

# **Big Sand Lake Land-Use and Development History: A Chronological Reconstruction for Paleolimnological Interpretation**

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***Abstract***

Big Sand Lake (1,434 acres, maximum depth 55 ft) in Burnett County, Wisconsin, has experienced progressive shoreline development since the early 20th century. This report integrates parcel-level tax assessments, sanitary-permit records, historical maps, US Census results, aerial and satellite photograph analysis, highway-construction archives, and pioneer narratives to reconstruct residential growth, sanitary infrastructure, transportation corridors, and lake-use changes. Key findings include:

- (1) Clearing of area forests, 1890-1907.
- (2) modest early development (27 dwellings visible on the 1939–1941 Bordner Survey; 62 total structures on the 1964 DNR lake survey) followed by accelerated growth after 1960 that roughly doubled the housing stock between 1970 and 2010 (~250 dwellings in the 2010 census for the Big Sand Lake watershed);
- (3) exclusive reliance on private onsite wastewater treatment systems (POWTS), with 52% classified as conventional or cesspool systems carrying elevated phosphorus-loading risk;
- (4) State Trunk Highway 70 designation and grading in 1917 and paving in 1935 as primary erosional and geochemical markers; and
- (5) Loss of historic wild-rice beds concurrent with post-2000 recreational intensification.

## Executive Summary

This report provides a high-resolution, catchment-scale land-use and development chronology for Big Sand Lake that is explicitly designed to support paleolimnological interpretation of sediment cores. It integrates and reconciles multiple independent datasets—parcel tax assessments (226 parcels), sanitary-permit records, historic maps (e.g. Bordner Survey 1939–1941 and DNR 1964 lake survey), U.S. Census housing counts, historic aerial photos, satellite remote sensing, State Trunk Highway 70 construction archives, and oral-history interviews—to resolve apparent discrepancies and establish precise temporal anchors for stratigraphic proxies.

The chronology documents a clear sequence of catchment disturbance and shoreline change. Near-complete clearing of virgin pine forests occurred by ~1907, followed by immediate homesteading, limited small-scale agriculture, and subsequent reforestation/abandonment in the 1930s. Residential development remained modest through the mid-20th century but accelerated after 1960, producing a predominantly seasonal/recreational housing stock (mean occupancy  $\approx 40\%$ ).

Sanitary infrastructure consists almost entirely of private onsite wastewater treatment systems (POWTS), including a documented fraction of legacy cesspools that represent persistent phosphorus-loading pathways.

Transportation infrastructure and hydrological modifications supply further stratigraphic markers. State Trunk Highway 70 designation and grading (1917) and subsequent paving (1935) should coincide with erosion pulses, while culvert adjustments and highway-related changes to the Sand Creek outlet have contributed to contraction of historic wild-rice (Manoomin) beds.

Fisheries composition also shifted, from northern-pike dominance before 2000 to largemouth-bass dominance thereafter, consistent with intensified recreational use.

These timelines anchor the major expected signals in the sediment record: pronounced pollen and charcoal peaks associated with late-19th-century logging, strongest erosion and nutrient pulses in the late 1890s–1920s, geochemical and diatom responses to highway development, and later increases in anthropogenic markers linked to septic proliferation and shoreline development. The integrated framework resolves data discrepancies across sources and supplies robust, cross-validated horizons for core dating and proxy interpretation. All derived datasets and scripts are archived for reproducibility.

Key timeline events are shown in Figure 1. This chronology provides a robust framework for interpreting diatom, phytolith, geochemical, and sediment records in ongoing and future paleolimnological studies of Big Sand Lake.

**Big Sand Lake Land-Use Timeline**  
**Key Events for Paleolimnological Interpretation**  
**(Not To Scale)**

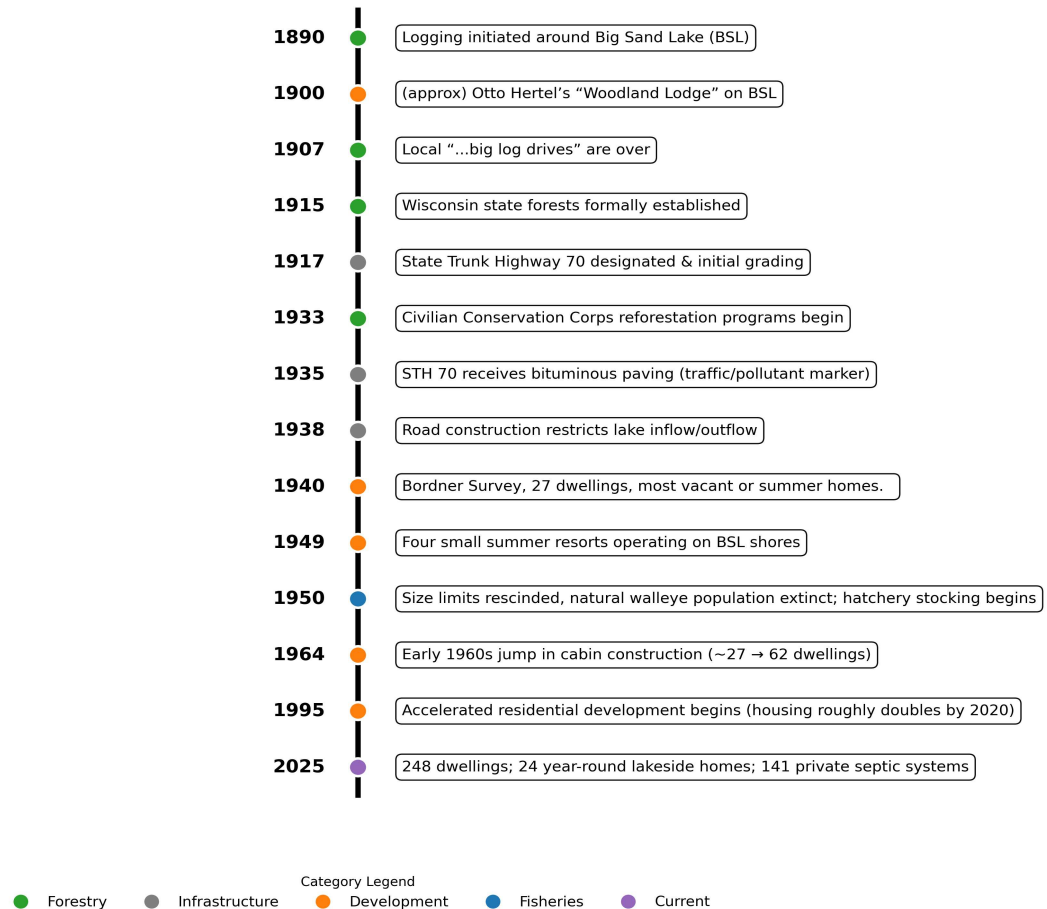


Figure 1: Big Sand Lake Land-Use Timeline Key Events for Paleolimnological Interpretation (Not To Scale)

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## ***Introduction***

Paleolimnological studies rely on precise land-use chronologies to interpret stratigraphic changes in sediment cores. For Big Sand Lake, human activities—residential expansion, septic-system proliferation, highway development, and shifts in fisheries and recreational use—represent the dominant drivers of catchment-scale nutrient and sediment loading. This report synthesizes previously compiled datasets (Appendices A–H) into a unified narrative. It focuses on the questions most directly linkable to paleolimnological proxies: timing of cabin/home construction, sanitary-system status, highway infrastructure, forest clearance, fisheries management, lake damming, and major changes in lake use.

## ***Methods***

Data were drawn from five primary sources:

1. Burnett County tax and parcel records (226 parcels) used to identify parcels with positive building value and derive “PresumedBuilt” years.
2. Sanitary-permit records (141 permits) extracted from the Burnett County As-

cent system.

### 3. Historical maps:

- Wisconsin Land Economic Inventory (Bordner Survey), Town of Sand Lake and Town of La Follette, 1939–1941<sup>1</sup>
- Wisconsin Conservation Department Lake Survey Map, June 1964<sup>2</sup>

### 4. Surveys, plat records, aerial and satellite photos<sup>3</sup>

<sup>1</sup>"Wisconsin Land Economic Inventory Maps (The Bordner Survey)," Steenbock Library Digital Collections, University of Wisconsin–Madison Libraries, 1941 1939, <https://www.library.wisc.edu/steenbock/collections/wisconsin-land-economic-inventory-the-bordner-survey-land-cover-maps/>.

<sup>2</sup>"Wisconsin Conservation Department Lake Survey Map," Wisconsin Department of Natural Resources, June 1964, <https://apps.dnr.wi.gov/lakes/lakepages/LakeDetail.aspx?wbic=2676800>.

<sup>3</sup>"[Public Land Survey System Map: Wisconsin Township 39 North, Range 15 West] - UWDC - UW-Madison Libraries," 1856, <https://search.library.wisc.edu/digital/ALFAOL34SRQGWN8D>; "Google Earth," Big Sand Lake, Burnett County, 2024, [https://earth.google.com/web/search/Big+Sand+Lake,+Burnett+County,+WI/@45.82376775,-92.2224791,298.23642396a,6480.0366703d,35y,0h,0t,0r/data=CpABGmISXAolMHg1MmFkOTVIY2U1N2U0NDczOjB4ZjgwZjc3ZDhhMGQ3ZmM0Mhn79OnCWelGQCEWN8nqMQ5XwCohQmInIFNhbmqGtGFrZSwgQnVybmV0dCBDb3VudHksIFdJGAIGASImCiQJ\\_D3405KKNUAR\\_D3405KKNCZDXi04SvFSUAhbogMG-ANSsBCAggBOgMKATBCAggASg0I\\_\\_\\_\\_\\_ARAA](https://earth.google.com/web/search/Big+Sand+Lake,+Burnett+County,+WI/@45.82376775,-92.2224791,298.23642396a,6480.0366703d,35y,0h,0t,0r/data=CpABGmISXAolMHg1MmFkOTVIY2U1N2U0NDczOjB4ZjgwZjc3ZDhhMGQ3ZmM0Mhn79OnCWelGQCEWN8nqMQ5XwCohQmInIFNhbmqGtGFrZSwgQnVybmV0dCBDb3VudHksIFdJGAIGASImCiQJ_D3405KKNUAR_D3405KKNCZDXi04SvFSUAhbogMG-ANSsBCAggBOgMKATBCAggASg0I_____ARAA); "Hertel, Wi 1948 1:48000," USGS Topoview, 1948, <https://ngmdb.usgs.gov/maps/topoview/viewer>; Edgar Sears, "Section Line: T39N R15W; Between Sections 27 and 28 (North)," September 1855, <https://digicoll.library.wisc.edu/cgi-bin/SurveyNotes/SurveyNotes-idx?type=article&byte=38384491&twp=T039NR015W>; "Town of LaFollette - UWDC - UW-Madison Libraries," Wisconsin Land Economic Inventory (Bordner Survey), Wisconsin Department of Agriculture, 1941 1939, <https://search.library.wisc.edu/digital/A6XZXKC6JCQS4I9C>; "Town of Sand Lake - University of Wisconsin Digital Collections - UW-Madison Libraries," Town of Sand Lake, Wisconsin Department of Agriculture, 1941 1939, <https://search.library.wisc.edu/digital/AYRXYEV6CECWID85>; "Township 39 N, Range 15 W,

5. Decennial Census of Population and Housing, 1970-2020<sup>4</sup>
6. Wisconsin Department of Transportation records for State Trunk Highway 70 (STH 70)<sup>5</sup>.

A cumulative-dwellings time series was synthesized and plotted from this data. All analyses targeted the Big Sand Lake Watershed; blocks in Tract 9704 / Block Group 1 (2020 U.S. Census blocks 1083, 1087, 1089, 1092, 1097, 1099, 1101 plus reservation blocks 1103–1105, 1112), Town of La Follette and Town of Sand Lake.

## **Results**

### **Residential, Cabin, and Resort Development Timeline**

Development around Big Sand Lake remained sparse through the mid-20th cen-

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Town of Sand Lake" Burnett County Plat Book," 1915, <https://sites.rootsweb.com/~wiburnet/platbook/39n15w.htm>; "Wisconsin Historic Aerial Imagery Finder," Wisconsin State Cartographer's Office., 1938, <https://maps.sco.wisc.edu/whaifinder/>.

<sup>4</sup>U.S. Census Bureau, "Current Census Address Count Listing Files Viewer," U.S. Census Bureau, 2025, <https://mtgis-portal.geo.census.gov/arcgis/apps/webappviewer/index.html?id=c754be823d6342949a4c50e519eb87be>; U.S. Census Bureau, "H1: Census Bureau Table," HOUSING UNITS, U.S. Census Bureau, 2010, <https://data.census.gov/table/DECENNIALSF12010.H1?q=ZCTA5+37312+Housing>; Jonathan Schroeder et al., "National Historical Geographic Information System: Version 20.0," version 20.0, with U.S. Census Bureau et al., Minneapolis, MN: IPUMS, 2025, <https://doi.org/10.18128/D050.V20.0>.

<sup>5</sup>"Wisconsin Department of Transportation Transportation Timeline," accessed May 12, 2026, <https://wisconsin.gov/Pages/about-wisdot/who-we-are/dept-overview/transp-timeline.aspx>; "Wisconsin Highway 70," *Wikipedia*, August 14, 2025, [https://en.wikipedia.org/w/index.php?title=Wisconsin\\_Highway\\_70&oldid=1305797743](https://en.wikipedia.org/w/index.php?title=Wisconsin_Highway_70&oldid=1305797743); United States and Wisconsin, *A History of Wisconsin Highway Development 1835-1945* (State Highway Commission, 1947), <https://catalog.hathitrust.org/Record/102497463>.

tury. The 1939–1941 Bordner Survey<sup>6</sup> recorded approximately 27 dwellings circa 1940. Hand-counted surveys and aerial photo interpretations show modest growth in the 1950s–1960s, reaching 76 structures by the mid-1950s and 62 by the June 1964 DNR Lake Survey<sup>7</sup> (including dwellings and resorts). Growth accelerated in the 1960s through 1980s, slowed, then accelerated 2000 through 2010. By 2010 the cumulative total had roughly doubled compared to mid-1970s levels (Figure 2).

