Aquatic Macrophyte Survey

Lake Nancy, Washburn County Wisconsin
WBIC: 2691500
August 2008

Sponsored by: Lake Nancy Lake Protection Association and Wisconsin Dept. of Natural Resources

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Abstract

A macrophyte survey was conducted on Lake Nancy starting July 29 and ending August 5 2008. There were 701 points in the sample grid. Of the points sampled, 425 had vegetation or 60.6%. There were 47 species of macrophytes sampled on the rake and an additional 7 species viewed, for a total of 54 species. One species sampled is a species of special concern, Eleocharis robbinsii (Robbin's spikerush). Of these 54 species one was non-native Eurasian water milfoil. This non-native plant was sampled or viewed in 45 sample points. The FQI calculated for Lake Nancy was very high at 44.62, which is much higher than the median for lakes studied in this same eco-region. Lake Nancy has a very diverse and robust aquatic plant community. The two southern bays contain a wide diversity of plants and virtually no Eurasian water milfoil. The larger deeper portions of the lake had less litoral zone and therefore less diversity. Most of the Eurasian water milfoil was located in these two areas.

Introduction

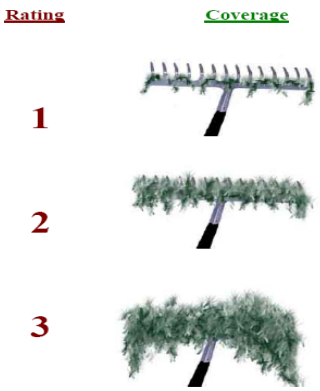
In June and August 2008, an aquatic macrophyte survey was conducted on Lake Nancy (WBIC: 2691500), in Washburn County Wisconsin (T42N R13W S33 NE SW). Lake Nancy is a 772-acre lake with a maximum depth of 38 feet. Development around the lakes is limited with much of the lakeshore not extensively developed and/or disturbed from an original native riparian zone.

This report presents a summary and analysis of data collected in a baseline aquatic macrophyte survey. The primary goal of the survey is to establish a baseline for long-term monitoring of aquatic plant populations and allow for the evaluation of any changes that may occur long-term. In addition, invasive species presence and locations are key components to a survey of this type. This survey is acceptable for aquatic plant management purposes.

Field Methods

A point intercept method was employed for the macrophyte sampling. The Wisconsin Department of Natural Resources (Wisconsin DNR) generated the sampling point grid of 701 points for Lake Nancy. Only points shallower than 25 feet were initially sampled until the maximum depth of plants could be established. If no plants were sampled, one sample point beyond that was sampled for plants. In areas such as bays that appear to be under-sampled, a boat survey was conducted. This involved going to the area and surveying that area for plants, recording the species viewed and/or sampled. The type of habitat is also recorded. These data are not used in the statistical analysis nor is the density recorded. Only plants sampled at predetermined sampled points were used in the statistical analysis. In addition, any plant within six feet of the boat was recorded as "viewed." A handheld Global Positioning System (GPS) located the sampling points in the field. The Wisconsin DNR guidelines for point location accuracy were followed with an 80 ft resolution window and the location arrow touching the point.

At each sample location, a double-sided fourteen-tine rake was used to rake a 1m tow off the bow of the boat. All plants contained on the rake and those that fell off of rake were identified and rated as to rake fullness. The rake fullness value was used based on the criteria contained in the diagram and table below. Those plants that were within six feet were recorded as "viewed," but no rake fullness rating was given.



	Criteria for rake fullness rating
1	Plant present, occupies less than ½ of tine space
2	Plant present, occupies more than ½ tine space
3	Plant present, occupies all or more than tine space
v	Plant not sampled but observed within 6 feet of boat

The depth and predominant bottom type was also recorded for each sample point. Caution must be used in using the sediment type in deeper water as it is difficult to discern between muck and sand with a rope rake. All plants needing verification were bagged and cooled for later examination. Each species was mounted and pressed for a voucher collection. On rare occasions a single plant may be needed for verification, not allowing it to be used as a voucher specimen and may be missing from the collection.

Data analysis methods

Data collected was entered into a spreadsheet for analysis. The following statistics were generated from the spreadsheet:

- Frequency of occurrence in sample points with vegetation (littoral zone) and points shallower than depth of plants
- Relative frequency
- Total points sampled
- Sample points with vegetation
- Simpson's diversity index
- Maximum plant depth
- Species richness
- Floristic Quality Index

An explanation of each of these data is provided below.

