the department uses two assessment methods that evaluate the condition of a lake's aquatic plant community by relating aquatic plant abundance to anthropogenic disturbance. The first assessment method is called the Macrophyte Assessment of Condition-General (MAC-Gen) and describes overall aquatic plant community condition in response to multiple sources of anthropogenic disturbance. The second version of the method, called the Macrophyte Assessment of Condition-Phosphorus (MAC-P) is more narrowly focused, reflecting a plant community's tolerance of, and response to, phosphorus. The MAC-P is discussed in the next section.

The MAC-Gen clusters plant species into three groups of species that are sensitive, moderately tolerant or tolerant to a broad variety of stressors related to eutrophication, population and land use. In general, when lakes are in poor condition, disturbance-tolerant plants are abundant, whereas lakes in good condition have high abundance of species that are sensitive to disturbance. Moderately tolerant plants often occur at intermediate levels of disturbance. This assessment method allows us to describe a lake's general condition using aquatic macrophytes.

MAC-Gen Results: For purposes of applying MAC-Gen and MAC-P, Dunes Lake is classified as a Northern Drainage Lake (its latitude is 44.86633°N at the center monitoring station, with inflow from Geisel Creek and outflow via Shivering Sands Creek), though it is extremely close to the North/South threshold of 44.84707°N.

Using the Point-Intercept data from 2021, the plant community in Dunes Lake was assigned to MAC-Gen tolerance groups based on the abundance of species that are sensitive to, moderately tolerant of, or tolerant of disturbance. Dunes Lake had a frequency of occurrence of 28.3% for Sensitive species, 98.3% for Moderately Tolerant species, and 65.0 % for P-Tolerant species (Table 5).

When comparing the results from Dunes Lake to the MAC-Gen attainment thresholds in Table 6 for Northern Drainage Lakes, the lake does attain the threshold of having less than or equal to 73% Tolerant species. These findings indicate that the overall aquatic plant community in Dunes Lake is not currently impaired by general disturbance.

Macrophyte Assessment of Condition for Phosphorus (MAC-P)

Aquatic plants are sensitive to nutrient enrichment, and species-specific differences in tolerance to enrichment may be used to detect impairment in natural lakes. Thus, the composition of aquatic plant communities in many cases will show impairment prior to algal indicators. Aquatic plants play stabilizing roles in lake ecosystems, supporting clear-water conditions via a positive influence on settling rates, nutrient burial and uptake. Some lakes that are enriched with nutrients will not show evidence of impairment in their free-water dissolved phosphorus or chlorophyll a concentrations. However, as a lake becomes enriched, plant community composition will shift toward more tolerant species adapted to enriched conditions. This is an important precursor to the lake shifting from a plant-dominated to an algal-dominated state, which is very hard to reverse. Lakes showing an abundance of phosphorus-tolerant species should have nutrient conditions addressed before the lake becomes algal dominated. Therefore, the department developed an assessment method relating aquatic plant abundance

and tolerance to total phosphorus (Macrophyte Assessment of Condition for Phosphorus, or MAC-P). (Waterbody Assessment Rule Package: Technical Support Document (2021)).

MAC-P Results: Using the Point-Intercept data from 2021, the plant community in Dunes Lake was assigned to MAC-P tolerance groups based on the abundance of species that are sensitive to or tolerant of total phosphorus. Dunes Lake had a frequency of occurrence of 83.3% for P-Sensitive species and 75.5 % for P-Tolerant species (Table 5). As with MAC-Gen, Dunes Lake is classified as a Northern Drainage Lake for the MAC-P.

When comparing the results from Dunes Lake to the MAC-P attainment thresholds in Table 7 for Northern Drainage Lakes, P-Sensitive species in the lake (83.3%) do attain the threshold of having greater than 51% P-Sensitive species. These findings indicate that the overall aquatic plant community in Dunes Lake is not currently impaired by total phosphorus.

Table 5. Dunes Lake aquatic plant community tolerance groups. Table shows percent of vegetated points with species in each tolerance group.

| MAC-Gen | | MAC-P | |
|--|-------|--|-------|
| Sensitive to general disturbance | 28.3% | Sensitive to total phosphorus | 83.3% |
| Moderately tolerant of general disturbance | 98.3% | (Moderately tolerant is not used in MAC-P) | NA |
| Tolerant of general disturbance | 65.0% | Tolerant of total phosphorus | 75.5% |

Table 6. MAC-Gen aquatic plant community thresholds for lakes and reservoirs.

| Lake Subcategory ¹ | Macrophyte Assessment of Condition- General is attained if: |
|-------------------------------|--|
| Northern Seepage | Moderately tolerant \leq 64% |
| <i>Northern Drainage</i> | <i>Tolerant \leq 73%</i> |
| Southern Seepage | Sensitive $>$ 15% |
| Southern Drainage | Tolerant \leq 50% |

¹ In Table 6, northern lakes are those north of 44.84707°N latitude, and southern lakes are those south of that latitude. Thresholds have not been established for the Great Lakes.

Table 7. MAC-P aquatic plant community phosphorus response thresholds for lakes and reservoirs.

| Lake Subcategory¹ | Macrophyte Assessment of Condition for Phosphorus Is Attained If: |
|-------------------------------------|--|
| Northern Seepage | Phosphorus Tolerant \leq 44% |
| <i>Northern Drainage</i> | <i>Phosphorus Sensitive > 51%</i> |
| Southern Seepage | Phosphorus Sensitive > 26% |
| Southern Drainage | Phosphorus Sensitive > 42% |

¹ In Table 7, northern lakes are those north of 44.84707°N latitude, and southern lakes are those south of that latitude. This plant phosphorus response indicator does not apply to the Great Lakes or lakes less than 5 acres in surface area.

This report summarizes the 2021 aquatic plant survey results for Dunes Lake. If you have any questions, please feel free to contact me at Mary.Gansberg@Wisconsin.gov.

Sincerely,

Mary Gansberg
Water Resources Management specialist