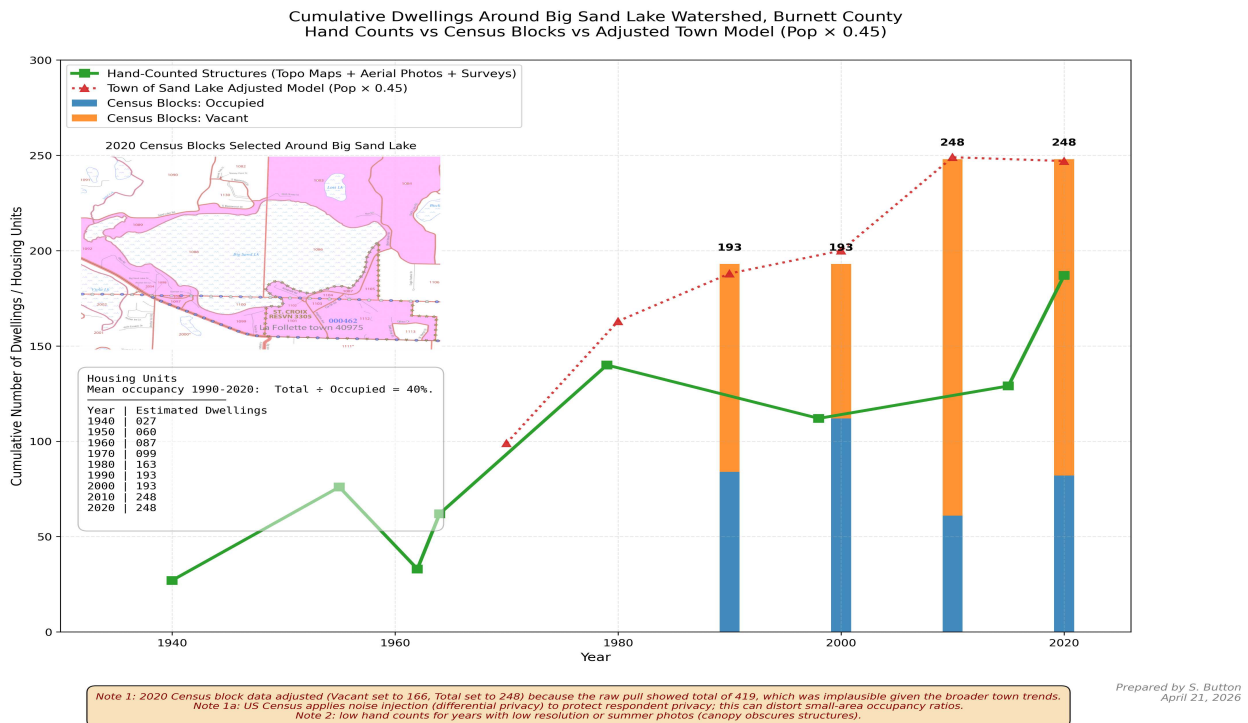


Figure 2: Cumulative number of dwellings built around Big Sand Lake (1930–2025) derived from US Census, hand counts from aerial photos, satellite photos; historical map anchor points from the Bordner Survey (≈1940) and DNR Lake Survey (1964).

Hand-counts on aerial photos taken in summer conditions (tree canopies hide structures) and/or with lower resolution under-report dwellings. The Bordner and 1964 maps, along with the decennial census data serve as critical independent

<sup>6</sup>Steenbock Libr. Digit. Collect. Univ. Wisconsin–Madison Libr., “Wisconsin Land Economic Inventory Maps (The Bordner Survey).”

<sup>7</sup>Wisconsin Department of Natural Resources, “Bathymetric Map, Big Sand Lake.”

benchmarks.

Approximate dwelling/structure counts at selected paleolimnological horizons (hybrid map + census-block data) are given in Table 1.

*Table 1: Dwelling counts for selected years.*

| Year | Estimated Dwellings |
|------|---------------------|
| 1940 | 027                 |
| 1950 | 060                 |
| 1960 | 087                 |
| 1970 | 099                 |
| 1980 | 163                 |
| 1990 | 193                 |
| 2000 | 193                 |
| 2010 | 248                 |
| 2020 | 248                 |

Mean occupancy 1990-2020: Total / Occupied = 40%.

Beyond structural development, hydrological and ecological changes—particularly wild-rice bed loss—represent additional drivers of catchment-scale sediment and nutrient dynamics.

### ***Wild Rice (Manoomin)***

Historic stands of wild rice were a cornerstone of Big Sand Lake ecology and St. Croix Chippewa culture. Yields reached “1,000 pounds per acre” within living memory, supporting waterfowl and traditional harvests<sup>8</sup>. Beds extended east from the north shore and were present in the west bay and west end through the 1940s. Loss began around 1980, as recalled by Lolita Taylor (spouse of Chief Ollie and

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<sup>8</sup>D. K. Button, “Properties of the Lake along with Some Possible Restorations,” *The Sand Lake Observer* (Big Sand Lake, Burnett County) 1, no. 1 (2009): 3.

grade-school teacher of D.K. Button), and was exacerbated by artificially elevated water levels from damming Sand Creek (c. 1938) and blockage of inflow from Warner Lake by Highway 70<sup>9</sup>.

Nearby Upper Clam Lake (WBIC 2656200) is the top producer of wild rice in Wisconsin, with over 47K lbs of green rice harvested 1992-2015. However, circa 2007 the rice beds were devastated, attributed to an increase in carp, after loss of bluegill, an effective predator of their eggs<sup>10</sup>.

Wild rice can vary dramatically year to year, and seems to follow a roughly four-year boom and bust cycle<sup>11</sup>. Abundance of wild rice increases in clear, shallow, slow moving waters of lakes and rivers with organic muddy sediments<sup>12</sup>. As flowing water is important for abundance, hydrological changes are the likely main overall cause of loss of wild rice beds<sup>13</sup>. Similar to Wisconsin, bordering Minnesota has seen a reduction in harvestable acres of wild rice. As with Clam Lake, prolific wild rice in lakes such as Lake Ogechie has almost completely disappeared<sup>14</sup>.

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<sup>9</sup>D. K. Button, "Nine Years of Progress," *The Sand Lake Observer* (Big Sand Lake, Burnett County) 3, no. 1 (2018): 10.

<sup>10</sup>J. A. Johnson, "Wild Rice Seed Enumeration Report: 2009-2010 Upper Clam Lake, Lower Clam Lake, Long Lake, and Clam River Flowage," Prepared for SEH / Freshwater Scientific Services, LLC., 2010; P. David et al., "Manoomin," Great Lakes Indian Fish and Wildlife Commission, 2019; D. K. Button, "Wild Rice--Can Big Sand Rebound?," *Lakelines Newsletter* 16, no. 1 (2011), //bclra.org/lakelines/.

<sup>11</sup>P. David et al., "Manoomin."

<sup>12</sup>C. L. Yost et al., "Detecting Ancient Wild Rice (*Zizania* Spp. L.) Using Phytoliths: A Taphonomic Study of Modern Wild Rice in Minnesota (USA) Lake Sediments," *Journal of Paleolimnology* 49, no. 2 (2013): 221–36, <https://doi.org/10.1007/s10933-012-9670-x>.

<sup>13</sup>P. David et al., "Manoomin."

<sup>14</sup>Yost et al., "Detecting Ancient Wild Rice (*Zizania* Spp. L.) Using Phytoliths."

Regional populations of wild rice have declined. Recent observations indicate steeper population declines since 2010. Potential causes include a warming climate and land development<sup>15</sup>

Pre-settlement, Big Sand Lake supported culturally significant wild-rice (*manoomin*) beds utilized by Ojibwe communities. Both historic (H1, H2) and remnant current rice beds are mapped in Figure 3. Current and historic rice bed annotations from interviews with D.K Button, April 2026 <sup>16</sup>. More details on the satellite imagery from Great Lakes Indian Fish and Wildlife Commission (GLIFWC)<sup>17</sup>, and further discussion of wild rice are in Appendix F.

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<sup>15</sup>Graphics – *Manoomin Education and Outreach Project*, n.d., accessed April 30, 2026, <https://seagrant.wisc.edu/manoomin/literature-background/>.

<sup>16</sup>D. K. Button, "Wild Rice Bed Locations," (Big Sand Lake, WI (telephone)), April 1, 2026.

<sup>17</sup>Austen Hilding "Big Sand Lake, Burnett County, Wild Rice," to scott.d.button@gmail.com et al., April 8, 2026.

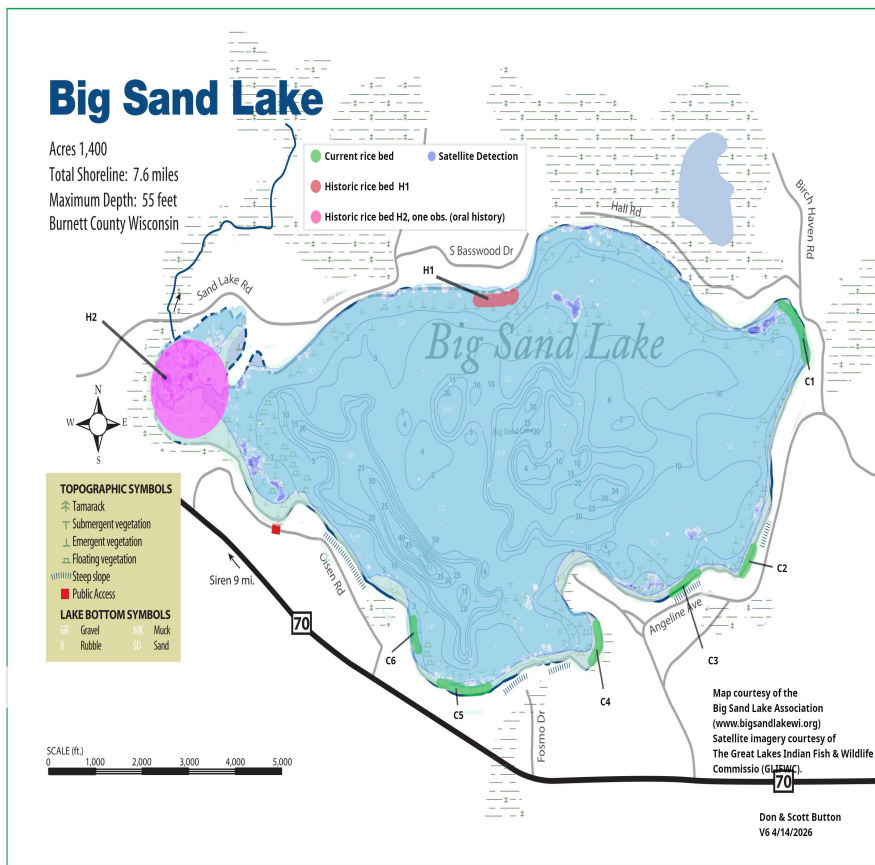


Figure 3: Sentinel 1 satellite imagery from Great Lakes Indian Fish and Wildlife Commission overlaid on Big Sand Lake map, showing persistent wild-rice beds in dark blue. Current and historic rice bed sites from interviews with D.K Button, April 2026. The information provided by GLIFWC's internal remote sensing is subject to change as the application is in the preliminary stages of development and the model may be fine-tuned after further seasons of ground-truthing manoomin distribution results.

## Paleolimnological Interpretation

Plant phytoliths are silica bodies ranging from 5 to 200  $\mu\text{m}$  in size. When plant material decomposes, phytoliths are released to the sediment layers<sup>18</sup>. Wild rice phy-

<sup>18</sup>Chad Yost, "Phytolith Evidence for the Presence and Abundance of Wild (Zizania Palustris) from Central Minnesota Lake Sediments" (Master of Science, St. Cloud State University,

toliths are a reliable tool for wild rice detection in paleolake sediments<sup>19</sup>.

### ***Sanitary Systems***

The Burnett County Beacon GIS map was used to select properties intersecting a 400 foot buffer around Big Sand Lake shoreline. This enabled download of 226 Parcel ID's and associated fields (Owner name, address, assessed value, etc.). Using this list of Parcel ID's, the sanitary permits linked to the parcels were extracted directly from the Burnett County Ascent Permit Management System (<https://web.burnettcounty.org>). These permits were then classified by type of system.

All 138 classified systems (3 were of unknown type) are private onsite wastewater treatment systems (POWTS); no centralized sewer serves the lake. System-type distribution is shown in Table 2.

*Table 2: Sanitary System Type and Count from Burnett County Ascent Permit Management System (<https://web.burnettcounty.org>).*

| <b>System Type</b>                       | <b>Count</b> | <b>% of Total</b> | <b>Typical P-Loading Risk</b> |
|------------------------------------------|--------------|-------------------|-------------------------------|
| Conventional (Non-Pressurized In-Ground) | 61           | 43%               | Medium-High                   |
| Mound                                    | 27           | 19%               | Low-Medium                    |
| Holding Tank                             | 24           | 17%               | Very Low                      |
| <b>Cesspool</b> (reclassified)           | <b>13</b>    | <b>09%</b>        | <b>Medium-High</b>            |
| Pit Privy                                | 9            | 06%               | Very Low                      |
| Unknown (no maintenance)                 | 3            | 02%               | Medium-High                   |
| Conventional w/ Lift                     | 2            | 01%               | Low-Medium                    |
| In-Ground Pressure                       | 1            | 0.7%              | Low-Medium                    |
| Privy (Sealed Vault)                     | 1            | 0.7%              | Very Low                      |
| <b>Total</b>                             | <b>141</b>   | <b>100%</b>       | —                             |

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2007).