Frequency of occurrence for each species- Frequency is expressed as a percentage by dividing the number of sites the plant is sampled by the number of sites. There can be two

values calculated for this. The first is the percentage of all sample points that this plant was sampled at depths less then maximum depth plants were found (littoral zone), regardless if vegetation was present. The second is the percentage of sample points that the plant was sampled at only points containing vegetation. The first value shows how often the plant would be encountered in the defined littoral zone (by depth), while the second value shows if considered where points contain plants. In either case, the greater this value, the more frequent the plant is in the lake. If one wants to compare how frequent in the littoral zone, we look at the frequency of all points below maximum depth with plants. This frequency value allows the analysis of how common plants are where they could grow based upon depth. If one wants to focus only where plants are actually present, then one would look at frequency at points in which plants were found. Frequency of occurrence is usually reported using sample points where vegetation was present.

Frequency of occurrence example:

Plant A sampled at 35 of 150 littoral points = 35/150 = 0.23 = 23%
Plant A's frequency of occurrence = 23% considering littoral zone depths.

Plant A sampled at 12 of 40 vegetated points = 12/40 = 0.3 = 30%
Plant A's frequency of occurrence = 30% in vegetated areas

These two frequencies can tell us how common the plant was sampled in the littoral zone or how common the plant was sampled at points plants actually grow. Generally the second will have a higher frequency since that is where plants are actually growing as opposed to where they could grow.

Relative frequency-This value shows, as a percentage, the frequency of a particular plant relative to other plants. This is not dependent on the number of points sampled. The relative frequency of all plants will add to 100%. This means that if plant A had a relative frequency of 30%, it occurred 30% of the time compared to all plants sampled or makes up 30% of all plants sampled. This value allows us to see which of the plants are the dominant species in the lake. The higher the relative frequency the more common the plant is compared to the other plants and therefore the more frequent in the plant community.

Relative frequency example:

Suppose we were sampling 10 points in a very small lake and got the following results:

	Frequency sampled
Plant A present at 3 sites	3 of 10 sites
Plant B present at 5 sites	5 of 10 sites
Plant C present at 2 sites	2 of 10 sites
Plant D present at 6 sites	6 of 10 sites

So one can see that Plant D is the most frequent sampled at all points with 60% (6/10) of the sites having plant D. However, the relative frequency allows us to see what the frequency is compared the other plants, without taking into account the number of sites. It is calculated by dividing the number of times a plant is sampled by the total of all plants sampled. If we add all frequencies (3+5+2+6), we get a sum of 16. We can calculate the relative frequency by dividing by the individual frequency.

Plant A = 3/16 = 0.1875 or 18.75%
Plant B = 5/16 = 0.3125 or 31.25%
Plant C = 2/16 = 0.125 or 12.5%
Plant D = 6/16 = 0.375 or 37.5%

Now we can compare the plants to one another. Plant D is still the most frequent, but the relative frequency tells us that of all plants sampled at those 10 sites, 37.5% of them are Plant D. This is much lower than the frequency of occurrence (60%) because although we sampled Plant D at 6 of 10 sites, we were sampling many other plants too, thereby giving a lower frequency when compared to those other plants. This then gives a true measure of the dominant plants present.

Number of points sampled- This may not be the same as the total points in the sample grid. When doing a survey, we don't sample at depths outside of the littoral zone (the area where plants can grow). Once the maximum depth of plants is established, many of the points deeper than this are eliminated to save time and effort.

Sample sites with vegetation- The number of sites where plants were actually sampled. This gives a good idea of the plant coverage of the lake. If 10% of all sample points had vegetation, it implies about a 10% coverage of plants in the whole lake, assuming an adequate number of sample points have been established. We also look at the number of sample sites with vegetation in the littoral zone. If 10% of the littoral zone had sample points with vegetation, then the plant coverage in the littoral zone would be estimated at 10%.

Simpson's diversity index-To measure how diverse the plant community is, Simpson's diversity index is calculated. This value can run from 0 to 1.0. The greater the value, the more diverse the plant community is in a particular lake. In theory, the value is the chance that two species sampled are different. An index of "1" means that the two will always be

different (very diverse) and a "0" would indicate that they will never be different (only one species found). The more diverse the plant community, the better the lake ecosystem.

Simpson's diversity example:

If one sampled a lake and found just one plant, the Simpson's diversity would be "0." This is because if we randomly sampled two plants, there would be a 0% chance of them being different, since there is only one plant.