<sup>19</sup>Yost et al., "Detecting Ancient Wild Rice (Zizania Spp. L.) Using Phytoliths."

Twenty-four properties were identified as year-round residences (local owner address). Conventional and cesspool systems together comprise ~52% of installations and represent the highest long-term risk once soil adsorption capacity is exceeded (typically 20–30 years).

Further details of the sanitary analysis are in Appendix E.

### ***Highway Infrastructure***

State Trunk Highway 70 (STH 70) borders the southern and eastern shores of Big Sand Lake and constitutes the primary access corridor. Major developmental milestones are: - 1917: Official designation into Wisconsin's State Trunk Highway System, with initial grading of the Burnett County segment. - Early 1920s: Eastward route extension (still gravel). - 1935: First bituminous paving, increasing traffic volume and introducing asphalt-derived hydrocarbons and vehicle-related pollutants.

No additional lake-specific road construction events were identified.

### **Forest Clearance and Logging History**

Pioneer Tales of Burnett County<sup>20</sup> provides vivid local narratives that anchor the timing of forest clearance around Big Sand Lake (Town of Sand Lake, T39N R15W) within the broader regional pattern of white pine and mixed hardwood logging.

In the pre-logging era, the landscape was dominated by “Great white and jack pine forests [that] grew over much of the country,” along with cranberries in the marshes, blueberries in the woods, and wild rice in the lakes and rivers. The 1855

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<sup>20</sup>Burnett County Homemakers Clubs, *Pioneer Tales Of Burnett County, Wisconsin* (Dan-Web Printing Co., 1830; repr., Higginson Book Company, 1976), <https://genealogytrails.com/wis/burnett/pioneertales.html>.

General Land Office section-line<sup>21</sup> notes describe the area as mostly pine timber, and the 1856 plat survey map<sup>22</sup> shows no carved-up sections—confirming the forest remained intact at the time of the original public-land survey.

Logging began in earnest in the late 1860s. A general entry notes that “In the year about 1868, 78 loggers came here to cut the pine timber,” with contracts let by companies such as Lair and Norton to crews from Chippewa Falls, Eau Claire, and elsewhere. Logs were floated via the Clam River system (which drains the Big Sand Lake watershed) through Clam Lake and onward to the St. Croix River and mills at Stillwater, Minnesota. Dams were constructed to facilitate drives, and a steam-powered “wannigan” (cook shanty and supply boat) followed the crews on Clam Lake.

The **main clearance around Big Sand Lake itself occurred in the 1890s**. A pioneer who homesteaded directly in the township in 1898 (Section 18, T39N R15W) described arriving by wagon from Barron County: “There was no road in this region, just trails through the woods.” The family lived in a tent the first summer before building a log cabin in the fall. Their first schoolhouse, built of logs, burned down in a forest fire before it was completed. Nearby Siren-area accounts place permanent settling between 1880 and 1900, with small-scale logging continuing; one 1893 entry simply states settlers “bought forty acres of land, cut the logs and sold them.”

Adjacent Blaine Township (immediately east of Sand Lake Township) offers the most geographically specific chronology. At the “turn of [the] century” the area was “a land of forests lately visited by loggers who had stripped the beautiful virgin forests of much of the stately pines.” A major logging camp in East Blaine—complete with a log tramway and ox teams hauling logs three miles to the St. Croix

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<sup>21</sup>Sears, “Survey Notes.”

<sup>22</sup>“[Public Land Survey System Map: Wisconsin Township 39 North, Range 15 West] - UWDC - UW-Madison Libraries.”

River—was destroyed in the great Hinckley Fire of September 1894. Smaller camps followed, and their operators often became the first permanent settlers around 1900, gradually replacing crooked logging roads with wider networks. One pioneer tale from the Scott / McKenzie Lake vicinity (watershed-connected to Big Sand Lake) echoes this exactly: the early 1890s were still “wild indeed,” but “soon the lumber companies learned of the white pine, Norway and jack pine forests here and in a few years there was very little left of the virgin timber.”

By the early 1900s the major pine stands were gone. A Clam Lake account notes that “About 1907, after the big log drives were over...” the focus had shifted. Regional logging of white pine and mixed hardwoods had peaked in the late 1860s–early 1900s; by 1915 less than 1% of the original timber remained in northern Wisconsin. The 1915 Burnett Plat Book<sup>23</sup> shows sections fully carved up (in contrast to the 1856 plat), reflecting post-cutover land sales or abandonment.

The cutover lands quickly became tax-delinquent. The Burnett County Forest was established in 1932 specifically for reforestation of these abandoned parcels, including large acreages in Sand Lake Township. The 1939–1941 Bordner Survey maps<sup>24</sup> document extensive clearcut areas, and 1938 aerial photographs<sup>25</sup> show forestation patterns with little change from recent satellite imagery<sup>26</sup> (Figure 4).

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<sup>23</sup>“Township 39 N, Range 15 W, Town of Sand Lake” Burnett County Plat Book.”

<sup>24</sup>Wisconsin Department of Agriculture, “Bordner - Sand Lake.”

<sup>25</sup>Wisconsin State Cartographer’s Office., “Wisconsin Historic Aerial Imagery Finder.”

<sup>26</sup>Big Sand Lake Burnett Cty., “Google Earth.”



Figure 4: 1938 Aerial (left) compared to 2024 Satellite (Right) Forestation Levels. 1938 image from the Wisconsin Historic Aerial Imagery Finder, 2024 © Google Earth / Airbus

## Agricultural Settlement and Farm Establishment

Farms around Big Sand Lake (in Sand Lake Township/Town of Sand Lake, Burnett County, Wisconsin) were primarily established in the **late 1890s to early 1900s** as part of broader homesteading on the clear cut lands following intensive logging. This timing directly overlaps with the final phases of major pine removal, as many loggers and camp operators transitioned into the first permanent settlers.

The area's sandy, glaciated soils were better suited initially for logging than intensive agriculture. Early farming on these cutover lands focused on hay (clover and grasses) for dairying, along with subsistence crops. Many of the 1898-era homesteaders (such as the Kuhnly family in Section 18) arrived precisely as logging wound down, clearing remaining stumps and slash for small family farms. Sand Lake Township was formally organized around 1915–1916, reflecting sufficient population growth from these agricultural settlers.

Agriculture remained limited due to poor soils, periodic fires, and economic pressures. By the 1930s, many marginal farms were abandoned, contributing to the

tax-delinquent lands incorporated into the Burnett County Forest. Later assessments noted only modest farmland acreage (around 1,500 acres in the township) persisting into the mid-20th century.

### **Integrated Paleolimnological Implications**

This combined chronology—**virgin pine forests intact through the 1850s, heavy logging peaking in the 1890s with near-complete clearance by ~1907, followed immediately by homesteading and small-scale farming in the late 1890s–1910s, and reforestation/abandonment in the 1930s**—provides a temporal framework for interpreting sediment-core proxies around Big Sand Lake.

Expect: - Pollen shifts and charcoal peaks corresponding to the 1890s logging disturbance. - Erosion/nutrient pulses (e.g., diatoms responding to increased runoff) strongest in the late 1890s–1920s from combined clearcutting, slash fires, road/trail building, and initial farm clearance. - Sustained but lower-intensity signals from ongoing small-scale dairying and hay production through the early–mid 20th century.

### ***Fisheries***

Big Sand Lake supported robust fisheries through the mid-20th century, with large northern pike, walleye, bluegills, and crappie drawing summer resorts and anglers from Illinois, Indiana, and the Twin Cities<sup>27</sup>. Market fishing around 1900 contributed to initial crashes in some populations<sup>28</sup>.

A summary of Wisconsin fishing regulations for major gamefish groups is in<sup>29</sup>.

<sup>27</sup>Brian Fagan, *Fishing: How the Sea Fed Civilization* (Yale University Press, 2017).

<sup>28</sup>D. K. Button, "Science-Based Stewardship," *The Sand Lake Observer* (Big Sand Lake, Burnett County) 4, no. 2 (2019): 1; Fagan, *Fishing*.

<sup>29</sup>Andrew L. Rypel et al., "Seventy-Year Retrospective on Size-Structure Changes in the Recreational Fisheries of Wisconsin," *Fisheries* 41, no. 5 (2016): 230–43, <https://doi.org/10.1080/03632415.2016.1160894>.

This is presented as Table 3, with size limits converted to inches.

*Table 3: Fishing Regulations Summary Table (from Rypel et al. 2016, Figure 5)*

| <b>Species/<br/>Group</b>         | <b>Period</b> | <b>Minimum<br/>Size Limit<br/>(mm)</b> | <b>Minimum<br/>Size Limit<br/>(inches)</b> | <b>Bag Limit</b>                         | <b>Regulation<br/>Type</b> |
|-----------------------------------|---------------|----------------------------------------|--------------------------------------------|------------------------------------------|----------------------------|
| Panfish                           | Pre-1936      | None                                   | None                                       | None                                     | Liberal                    |
| Panfish                           | 1936–1944     | 152 (sunfish)<br>178 (crappie)         | 6.0<br>7.0                                 | 15–25 fish                               | Restrictive                |
| Panfish                           | 1960–present  | None                                   | None                                       | 50 (1965) →<br>25 (1995–)                | Liberal                    |
| Muskellunge                       | 1925–1982     | 762                                    | 30                                         | 1 fish                                   | Restrictive                |
| Muskellunge                       | 1983–1994     | 813                                    | 32                                         | 1 fish                                   | Restrictive                |
| Muskellunge                       | 1995–2011     | 864                                    | 34                                         | 1 fish                                   | Restrictive                |
| Muskellunge                       | 2012–present  | 1016                                   | 40                                         | 1 fish                                   | Restrictive                |
| Northern Pike                     | 1917–1948     | 406–457                                | 16.0–18.0                                  | 7–15 fish                                | Restrictive                |
| Northern Pike                     | 1949–1957     | 457                                    | 18                                         | 5 fish                                   | Restrictive                |
| Northern Pike                     | 1958–1994     | None                                   | None                                       | None (all size<br>limits abol-<br>ished) | Liberal                    |
| Northern Pike                     | 1995–present  | 660 (South<br>only)                    | 26.0 (South)                               | 2 fish (South);<br>5 fish (North)        | Mixed                      |
| Walleye                           | 1909–1988     | 305                                    | 12                                         | 7 (1936) → 5<br>(1949)                   | Restrictive                |
| Walleye                           | 1990–present  | 381                                    | 15                                         | Sliding 5–0<br>(tribal)                  | Restrictive                |
| Largemouth/<br>Smallmouth<br>Bass | 1917–1948     | 254                                    | 10                                         | 5–10 fish                                | Restrictive                |
| Largemouth/<br>Smallmouth<br>Bass | 1953–1988     | None                                   | None                                       | 5 fish                                   | Liberal                    |
| Largemouth/<br>Smallmouth<br>Bass | 1989–1997     | 288 (North)<br>356 (South)             | 11.3 (North)<br>14.0 (South)               | 5 fish                                   | Restrictive                |
| Largemouth/<br>Smallmouth<br>Bass | 1998–present  | 356                                    | 14                                         | 5 fish                                   | Restrictive                |

Regulations have cycled between relatively restrictive periods (size limits combined with low bag limits) and liberal periods (no size limits and higher bag limits). During the 1940s, panfish, northern pike, and walleye were managed under relatively restrictive rules (e.g., size limits for bluegills/sunfish and crappie, fluctuating bag limits for pike). These protections were largely relaxed or eliminated by the late 1950s–1960s, a shift widely linked to long-term statewide declines in panfish size structure. This regulatory timeline aligns with D.K. Button’s discussion of 1940s limits on Big Sand Lake (7-inch minimum for bluegills/sunfish, 10-inch for crappie, ~18-inch for northern pike) before the limits were rescinded around 1950<sup>30</sup>.

D.K. Button’s firsthand accounts in the Sand Lake Observer document the subsequent decline. In the 1940s, “large northern pike were replaced with an abundance of small ones despairingly known as ‘hammer handles’” and bluegill catches were regulated to those over seven inches, but “bluegill size decreased sharply and small ones greatly overpopulated”<sup>31</sup>. The annual spring run of redhorse suckers and walleye stopped after Highway 70 blocked inflow from Warner Lake and Sand Lake Road restricted outflow, eliminating spawning habitat and nutrient inputs. Wild rice beds, once harvested for food and waterfowl, could no longer sustain yields of “1,000 pounds per acre” and “only two small rice beds now remain”<sup>32</sup>.

By the 1970s–1980s, summer homes replaced fishing resorts, and repeated stocking of musky and walleye proved unsuccessful. Overfishing favored early maturation and dwarfing: “the old one-pounders were gone” among bluegills, and north-

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<sup>30</sup>Button, “Nine Years of Progress.”

<sup>31</sup>D. K. Button, “System Health,” *The Sand Lake Observer* (Big Sand Lake, Burnett County) 2, no. 3 (2015): 11.

<sup>32</sup>Button, “System Health”; D. K. Button, “The Draw of Big Sand,” *The Sand Lake Observer* (Big Sand Lake, Burnett County) 1, no. 4 (2012): 1.

ern pike populations were reduced to levels too low for effective cropping of mid-sized fish <sup>33</sup>. Largemouth bass overpopulated and stunted, competing with other game fish. A 2014 fish population sampling effort (Nick Nelson) confirmed small sizes and low catch rates for larger specimens <sup>34</sup>.

Recent management has emphasized walleye fingerling/fry stocking (primarily by the St. Croix Chippewa Tribe and Wisconsin DNR, 2000–2022) and habitat improvements. Larger culverts installed under Sand Lake Road (with Tribal support) restored some flushing and fish passage without lowering lake levels, improving biodiversity and resistance to invasives such as carp <sup>35</sup>. Bluegills continue to patrol spawning beds and limit carp reproduction in the west bay. Walleye fingerling and fry stocking (primarily by the St. Croix Tribe and Wisconsin DNR, 2000–2022) represents the dominant management intervention. Standard statewide regulations apply; no lake-specific slot limits or major non-native introductions were found.

## **Fish Abundance**

Data on freshwater game fish sampled from 1966 to 2022 were provided by the Wisconsin Department of Natural Resources (WDNR). Fish were collected primarily using electrofishing and fyke nets. The dataset includes gear type, sampling date, fish species, number of fish measured, and total length (inches). Additional methodological details and context are available in WDNR reports<sup>36</sup>.

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<sup>33</sup>Button, "System Health"; Button, "The Draw of Big Sand."

<sup>34</sup>Button, "System Health."

<sup>35</sup>Button, "System Health."

<sup>36</sup>Craig Roberts, *Fisheries Survey Report for Big Sand Lake, Burnett County, WI 2022*, Waterbody Code 2676800 (Wisconsin Department of Natural Resources, 2023); S. Johannes, *Basic Fish Inventory, Big Sand Lake, Burnett County*, Correspondence/Memorandum nos. 3610–1 (State of Wisconsin, 1984).

Fish biomass was determined from species-specific length-to-weight relationships, where for bluegill, the weight in pounds was taken as length in inches cubed divided by 1,200, and for northern pike, length in inches cubed divided by 3,500 [WIDNR]. The total biomass per sampling date was computed by converting from pounds to kilograms and summing the mass of each sampling date.

The biomass of each fish species with a total biomass of over one kg is shown in Table 4.

*Table 4: Total biomass by species, 1966-2022.*

| Species         | Kg     |
|-----------------|--------|
| NORTHERN PIKE   | 303.00 |
| LARGEMOUTH BASS | 209.00 |
| BLUEGILL        | 119.00 |
| WALLEYE         | 90.60  |
| YELLOW BULLHEAD | 22.80  |
| BROWN BULLHEAD  | 15.00  |
| PUMPKINSEED     | 12.10  |
| BLACK CRAPPIE   | 8.98   |

The most abundant species collected over the period of this study were northern pike, largemouth bass, bluegill, and walleye. The biomass sampled for each species over time is shown as Figure 5

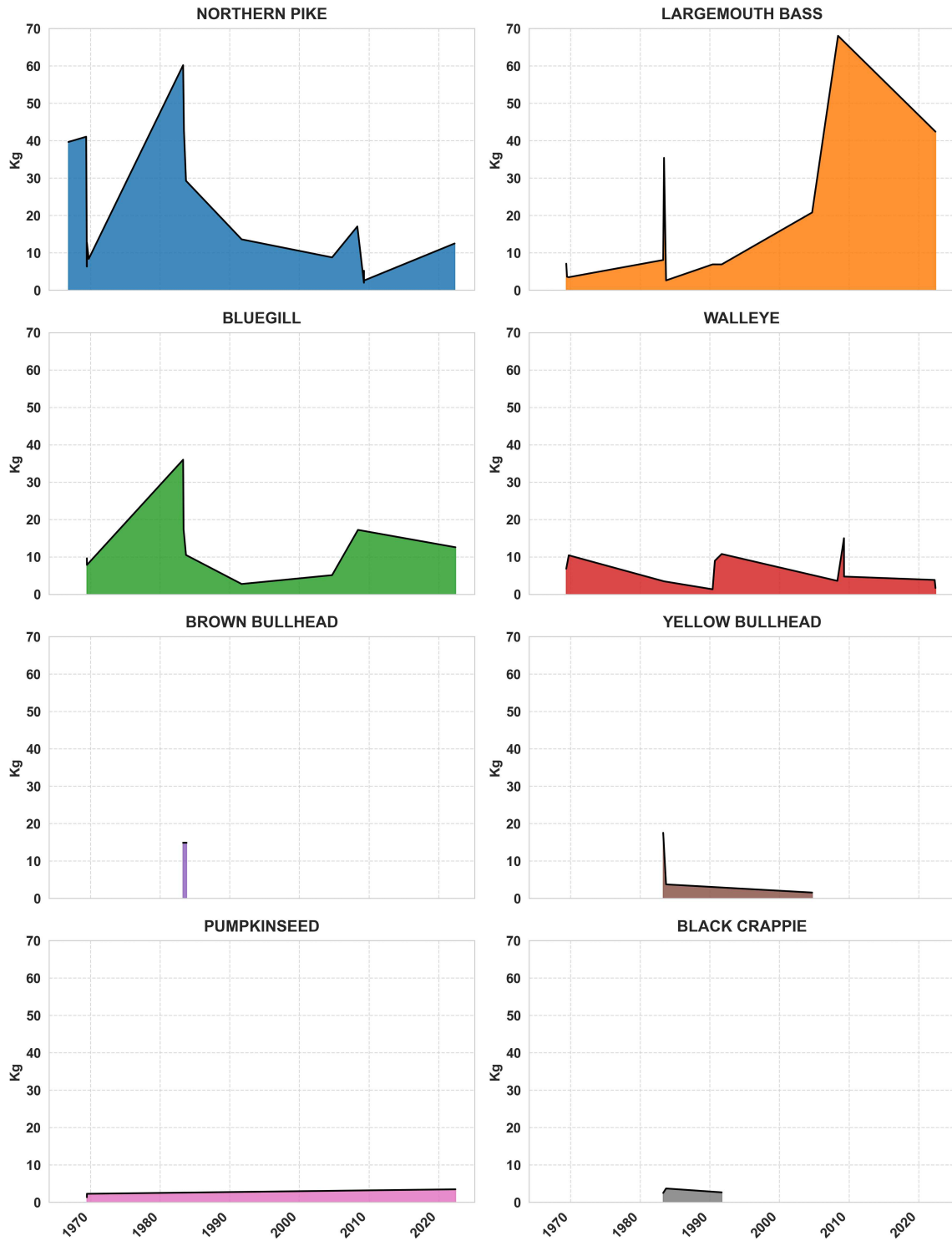


Figure 5: All species biomass over time, 1966-2022.

Before the year 2000, the most abundant fish were northern pike while after year 2000 largemouth bass were most abundant. The fourth most abundant fish, wall-eye, have been the only fish stocked into Big Sand Lake since 2011<sup>37</sup>.

**These trends should be interpreted with caution.** Sampling effort, locations, gear types, seasonal timing, and protocols varied across decades and waterbodies. Although a statistical treatment is available<sup>38</sup>, these differences can influence catch rates, size distributions, and species representation, potentially confounding long-term comparisons.

### ***Lake Water Levels***

Pre-1930, Big Sand functioned as a drainage lake with seasonal fish runs. Post-1938 damming and Highway 70 blockage converted it to a seepage lake, raising levels, drowning rice beds, and reducing nutrient flushing and fish exchange<sup>39</sup>.

Although disputed by WisDOT<sup>40</sup>, it appears changes to the Warner Lake outlet culvert in the late 1960s affected discharge rates into Big Sand Lake, and the current culvert may be too small and too high<sup>41</sup>.

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<sup>37</sup>Roberts, *Fisheries Survey Report for Big Sand Lake, Burnett County, WI 2022*.

<sup>38</sup>Scott Button, *Trajectory of Northern Pike and Bluegill Length and Biomass in a Wisconsin Lake, 1966–2022: Supplementary Materials*, May 18, 2026, <https://doi.org/10.5281/zenodo.20270807>.

<sup>39</sup>Button, "The Draw of Big Sand."

<sup>40</sup>Pete Young, "Highway 70 Culvert and Historical Water Flow Between Warner Lake And Big San Lake," personal communication, November 2025.

<sup>41</sup>Chip Applegath, *BSLA Board Meeting Minutes* (Big Sand Lake, Burnett County, 2025), <https://www.bigsandlakewi.org/wp-content/uploads/2025/07/BSLA-Board-Mtg-Minutes-07Jun2025.pdf>.

### ***Changes in Lake Use***

Traditional water skiing has been a common summer activity on Big Sand Lake since at least the 1940s–1950s, when summer resorts and early cabin owners regularly used the lake for boating and skiing. In contrast, the use of modern wake boats equipped with ballast tanks for wake surfing represents a relatively recent intensification of recreational activity. These high-wake vessels became a noticeable presence on Big Sand Lake in the early 2020s. By late 2024, concern over shoreline erosion, sediment re-suspension, and potential nutrient pulses prompted the Big Sand Lake Association to issue a formal position statement and the Town of Scott to adopt a specific ordinance restricting artificial wake enhancement.

The Big Sand Lake Association (BSLA) has explicitly linked wake boats to ecological harm, noting that “growth of wild rice in the lake is incompatible with wake boats”<sup>42</sup>. The Town of Scott ordinance states: “No person may operate a boat in an artificially bow-high manner having the effect of increasing the boat’s wake”<sup>43</sup>. BSLA had discussed proposing a similar ordinance to Town of Sand Lake, but has since tabled wake boat discussion due to a lawsuit against the Town of Scott over the ordinance<sup>44</sup>.

For paleolimnological interpretation, the proliferation of wake boats provides a

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<sup>42</sup>Chip Applegath, *BSLA Board Meeting Minutes* (Big Sand Lake, Burnett County, 2024), <https://www.bigsandlakewi.org/wp-content/uploads/2025/01/BSLA-Board-Meeting-Minutes-18Dec2024-1.pdf>.

<sup>43</sup>An Ordinance Restricting Certain Artificial Wake Enhancement, Pub. L. Nos. 2024–01, 3 (2024), <https://townofscottwi.org/ordinances-resolutions/>.

<sup>44</sup>Danielle Kaeding, “Wake Boat Owners Sue Northern Wisconsin Town to Overturn Ban on Wake Surfing,” *WPR*, May 30, 2025, <https://www.wpr.org/news/wake-boat-owners-sue-northern-wisconsin-town-to-overturn-ban-on-wake-surfing>; Applegath, *BSLA Board Meeting Minutes* (2025).

clear recent marker: increased wave energy can re-suspend shallow-water sediments and liberate previously buried phosphorus, producing detectable signals in the uppermost sediment layers (e.g., elevated mineral deposition rates, shifts in diatom assemblages, or increased cyanobacteria pigments). These effects are expected to be most pronounced in the post-2020 sediment record.

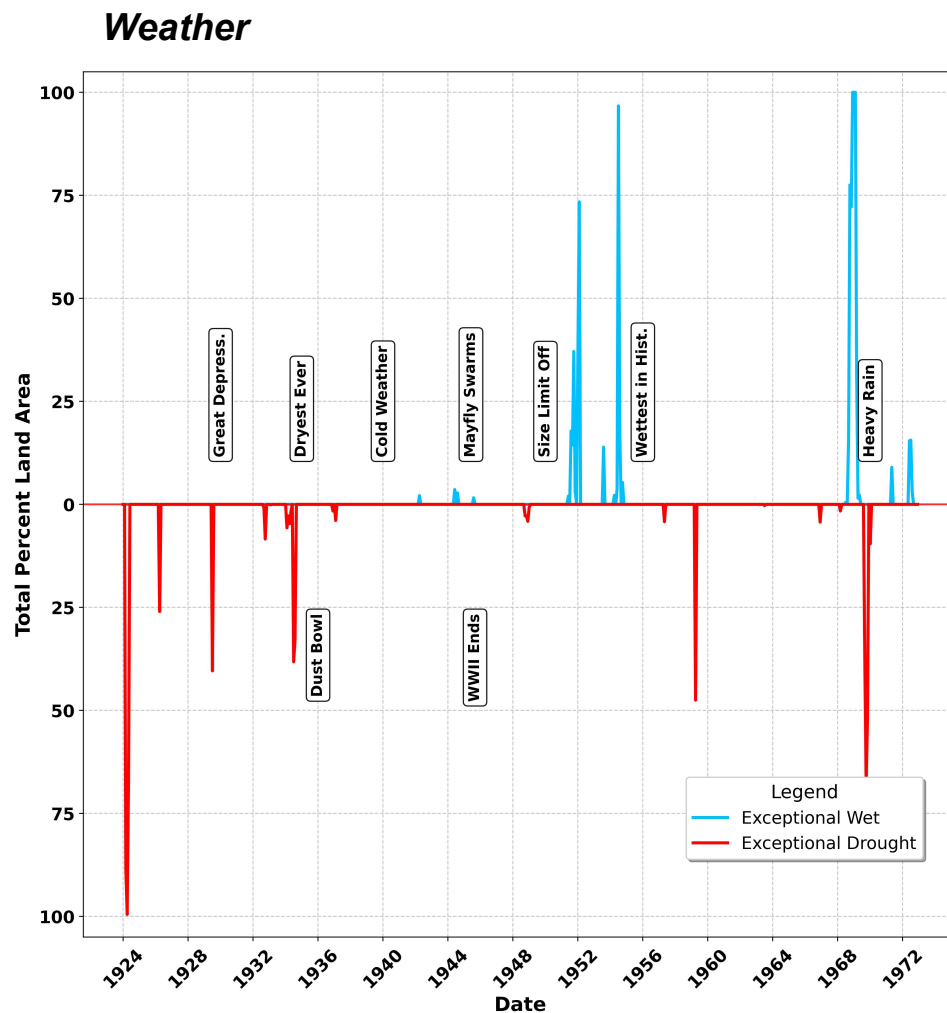


Figure 6: Burnett County Drought Data, 1924-1972.

Figure 6 shows the percentage of Burnett County's land area in the two most extreme Standardized Precipitation Index (SPI) categories from 1924 to 1972, anno-

tated with notable events.<sup>45</sup> For example, 1924 marked a D4 “exceptional drought” (<2 percentile of rainfall). Severe droughts in the 1920s and 1930s, intensified by the Midwest Dust Bowl, dried down much of the lake allowing foot travel across Big Sand lake<sup>46</sup>; other lakes were mowed for livestock feed.

## Discussion

The reconstructed timelines align with expected paleolimnological signals. Highway grading (1917) and paving (1935) should register as distinct erosional and geochemical horizons (clastics, PAHs, Pb). The 1960s cabin increase and especially the post-1995 housing boom provide markers for accelerated nutrient loading via septic systems and shoreline runoff. Conventional/cesspool systems (~54%) are the most probable historical phosphorus sources; their installation and aging dates can be directly correlated with diatom-inferred trophic shifts. Wild-rice decline and modern boating intensification offer additional context for recent sediment resuspension or hydrocarbon increases. Cross-validation with Pb-210/Cs-137 dating and independent markers (e.g., spheroidal carbonaceous particles) is recommended.

## Conclusions

Big Sand Lake transitioned from a largely undeveloped, rice-rich system in the early

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<sup>45</sup> The values in Figure 6 represent the percentage of Burnett County’s total land area that fell into the two most extreme Standardized Precipitation Index (SPI) categories: D4 “exceptional drought” and W4 “exceptional wet.” This index shows how observed precipitation (rain, hail, snow) deviates from the climatological average (using the base period 1895–2014) over the 9 months leading up to each date plotted. For example, in 1934, 38% of Burnett County fell into D4 drought condition, meaning 98% of the weather history had more precipitation than seen in 38% of Burnett County. The remaining 62% of Burnett County fell into less severe drought categories, which are not shown.

<sup>46</sup>D. K. Button, “Lake Levels,” *The Sand Lake Observer* (Big Sand Lake, Burnett County) 2, no. 4 (2017): 11.

20th century to a moderately developed recreational lake by 2025. The primary anthropogenic inflection points—1917/1935 highway development and post-1995 residential expansion—offer high-confidence tie-points for sediment-core chronology. The exclusive use of Private Onsite Wastewater Treatment Systems (POWTS), with a substantial fraction of legacy high-risk systems, underscores the need to link septic proliferation directly to phosphorus and diatom records. This dataset provides a spatially explicit, parcel-level land-use history suitable for integration into ongoing paleolimnological analyses.

**Data Availability:** The data and Python code supporting this report are available on Zenodo at <https://zenodo.org/records/20127391>. For fish abundance, the data and R code are at <https://zenodo.org/records/20738909>.

## Acknowledgments

Python scripts for data processing and figure generation were developed and iteratively refined with the assistance of Grok, an AI model developed by xAI (accessed Sept 2025 -May 2026). The final scripts were validated and executed by the author.

Big Sand Lake Map courtesy of the Big Sand Lake Association.

Manoomin remote sensing map courtesy of Austen Hilding, Great Lakes Indian Fish & Wildlife Commission. Fish survey data from Big Sand Lake provided by Craig Roberts of the Wisconsin Department of Natural Resources.

## **Appendix A: Structure Counts from Historic Maps**

### **Wisconsin Land Economic Inventory Maps (The Bordner Survey)**

The Wisconsin Land Economic Inventory, commonly known as the Bordner Survey after its director John Bordner, was a comprehensive Depression-era project to document land use and resources across Wisconsin<sup>47</sup>. Field mapping for the Town of Sand Lake and the Town of LaFollette (both in Burnett County) was conducted between 1939 and 1941<sup>48</sup>.

An annotated composite image derived from selected portions of these survey maps showing the number of dwellings recorded in chosen areas, is presented in Figure 7.

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<sup>47</sup>Steenbock Libr. Digit. Collect. Univ. Wisconsin–Madison Libr., “Wisconsin Land Economic Inventory Maps (The Bordner Survey).”

<sup>48</sup>Wisconsin Department of Agriculture, “Bordner - LaFollette”; Wisconsin Department of Agriculture, “Bordner - Sand Lake.”

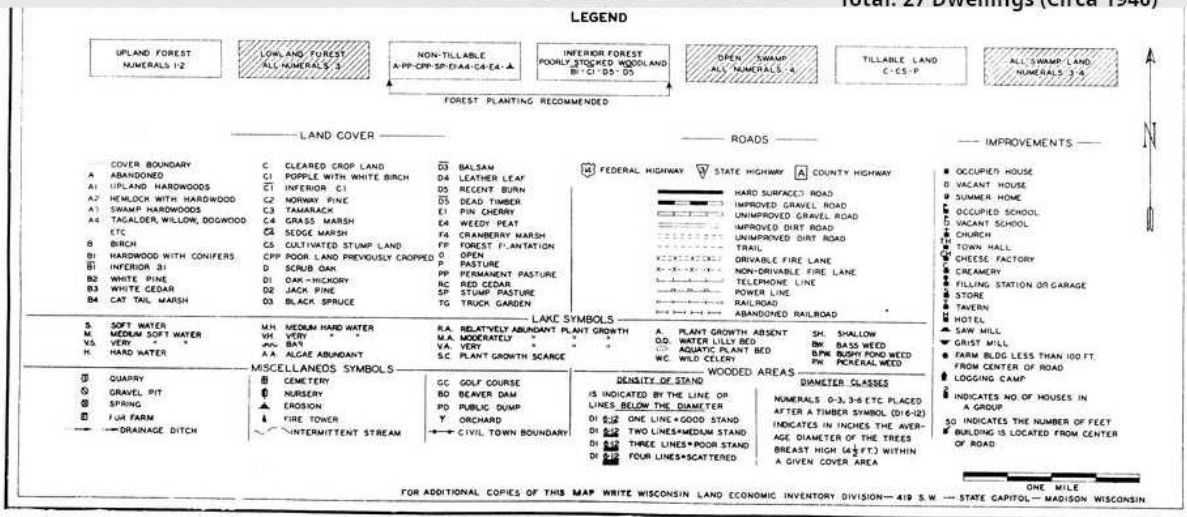
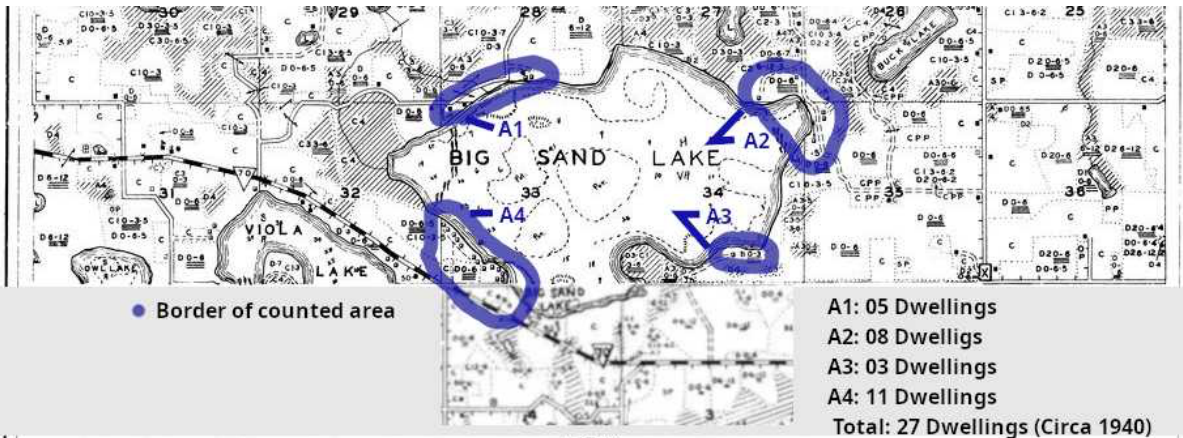


Figure 7: Composite of Wisconsin Land Economic Inventory (Bordner Survey) maps for the Town of Sand Lake and Town of Lafollette (Burnett County, Wisconsin), surveyed 1939–1941, annotated with the number of dwellings recorded in selected areas. Annotations indicate counts for clustered structures from the original field survey (Source: University of Wisconsin Digital Collections).

A 1964 historical lake map produced by the Wisconsin Conservation Department (now the Wisconsin Department of Natural Resources) for Big Sand Lake, Burnett County, was also examined. This map<sup>49</sup>, dated June 1964, used sonar recordings to generate the bathymetric contours. According to the map legend, individual dwellings are symbolized by a small filled square, while resorts are indicated by a small filled square inside a larger outlined square. Manual counts from this map indicate that 56 dwellings and 6 resorts were present on Big Sand Lake in 1964 (Figure 8).

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<sup>49</sup>Wisconsin Department of Natural Resources, "Bathymetric Map, Big Sand Lake."

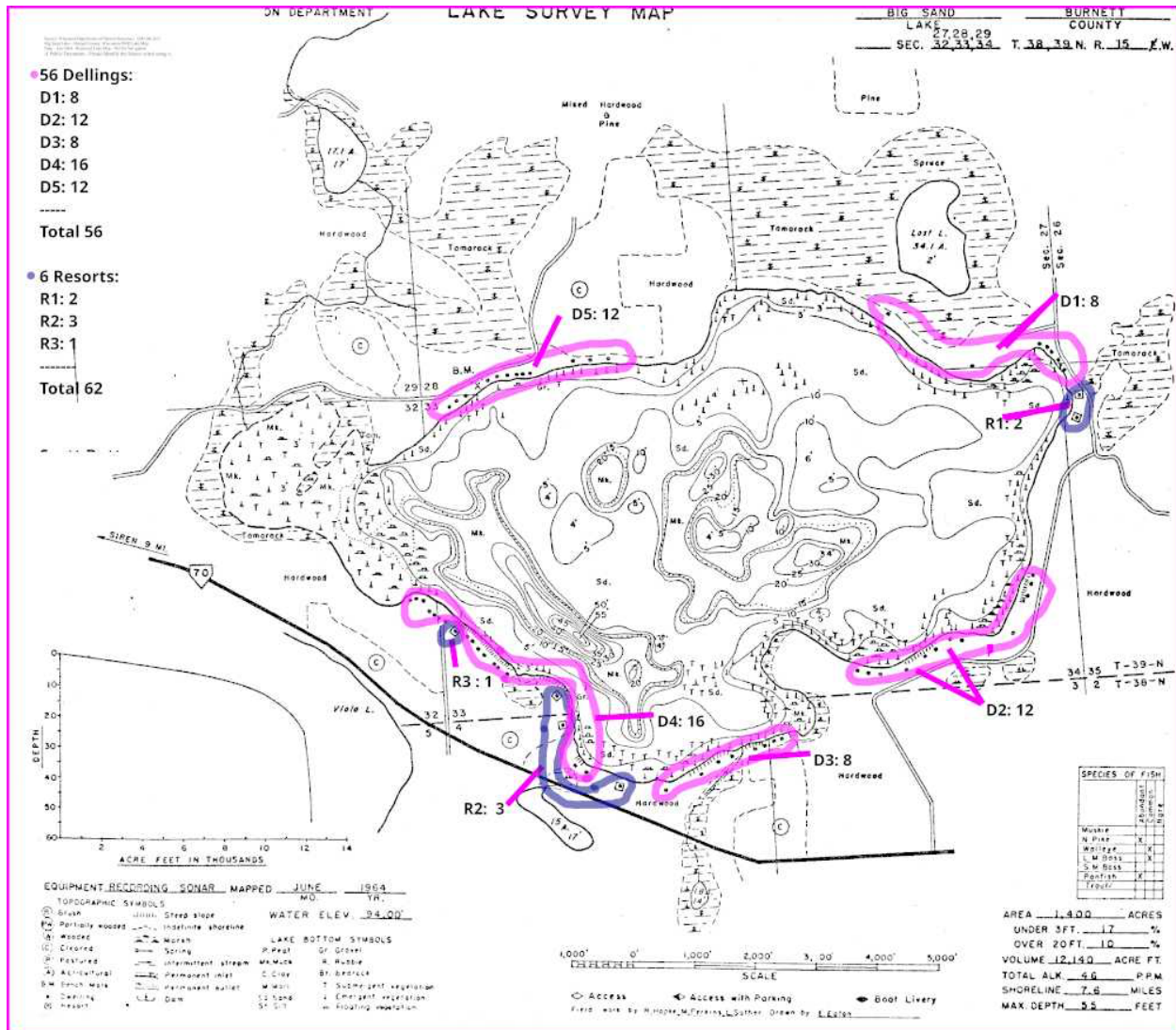


Figure 8: Annotated Wisconsin Conservation Department historical lake map of Big Sand Lake, Burnett County, Wisconsin (June 1964), with bathymetric contours from sonar soundings. Annotations show counts of dwellings and resorts in selected lakeshore sections. Dwellings are marked by a small filled square and resorts by a small filled square within a larger outlined square (original legend). Counts indicate 56 dwellings and 6 resorts in 1964. (Wisconsin Department of Natural Resources)

## Appendix B: Housing Development Analysis

### Summary Report: Reconstructing Housing Development in the Sand Lake Area Using Parcel Assessment and Sanitary Inspection Records

**Date:** April 2026

#### 1. Objective

The goal was to create a reliable timeline of dwelling construction around Sand Lake by combining modern parcel assessment records with historical map data.

Primary source used:

- Parcel assessor data (`SandLakeAssessedValues_YearBuilt.CSV`) merged with `burnett_sanitary_details.csv` (`FinalInspection` dates) to derive **PresumedBuilt** years.

#### 2. Data Processing Steps

1. **Merged** the `FinalInspection` column into the main Sand Lake parcel file using `ParcelID` as the key.
2. **Created PresumedBuilt** column:
  - Use reported `YearBuilt` when available.
  - If `YearBuilt` is blank or zero, extract the year from the `FinalInspection` date.
3. **Filtered** to parcels where `HasBuilding == True`.

4. **Aggregated** by `PresumedBuilt` year to calculate yearly new dwellings and **CumulativeDwellings** (running total).

5. **Generated outputs:**

- `Dwellings_Built_Per_Year.csv`

### 3. Key Results

The parcel-based dataset identifies 141 **dwellings** with construction-year information spanning approximately 1930–2025. this is low compared to US Census records of ~250 dwellings.

### 4. Explanation of the Mismatch

The parcel/PresumedBuilt method only captures dwellings that still exist today **and** have usable `YearBuilt` or `FinalInspection` data. Historical maps provide direct visual counts of all structures present at the time, including: - Older seasonal cabins and homes that may no longer have active assessor records. - Resorts and multi-unit properties that are often classified differently in modern tax records. - Structures that were later demolished, replaced, or merged into newer parcels. Finally, dwellings on the St. Croix Chippewa Reservation<sup>50</sup> are not visible in the tax assessment data.

The Bordner Survey and DNR 1964 map therefore serve as valuable **independent benchmarks** that reveal the limitations of relying solely on current parcel data for pre-1970 development.

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<sup>50</sup>DAT, *Land Ownership and Management*, Burnett County Land Information Office, October 30, 2008, <https://www.burnettcountywi.gov/DocumentView.aspx?DID=262>.

## 5. Files Available

- `Dwellings_Built_Per_Year.csv` – yearly counts and cumulative totals from parcel data
- `Cumulative_Dwellings_By_Year_With_Historical_Points.png` – updated chart showing both parcel trend and historical map points
- Full processed parcel file with `PresumedBuilt` column

All Python scripts available (<https://zenodo.org/records/20127391>) for reproducibility.

## Appendix C: US Census Data and Cumulative Dwellings Visualization Phase 2

**Prepared for:** Big Sand Lake Paleolimnology / Land-Use History Project (Burnett County, Wisconsin)

**Date:** April 20, 2026

### 1. Purpose of the Visualization

This report documents the final version of the cumulative dwellings chart for the watershed area surrounding Big Sand Lake (primarily Town of Sand Lake and southern Town of La Follette, with selected census blocks). The chart was developed to support paleolimnological interpretation of sediment cores by establishing precise chronological markers for residential growth, septic-system proliferation, and associated land-use changes.

The visualization integrates **four independent data streams** to reconcile discrepancies between official records and direct visual evidence. It emphasizes hand-counted structures (the most lake-specific and reliable source for visible dwellings) while retaining parcel records for comparison and adding census-block bars plus a town-adjusted model for broader context and validation.

The output is a high-resolution (300 dpi) PNG titled *Cumulative\_Dwellings.png*, generated by the script `plot_cumulative_dwellings.py`.

### 2. Data Sources

All data are loaded directly from CSV files and type-cast for plotting. Key sources, cross-referenced from project context and historical records, are:

- **Parcel/Tax Records** (`Dwellings_Built_Per_Year.csv`)

County assessor data combined with sanitary permit records (141 POWTS). Contains “PresumedBuilt” year and cumulative dwellings ( $\approx 141$  total by 2025). Omitted from plots as U.S. Census is more accurate.

*Known limitation:* Systematic undercount of St. Croix Chippewa trust lands, which are exempt from county property taxes.

- **Hand-Counted Structures** (`DwellingCountByYear.csv`)

Direct counts from USGS topographic maps, aerial photographs, and historical surveys. This is the **primary emphasized dataset**. Includes Bordner Survey,<sup>51</sup> (1939–1941: 27 dwellings) and Wisconsin Conservation Department / DNR Lake Survey Map<sup>52</sup> (June 1964: 62 total structures), aerial and satellite photos<sup>53</sup>. Updated hand counts from iterative reviews (e.g., 1955: 76, 1982: 140, 1998: 112, 2015: 129, 2020: 187, 2024: 131). Plotted as a solid green line with square markers.

*Note:* Low counts in some years reflect low-resolution photos or summer canopy obscuration, as flagged in the chart footnote.

- **Census Block Data** (`CensusOccupancyByBlocks.csv`)

Selected blocks in Tract 9704 / Block Group 1 (core shoreline blocks 1083, 1087, 1089, 1092, 1097, 1099, 1101 plus reservation blocks 1103–1105, 1112). Pulled from U.S. Census decennial sources<sup>54</sup> (1990 STF1 via NHGIS,

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<sup>51</sup>Wisconsin Department of Agriculture, “Bordner - Sand Lake”; Wisconsin Department of Agriculture, “Bordner - LaFollette.”

<sup>52</sup>Wisconsin Department of Natural Resources, “Bathymetric Map, Big Sand Lake.”

<sup>53</sup>Big Sand Lake Burnett Cty., “Google Earth”; Wisconsin State Cartographer’s Office., “Wisconsin Historic Aerial Imagery Finder.”

<sup>54</sup>U.S. Census Bureau, “Current Census Address Count Listing Files Viewer”; U.S. Census Bureau, “H1: Census Bureau Table”; Schroeder et al., “National Historical Geographic Information System.”

2000 SF1, 2010 and 2020 DHC Table H3.). Contains total, occupied, and vacant housing units. Plotted as stacked bars (blue = occupied, orange = vacant) with total labels above each bar.

*2020 adjustment (explicitly noted on chart):* Raw total of 419 was implausible relative to town trends; adjusted to Total = 248 and Vacant = 166 for consistency with broader data and prior decades.

- **Town of Sand Lake Adjusted Model** (`TSandLakeAdjustedDwellings.csv`)  
Full township housing totals scaled by total housing units  $\times 0.45$  to approximate lake-specific dwellings. Plotted as a dotted red line with triangle markers (labeled "TOWAN ORDINANCE RESTRICTING CERTAIN ARTIFICIAL WAKE ENHANCEMENTn of Sand Lake Adjusted Model ( $\text{Pop} \times 0.45$ )").

### 3. Chart Development and Script Methodology

The script `plot_cumulative_dwellings.py` represents the culmination of iterative refinements:

- Early versions focused primarily on parcel records with hand-counted points added as discrete anchors.
- Subsequent iterations shifted emphasis to hand-counted data (green line), grouped Bordner/DNR surveys into the hand-counted series, removed separate historical legend entries, and connected all points with a solid line.
- Final enhancements (this version): added census-block stacked bars for occupancy/vacancy detail, incorporated the town-adjusted model for contextual validation, and included a left-side "Development Summary" table (decadal estimates 1940–2020) plus a detailed footnote explaining the 2020 adjustment and hand-count limitations.

**Technical workflow (script summary):** 1. Load and clean all four CSVs (pandas). 2.

Create a single Matplotlib axis (16 × 10.8 inches). 3. Plot each series with distinct styling (colors, markers, line weights, alpha transparency). 4. Add bar totals, legend (upper left), development summary text box (monospace, inside plot area), and italicized footnote (bottom center, wheat background). 5. Set title, labels, limits (x: 1930–2026; y: 0–300), grid, and rotated x-ticks. 6. Export at 300 dpi with tight bounding box.

#### 4. Key Features of the Final Chart

- **Primary emphasis:** Green hand-counted line (most accurate lake-specific record).
- **Secondary comparison:** Light-blue parcel line (de-emphasized).
- **Occupancy detail:** Stacked census bars showing high vacancy (seasonal/recreational character; mean occupancy 1990–2020  $\approx$  40 % as noted in summary table).
- **Contextual benchmark:** Dotted red town-adjusted model.
- **Transparency elements:** Summary table (1940: 27 → 2020: 248), explicit 2020 adjustment note, and footnote on data caveats.

#### 5. Interpretation and Project Relevance

The chart clearly illustrates the systematic divergence between parcel records (under-count) and visual/hand-counted + census sources. This supports the hypothesis that tribal trust lands are largely absent from tax records. Growth was modest and episodic, consistent with post-WWII recreational development, highway improvements, and the area's strongly seasonal nature (high vacancy). These timelines provide reliable markers for sediment-core analysis—e.g., correlating dwelling increases with nutrient/pollutant inputs from septic systems (46 % conventional, 8 % reclassified cesspool, 21 year-round homes).

The visualization resolves earlier data gaps (1970–1990) by anchoring to the 1964 DNR map and extending hand counts forward, while the adjusted town model offers an independent check against full-township trends.

## **6. Conclusion and Recommendations**

The script `plot_cumulative_dwellings.py` and resulting chart represent the current “best-available” synthesis of dwelling data for Big Sand Lake.

## **Appendix D: Big Sand Lake Tax Record/Permit Analysis**

Scott D. Button

This report provides an overview of the methodology and findings related to the analysis of year-round homes with sanitary systems around Big Sand Lake. The objective was to identify properties with year-round occupancy and assess their sanitary system permits, leveraging geographic data, property records, and automated permit extraction processes. This work will develop a land-use history for structures around the lake, which will be an input to a paleolimnology study.

### ***Methodology***

#### 1. Data Collection and Sources:

- Geographic Data: A map of Big Sand Lake and surrounding areas (e.g., Viola Lake) was used to identify relevant parcels, with sections labeled (e.g., 26, 27, 33, 34, 35).

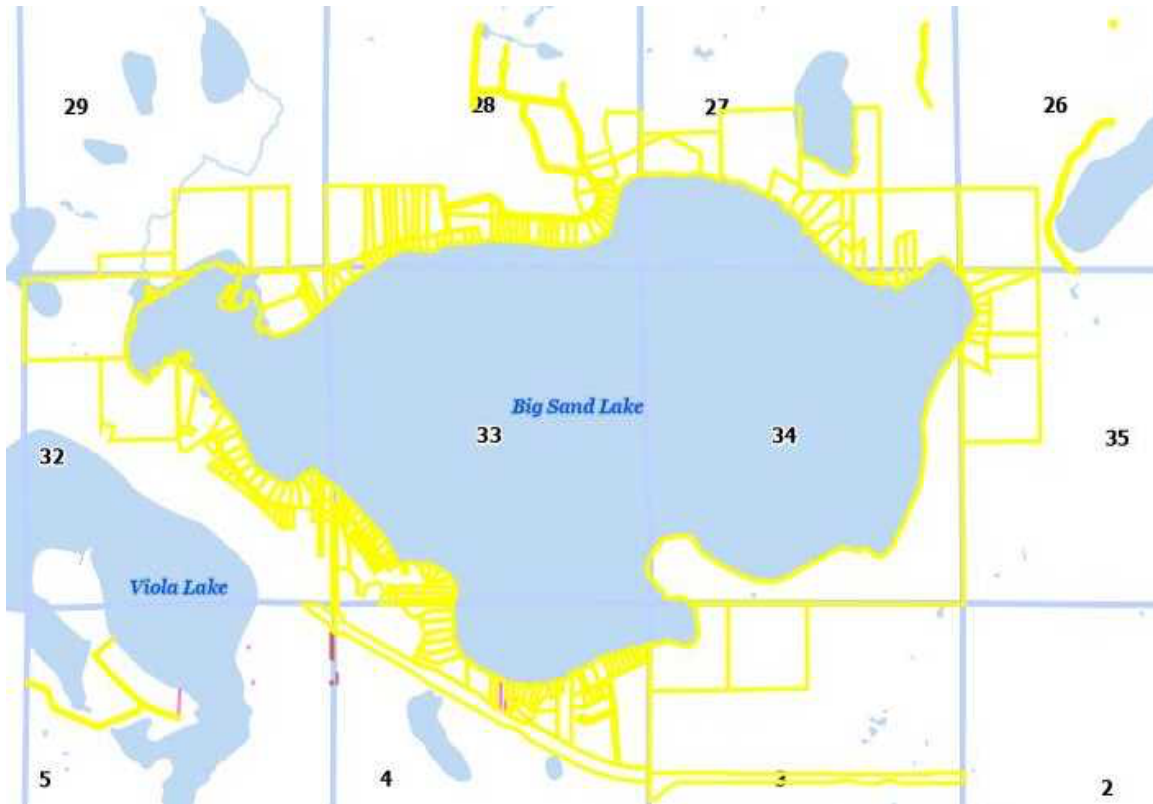


Figure 9: Selected Properties, 400 Foot Buffer Select Method

- Buffer Select method on the Burnett County Website was used to draw a line on the map 400 feet inshore of Big Sand Lake, which intersected the properties shown in Figure 9. The 400 foot buffer was used to generally align with tax parcels selected to include the Big Sand Lake near-watershed. This enabled the download of 400Ft-BufferBigSand.xlsx from:  
<https://beacon.schneidercorp.com/Application.aspx?AppID=1195>
- 400FtBufferBigSand.xlsx has 236 records. The records show parcel IDs, property addresses, owner information, and assessed values for properties in the Town of Sand Lake and Town of La Follette. The properties are primarily along Birch Haven Rd, S Basswood Dr, Spencer Ln, and Sand Lake Rd.

- Using Python3 script "beacon\_enrich.py", Has\_House\_Cabin was inferred when building value in the tax records was greater than \$5000. 137 of 236 (58%) of the parcels met this criterion.
- Full time properties were inferred where the owner address was at or near the property address, using update\_primary\_residence.py. The result is 24 (10%) of the 236 parcels have inferred full-time homes.
- Permit Data: Using those parcel id's, a Python script ("scrape\_permit-s.py") was developed to automate the extraction of permit documents from the Burnett County website <https://web.burnettcounty.org/WebLink/Search.aspx> using Selenium. The script searched by parcel ID, downloaded PDFs, and logged the process, handling duplicates and errors.

## 2. Data Processing:

- An R script ("PermitAnalysis.R.txt") processed the downloaded PDFs using the pdftools and tesseract libraries for text extraction and Optical Character Recognition (OCR) where needed. It extracted:
  - Parcel ID: Identified from text or filenames using regex patterns (e.g., "07-026-2-39-15-28-5 05-001-026000").
  - Permit Date: Parsed from text using multiple date formats (e.g., MM/DD/YYYY, MMM DD, YYYY).
  - System Type: Classified as "Holding Tank" or "Septic with Drain-field" based on keywords, with "Unknown" as a fallback.
- The script matched permits to year-round homes, aggregated results, and saved them to "year\_round\_homes\_with\_systems\_sorted.csv".
- This analysis was later updated with a larger dataset, and to use Python scripts, "scrape\_san\_permits.py", "summarize\_system\_type-

s.py” rather than R.

### 3. Analysis:

- The methodology focused on lakefront properties, filtering PDFs for sanitary-related content. Unmatched or non-sanitary PDFs were logged for further review.
- Results were merged with the initial property dataset to provide a comprehensive view of system installations.

### ***Findings***

- Total Year-Round Homes: 24 properties were identified as year-round residences around Big Sand Lake, all with local owners based on the data.
- Key Locations: Properties are concentrated along Birch Haven Rd (e.g., 25099, 25131, 25202), S Basswood Dr (e.g., 4687, 4713, 4747), Spencer Ln (e.g., 4837, 4841, 4851), and Sand Lake Rd (e.g., 5063, 5160, 5260).
- Assessed Values: Range from \$1,000 to \$901,600, with higher values indicating developed properties.
- Two citations (violations) were found. One for an unpermitted structure, the other for removing too much lakeshore vegetation at a property off Birch Haven Road.
- Jan 17, 2015 - a Conditional Permit was GRANTED to reopen Bir Oaks Resort with a convenience store, bait shop, bar and restaurant on Big Sand Lake, located at 25131 and 25079 Birch Haven Road. Bir Oaks was established in 1946 is seasonal, and the permit discusses opening two rental cabins.

## Appendix E: Sanitary Permit Analysis

### Septic System Summary Report

### Big Sand Lake Paleolimnology Study – Burnett County, Wisconsin

Date: April 27, 2026

#### 1. Purpose

This report summarizes the septic (POWTS) systems serving properties around Big Sand Lake, based on a complete scrape of Burnett County's public permit database. The primary goal is to classify current and historical septic infrastructure by **SystemType** for correlation with sediment-core phosphorus profiles, diatom records, and lake trophic history. Special attention was given to older or undocumented systems that may have functioned as cesspools.

#### 2. Data Collection & Processing

- **Source:** All sanitary permits linked to the parcels in `400ftBuffer-BigSand.csv` were extracted directly from the Burnett County Ascent Permit Management System (<https://web.burnettcounty.org>).
- **Scraper:** A custom Selenium + BeautifulSoup hybrid script navigated the search form, opened each sanitary permit detail page, expanded the **Powts System** and **Maintenance** accordions, and extracted key fields.
- **Key fields captured:**
  - `SystemType` (official dropdown value)
  - Installer, Design Flow, Soil Application Rate, Final Inspection date, Status
  - Full maintenance pumping history (Service Date, Gallons, Company)
- **Post-processing** (applied in `summarize_system_types.py`):
  - Any record listed as **"Unknown"** that contained actual maintenance/pumping records was automatically reclassified as **"Cesspool"**. This re-

flects the historical reality that many pre-1970s systems in northern Wisconsin were simple cesspools that were pumped rather than replaced.

- A `P_Load_Category` column was assigned to each record (Very Low / Low-Medium / Medium-High) for future phosphorus-loading modeling.

### 3. Results – System Type Distribution

| SystemType                               | Count      | % of Total  | Typical P-Loading Risk |
|------------------------------------------|------------|-------------|------------------------|
| Conventional (Non-Pressurized In-Ground) | 61         | 43%         | Medium-High            |
| Mound                                    | 27         | 19%         | Low-Medium             |
| Holding Tank                             | 24         | 17%         | Very Low               |
| <b>Cesspool</b> (reclassified)           | <b>13</b>  | <b>09%</b>  | <b>Medium-High</b>     |
| Pit Privy                                | 9          | 06%         | Very Low               |
| Unknown (no maintenance)                 | 3          | 02%         | Medium-High            |
| Conventional w/ Lift                     | 2          | 01%         | Low-Medium             |
| In-Ground Pressure                       | 1          | 0.7%        | Low-Medium             |
| Privy (Sealed Vault)                     | 1          | 0.7%        | Very Low               |
| <b>Total</b>                             | <b>141</b> | <b>100%</b> | —                      |

### 4. Key Observations

- **Dominant system:** Nearly half (43%) of all sanitary systems are conventional in-ground systems — the type most likely to contribute phosphorus to the lake via groundwater once soil adsorption capacity is saturated (typically after 20–30 years).
- **Advanced systems:** Mound systems (19%) represent modern replacements on marginal lakeshore soils and carry lower long-term P risk.
- **Cesspool signal:** 13 permits were reclassified from “Unknown” to “Cesspool” because they had documented pumping records. These older systems are of particular interest to the paleolimnology study because they often discharged partially treated effluent directly to soil or shallow groundwater.

- **Very-low-risk systems:** Holding tanks + privies together account for 25 permits (18%).
- **Maintenance data:** 5 of the 10 reclassified cesspools (and many conventional systems) have multi-decade pumping histories, giving confidence in the reclassification.

## 5. Implications for Paleolimnological Interpretation

The distribution provides a spatially explicit inventory of potential phosphorus sources around Big Sand Lake. Conventional and cesspool systems (combined ~52%) are the most probable historical contributors.

**Files generated:** - `burnett_sanitary_details.csv` — raw + cleaned data (141 sanitary records) - `system_type_summary.csv` — contains results table.

## Appendix F: Wild Rice (Manoomin)

### Regional context and variability

Nearby Upper Clam Lake (WBIC 2656200) is historically the top producer of wild rice in Wisconsin, with over 47K lbs of green rice harvested between 1992 and 2015. However, the rice beds were devastated in 2007<sup>55</sup>. “Evidence suggests the decline occurred when carp (present in the system for decades) markedly increased following a blue-gill die-off; blue-gills are effective predators of carp eggs.”<sup>56</sup>

Wild rice can vary dramatically from year to year and appears to follow a roughly four-year boom-and-bust cycle. In contrast with the carp increase, hydrological changes are often the main cause of loss of wild rice beds, as flowing water is important for abundance.<sup>57</sup>

### Big Sand Lake history and current status

A Great Lakes Indian Fish and Wildlife Commission publication described Big Sand Lake (WBIC 2676800) as “a bit of an enigma at this time.” It was added to the list of waters whose harvest is data-regulated in 1985, but recent stands have been very limited and historical abundance is poorly documented. Both the inputs and outputs of the lake appear to have been altered hydrologically. Reconstruction of the historic presence of manoomin on this water—and determination of whether restoration is needed and feasible—remains a priority.

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<sup>55</sup>P. David et al., “Manoomin.”

<sup>56</sup>Johnson, “Wild Rice Seed Enumeration Report: 2009-2010 Upper Clam Lake, Lower Clam Lake, Long Lake, and Clam River Flowage.”

<sup>57</sup>P. David et al., “Manoomin.”

The St. Croix Tribe, whose reservation includes frontage on the lake, conducted an intensive survey in 2009 and mapped 11.6 acres of rice in two beds (one on the north side of the most northeastern bay and one in the small bay east of the peninsula on the south shore). In the fall of 2009 they also planted 510 pounds of seed in the shallow bay near the outlet on the west side of the lake, where the larger historical beds reportedly occurred. According to anecdotal information, water levels may have been altered when a culvert was re-set on the outlet stream. It remains to be seen whether seeding alone will allow these historic beds to be re-established<sup>58</sup>.

### **Satellite remote sensing (2015–2025)**

Figure 9 shows persistent wild-rice beds derived from Sentinel-1 satellite imagery (Great Lakes Indian Fish and Wildlife Commission remote sensing database). According to Austen Hilding, Wetland Ecologist with the Great Lakes Indian Fish and Wildlife Commission<sup>59</sup>:

*"...attached is a rough map from our remote sensing database (which is still being fine-tuned and may show some "false positives" but should provide some valuable perspective on distribution). This dataset uses satellite imagery from sentinel 1 that dates back to 2015...". "The darker the blue color on the map indicates that rice was present in that location more often across the years and thus its presence at that location is more resilient and less variable annually."*

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<sup>58</sup>Hilding to scott.d.button@gmail.com et al., "Manoomin Satellite Imagry."

<sup>59</sup>Hilding to scott.d.button@gmail.com et al., "Manoomin Satellite Imagry."



Figure 10: Sentinel 1 satellite imagery overlaid on Big Sand Lake map by Great Lakes Indian Fish and Wildlife Commission showing persistent wild-rice beds. The information provided by GLIFWC's internal remote sensing is subject to change as the application is in the preliminary stages of development and the model may be fine-tuned after further seasons of ground-truthing manoomin distribution results.

## Management considerations

The Manoomin guide provides clear guidance on restoration efforts:

### Seeding:

*"You should not seed a site that has produced a crop within the past 8-10 years. On these sites it is possible that a viable seed bank still exists, but some other negative factor is affecting the rice. Perhaps a beaver dam has raised water levels, a downstream culvert was altered or the carp population has markedly increased. In these instances, it is best to try to determine and address the factor causing the decline, and give the remnant seed bank a chance to reestablish the bed before considering seeding. In some instances, it may be worthwhile to collect sediment samples to verify the presence or absence of a manoomin seed bank."*

### **Fall planting is recommended:**

*"Fall planting is recommended, to allow the seed to overwinter in the sediments and naturally break its dormancy. The easiest option is to plant the seed within a couple of days of getting it. Immediate seeding is often the least amount of work, but it may have the drawback that some seed may be consumed by ducks or other animals during the remainder of the fall. For this reason, some people store the rice as described below, and plant it later in the fall when most of the duck migration has passed."*

There is some evidence that plowing the snow off sections of ice over rice beds helps them out-compete perennial vegetation<sup>60</sup>.

### **Paleolimnological Interpretation**

Plant phytoliths are silica bodies ranging from 5 to 200  $\mu\text{m}$  in size. When plant material decomposes, phytoliths are released to the sediment layers<sup>61</sup>. Wild rice phytoliths are a reliable tool for wild rice detection in paleolake sediments.<sup>62</sup>

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<sup>60</sup>P. David et al., "Manoomin."

<sup>61</sup>Yost, "Phytolith Evidence for the Presence and Abundance of Wild (Zizania Palustris) from Central Minnesota Lake Sediments."

<sup>62</sup>Yost et al., "Detecting Ancient Wild Rice (Zizania Spp. L.) Using Phytoliths."

## **Appendix G: State Trunk Highway (STH) 70 Timeline**

**Report: Timeline of Major Highway Development for State Trunk Highway 70**

**(STH 70) Near Big Sand Lake, Burnett County, Wisconsin**

**Prepared for Paleolimnological Sediment Core Analysis**

**Date: April 2026**

### **Executive Summary**

State Trunk Highway 70 (STH 70 / WIS 70) is the primary east-west state highway directly adjacent to or bordering Big Sand Lake in the Town of La Follette, Burnett County, Wisconsin (near Siren and Webster). The lake lies along the highway corridor in eastern Burnett County, with public access and shoreline properties tied to STH 70.

The major developmental milestones for STH 70 relevant to paleolimnological interpretation occurred in the **1917–1935 period**: - **1917**: Official designation and integration into Wisconsin’s statewide State Trunk Highway System, including initial grading and assumption of existing local road segments (particularly the section east of Grantsburg in Burnett County). - **Early 1920s**: Route extension and improvements eastward through Burnett County. - **1935**: Initial paving (bituminous/asphalt surfacing) in sections, marking a shift to higher traffic volumes, vehicle-related pollutants (e.g., lead from leaded gasoline), and altered runoff/erosion patterns.

These events align with Wisconsin’s “Good Roads” movement and the 1917 creation of the 5,000-mile numbered state highway system. They provide strong chronological markers for sediment cores, as highway construction/grading increases erosion and sediment deposition, while paving introduces anthropogenic markers (hydro-

carbons, metals, increased dust/traffic runoff). Later 20th-century maintenance and modern reconstructions (e.g., 2020s roundabout at STH 35/70 in Siren) are too recent for most paleolimnological contexts.

### **Location Context**

Big Sand Lake (approx. 1,434 acres, max depth 55 ft) is located in Burnett County, with STH 70 serving as the main access corridor. The highway runs east from the St. Croix River at Grantsburg, through Siren (intersection with STH 35), and continues eastward past the lake area. Pre-highway development relied on local unimproved roads; STH 70 transformed regional access, tourism, and land use around the lake.

### **Historical Development Timeline of STH 70 (Focus on Burnett County Segment)**

- **Pre-1914 / Early Local Roads:** Portions of the future STH 70 route east of Grantsburg in Burnett County existed as unimproved local roads. Much of the overall corridor remained unbuilt or rudimentary.
- **1917:** Key designation year. A short stub connecting WIS 35 (near the Siren/ Grantsburg area) to Grantsburg was officially assumed into the state system and designated WIS 70 under Chapter 175, Laws of 1917. This coincided with the establishment of Wisconsin's 5,000-mile State Trunk Highway System. Signage was erected statewide in 1918. Initial grading and improvements likely occurred as part of county/state efforts to create a connected network. The Burnett County segment (including areas near Big Sand Lake) was part of this early corridor.
- **Early 1920s:** The route was extended eastward (reaching Eagle River by the early 1920s). The Burnett County portion saw continued upgrades as part of

the expanding system. The highway remained gravel/unpaved.

- **1929–1931:** The western terminus was formalized at the new toll bridge over the St. Croix River (opened 1929); the highway was officially extended west to this point in 1931.
- **1935:** Paving (bituminous surfacing) began in some sections of STH 70. This represented a major upgrade from gravel, increasing traffic capacity, vehicle speeds, and associated runoff/pollutants. Statewide, the highway commission pursued bituminous surfaces on the trunk system (noted more broadly around 1937).
- **1940s–1950s and Later:** Eastern extensions (to Florence by 1956) and redesignations occurred, but these are east of Burnett County. Post-WWII paving and maintenance continued, with modern projects (e.g., mill-and-overlay, roundabout at STH 35/70 in Siren) in the 21st century. These are not relevant to historical sediment markers.<sup>63</sup>

### **Relevance to Paleolimnology and Sediment Core Studies**

Sediment cores from Big Sand Lake can use STH 70 development as a reliable dating horizon: - **~1917–1920s (Designation & Grading):** Increased construction activity, roadbed preparation, and erosion from cut-and-fill work would elevate clastic sediment input and possibly alter pollen or nutrient signals. This aligns with the statewide “Good Roads” push and federal aid for rural roads. - **~1935 (Paving):** Introduction of asphalt/bituminous materials, combined with rising automobile use (and leaded gasoline from the 1920s onward), provides geochemical markers (e.g., PAHs, lead, zinc). Higher traffic volumes increase dust, salts, and runoff, often de-

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<sup>63</sup>*Wikipedia*, “Wisconsin Highway 70”; “Wisconsin Highways: Historical Overview,” accessed May 12, 2026, [https://www.wisconsinhighways.org/historical\\_overview.html](https://www.wisconsinhighways.org/historical_overview.html); “Wisconsin Department of Transportation Transportation Timeline.”

tectable in lake sediments. - Cross-validation with other markers (e.g., Pb-210, Cs-137 for recent layers; industrial signals or pollen shifts) is recommended. Pre-1917 local roads had minimal impact compared to the state trunk system upgrade.

No lake-specific “Big Sand Lake Road” construction events were identified beyond the STH 70 corridor; county highways (e.g., CTHs) may have fed into it but were secondary.

### **Conclusions and Recommendations**

The primary “major highway development” around Big Sand Lake occurred between **1917 (state designation/initial improvements)** and **1935 (paving)**.

## Appendix H: Key Events in Wisconsin Forest History

|      |                             |      |                                     |
|------|-----------------------------|------|-------------------------------------|
| 1854 | Tribal Reservations         | 1934 | Avoiding drought                    |
| 1910 | Early Fire Protection       | 1935 | Protection of Wisconsin groups      |
| 1905 | State Borough of Farming    | 1938 | Use of light aircraft to spot fires |
| 1920 | Rail transportation         | 1944 | Forest Rangers were hired           |
| 1914 | Cultivation of fruit trees  | 1947 | Timberland owners now profited      |
| 1915 | State forests formed        | 1955 | Pulp production for paper           |
| 1920 | Farms closed by drought     | 1953 | Size limits on panfish              |
| 1927 | Free land available         | 1950 | Tax breaks for woodland owners      |
| 1928 | Plans for cutover land      | 1954 | Small forest owners assisted        |
| 1933 | Civilian Conservation Corps | 1957 | Resorts on Big Sand Lake            |
| 1934 | Trees planted in open rows  | 1960 | Hardwoods can grow in shade.        |
| 1950 | Smokey the bear on fires    | 1954 | Livestock removed from forests      |

Table compiled by D.K. Button, September 2025 from One Hundred Years of Wisconsin Forestry<sup>64</sup>.

<sup>64</sup>Wisconsin Woodland Owner's Association, *One Hundred Years of Wisconsin Forestry, 1904-2004* (Trails Custom Pub., 2004).

## Bibliography

- An Ordinance Restricting Certain Artificial Wake Enhancement, Pub. L. Nos. 2024–01, 3 (2024). <https://townofscottwi.org/ordinances-resolutions/>.
- Applegath, Chip. *BSLA Board Meeting Minutes*. Big Sand Lake, Burnett County, 2024. <https://www.bigsandlakewi.org/wp-content/uploads/2025/01/BSLA-Board-Meeting-Minutes-18Dec2024-1.pdf>.
- Applegath, Chip. *BSLA Board Meeting Minutes*. Big Sand Lake, Burnett County, 2025. <https://www.bigsandlakewi.org/wp-content/uploads/2025/07/BSLA-Board-Mtg-Minutes-07Jun2025.pdf>.
- Association, Wisconsin Woodland Owner's. *One Hundred Years of Wisconsin Forestry, 1904-2004*. Trails Custom Pub., 2004.
- Big Sand Lake, Burnett County. "Google Earth." 2024. [https://earth.google.com/web/search/Big+Sand+Lake,+Burnett+County,+WI/@45.82376775,-92.2224791,298.23642396a,6480.0366703d,35y,0h,0t,0r/data=CpABGmISXAolMHg1MmFkOTVIY2U1N2U0NDczOjB4ZjgwZjc3ZDhhMGQ3ZmM0Mhn79OnCWelGQCEWN8nqMQ5XwCohQmlnIFNhbmgqTGFrc3ZSwgQnVybmgV0dCBDb3VudHksIFdJGAIGASImCiQJ\\_D3405KKNUAR\\_D3405KKNCaZDXi04SvFSUAhbogMG-ANSsBCAggBOgMKATBCAggASg0I\\_\\_\\_\\_\\_ARAA](https://earth.google.com/web/search/Big+Sand+Lake,+Burnett+County,+WI/@45.82376775,-92.2224791,298.23642396a,6480.0366703d,35y,0h,0t,0r/data=CpABGmISXAolMHg1MmFkOTVIY2U1N2U0NDczOjB4ZjgwZjc3ZDhhMGQ3ZmM0Mhn79OnCWelGQCEWN8nqMQ5XwCohQmlnIFNhbmgqTGFrc3ZSwgQnVybmgV0dCBDb3VudHksIFdJGAIGASImCiQJ_D3405KKNUAR_D3405KKNCaZDXi04SvFSUAhbogMG-ANSsBCAggBOgMKATBCAggASg0I_____ARAA).
- Burnett County Homemakers Clubs. *Pioneer Tales Of Burnett County, Wisconsin*. Dan-Web Printing Co., 1830. Reprint, Higginson Book Company, 1976. <https://genealogytrails.com/wis/burnett/pioneertales.html>.
- Button, D. K. "Lake Levels." *The Sand Lake Observer* (Big Sand Lake, Burnett County) 2, no. 4 (2017): 11.
- Button, D. K. "Nine Years of Progress." *The Sand Lake Observer* (Big Sand Lake, Burnett County) 3, no. 1 (2018): 10.
- Button, D. K. "Properties of the Lake along with Some Possible Restorations." *The Sand Lake Observer* (Big Sand Lake, Burnett County) 1, no. 1 (2009): 3.
- Button, D. K. "Science-Based Stewardship." *The Sand Lake Observer* (Big Sand Lake, Burnett County) 4, no. 2 (2019): 1.
- Button, D. K. "System Health." *The Sand Lake Observer* (Big Sand Lake, Burnett County) 2, no. 3 (2015): 11.

- Button, D. K. "The Draw of Big Sand." *The Sand Lake Observer* (Big Sand Lake, Burnett County) 1, no. 4 (2012): 1.
- Button, D. K. "Wild Rice--Can Big Sand Rebound?" *Lakelines Newsletter* 16, no. 1 (2011). [//bclra.org/lakelines/](https://bclra.org/lakelines/).
- Button, Scott. *Trajectory of Northern Pike and Bluegill Length and Biomass in a Wisconsin Lake, 1966–2022: Supplementary Materials*. May 18, 2026. <https://doi.org/10.5281/zenodo.20270807>.
- DAT. *Land Ownership and Management*. Burnett County Land Information Office, October 30, 2008. <https://www.burnettcountywi.gov/DocumentView.aspx?DID=262>.
- Fagan, Brian. *Fishing: How the Sea Fed Civilization*. Yale University Press, 2017.
- Graphics – Manoomin Education and Outreach Project. n.d. Accessed April 30, 2026. <https://seagrant.wisc.edu/manoomin/literature-background/>.
- Johannes, S. *Basic Fish Inventory, Big Sand Lake, Burnett County*. Correspondence/Memorandum Nos. 3610–1. State of Wisconsin, 1984.
- Johnson, J. A. "Wild Rice Seed Enumeration Report: 2009-2010 Upper Clam Lake, Lower Clam Lake, Long Lake, and Clam River Flowage." Prepared for SEH / Freshwater Scientific Services, LLC., 2010.
- Kaeding, Danielle. "Wake Boat Owners Sue Northern Wisconsin Town to Overturn Ban on Wake Surfing." *WPR*, May 30, 2025. <https://www.wpr.org/news/wake-boat-owners-sue-northern-wisconsin-town-to-overturn-ban-on-wake-surfing>.
- P. David et al. "Manoomin." Great Lakes Indian Fish and Wildlife Commission, 2019.
- "[Public Land Survey System Map: Wisconsin Township 39 North, Range 15 West] - UWDC - UW-Madison Libraries." 1856. <https://search.library.wisc.edu/digital/ALFAOL34SRQGWN8D>.
- Roberts, Craig. *Fisheries Survey Report for Big Sand Lake, Burnett County, WI 2022*. Waterbody Code 2676800. Wisconsin Department of Natural Resources, 2023.
- Rypel, Andrew L., John Lyons, Joanna D. Tober Griffin, and Timothy D. Simonson. "Seventy-Year Retrospective on Size-Structure Changes in the Recreational Fisheries of Wisconsin." *Fisheries* 41, no. 5 (2016): 230–43. <https://doi.org/10.1080/03632415.2016.1160894>.

- Schroeder, Jonathan, David Van Riper, Steven Manson, et al. "National Historical Geographic Information System: Version 20.0." Version 20.0. With U.S. Census Bureau, Interuniversity Consortium for Political and Social Research (ICPSR), U.S. Public Health Service, et al. Minneapolis, MN: IPUMS, 2025.  
<https://doi.org/10.18128/D050.V20.0>.
- Sears, Edgar. "Section Line : T39N R15W; Between Sections 27 and 28 (North)." September 1855.  
<https://digicoll.library.wisc.edu/cgi-bin/SurveyNotes/SurveyNotes-idx?type=article&byte=38384491&twp=T039NR015W>.
- Steenbock Library Digital Collections, University of Wisconsin–Madison Libraries. "Wisconsin Land Economic Inventory Maps (The Bordner Survey)." 1941 1939. <https://www.library.wisc.edu/steenbock/collections/wisconsin-land-economic-inventory-the-bordner-survey-land-cover-maps/>.
- "Township 39 N, Range 15 W, Town of Sand Lake" Burnett County Plat Book." 1915.  
<https://sites.rootsweb.com/~wiburnet/platbook/39n15w.htm>.
- United States and Wisconsin. *A History of Wisconsin Highway Development 1835-1945*. State Highway Commission, 1947.  
<https://catalog.hathitrust.org/Record/102497463>.
- U.S. Census Bureau. "Current Census Address Count Listing Files Viewer." U.S. Census Bureau, 2025.  
<https://mtgis-portal.geo.census.gov/arcgis/apps/webappviewer/index.html?id=c754be823d6342949a4c50e519eb87be>.
- U.S. Census Bureau. "H1: Census Bureau Table." HOUSING UNITS, U.S. Census Bureau, 2010. <https://data.census.gov/table/DECENNIALSF12010.H1?q=ZCTA5+37312+Housing>.
- USGS Topoview. "Hertel, Wi 1948 1:48000." 1948.  
<https://ngmdb.usgs.gov/maps/topoview/viewer>.
- Wisconsin Department of Agriculture. "Town of Lafollette - UWDC - UW-Madison Libraries." Wisconsin Land Economic Inventory (Bordner Survey), 1941 1939.  
<https://search.library.wisc.edu/digital/A6XZXKC6JCQS4I9C>.
- Wisconsin Department of Agriculture. "Town of Sand Lake - University of Wisconsin Digital Collections - UW-Madison Libraries." Town of Sand Lake, 1941 1939.  
<https://search.library.wisc.edu/digital/AYRXYEV6CECWID85>.
- Wisconsin Department of Natural Resources. "Wisconsin Conservation Department

- Lake Survey Map." June 1964.  
<https://apps.dnr.wi.gov/lakes/lakepages/LakeDetail.aspx?wbic=2676800>.
- "Wisconsin Department of Transportation Transportation Timeline." Accessed May 12, 2026. <https://wisconsindot.gov/Pages/about-wisdot/who-we-are/dept-overview/transp-timeline.aspx>.
- "Wisconsin Highways: Historical Overview." Accessed May 12, 2026.  
[https://www.wisconsinhighways.org/historical\\_overview.html](https://www.wisconsinhighways.org/historical_overview.html).
- Wisconsin State Cartographer's Office. "Wisconsin Historic Aerial Imagery Finder." 1938. <https://maps.sco.wisc.edu/whaifinder/>.
- Yost, C. L., M. S. Blinnikov, and M. L. Julius. "Detecting Ancient Wild Rice (*Zizania* Spp. L.) Using Phytoliths: A Taphonomic Study of Modern Wild Rice in Minnesota (USA) Lake Sediments." *Journal of Paleolimnology* 49, no. 2 (2013): 221–36.  
<https://doi.org/10.1007/s10933-012-9670-x>.
- Yost, Chad. "Phytolith Evidence for the Presence and Abundance of Wild (*Zizania Palustris*) from Central Minnesota Lake Sediments." Master of Science, St. Cloud State University, 2007.