If every plant sampled were different, then the Simpson's diversity would be "1." This is because if two plants were randomly sampled, there would be a 100% chance they would be different since every plant is different.

These are extreme and theoretical scenarios, but they demonstrate how this index works. The greater the Simpson's index is for a lake, the greater the diversity since it represents a greater chance of two randomly sampled plants being different.

Maximum depth of plants-This depth indicates the deepest that plants were sampled. Generally more clear lakes have a greater depth of plants while lower water clarity limits light penetration and reduces the depth at which plants are found.

Species richness-The number of different individual species found in the lake. There is a number for the species richness of plants sampled, and another number that takes into account plants viewed but not actually sampled during the survey.

Floristic Quality Index-The Floristic Quality Index (FQI) is an index developed by Dr. Stanley Nichols of the University of Wisconsin-Extension. This index is a measure of the plant community in response to development (and human influence) on the lake. It takes into account the species of aquatic plants found and their tolerance for changing water quality and habitat quality. The index uses a conservatism value assigned to various plants ranging from 1 to 10. A high conservatism value indicates that a plant is intolerant while a lower value indicates tolerance. Those plants with higher values are more apt to respond adversely to water quality and habitat changes, largely due to human influence (Nichols, 1999). The FQI is calculated using the number of species and the average conservatism value of all species used in the index. The formula is:

$$\mathbf{FQI = Mean\ C \cdot \sqrt{N}}$$

Where C is the conservatism value and N is the number of species.

Therefore, a higher FQI, indicates a healthier aquatic plant community. This value can then be compared to the median for other lakes in the assigned eco-region. There are four eco-regions used throughout Wisconsin. These are Northern Lakes and Forests, Northern Central Hardwood Forests, Driftless Area and Southeastern Wisconsin Till Plain. Lake Nancy is in the Northern Lakes and Forests eco-region.

Summary of Northern Lakes and Forests Median Values for Floristic Quality Index:
(Nichols, 1999)

Mean species richness = 14

Mean conservatism = 5.6

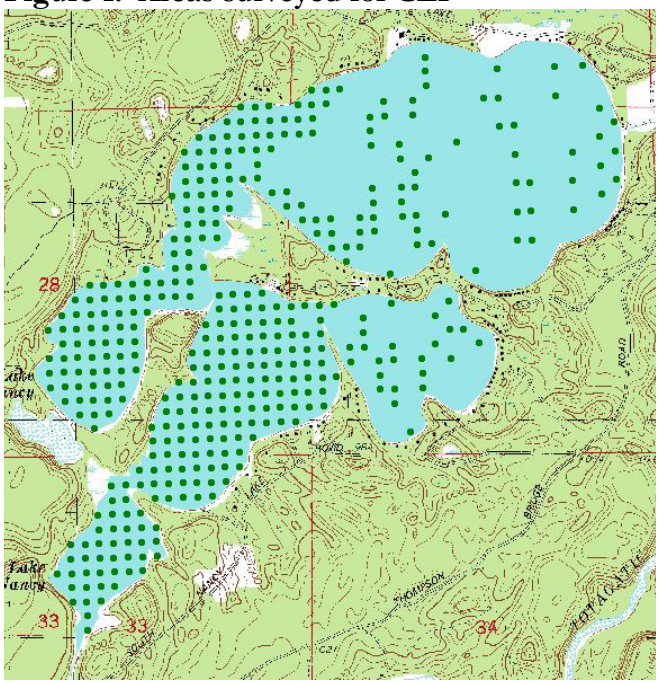
Mean Floristic Quality = 20.9*

*Floristic Quality has a significant correlation with area of lake (+), alkalinity(-), conductivity(-), pH(-) and Secchi depth (+). In a positive correlation, as that value rises so will FQI, while with a negative correlation, as a value rises, the FQI will decrease.

Results

In June 2008 an early season survey for curly leaf pondweed (CLP) (*Potamogeton crispus*) was conducted. This survey is done in June so the CLP can be surveyed while it is robust. Since CLP dies in early July, the survey must be done before that time. After completion of the survey, no CLP was sampled or observed. Figure 1 shows the area/points surveyed.

Figure 1: Areas surveyed for CLP



In August 2008, the full survey was conducted. Figure 2 is a map of the sample grid. In the southern most bay, several points could not be sampled because it was too shallow to navigate. However, plants were observed so these points were entered as having vegetation with species unknown. Figure 3 is a map showing where plants were actually sampled (or observed) on Lake Nancy.

Figure 2: Sample grid for Lake Nancy

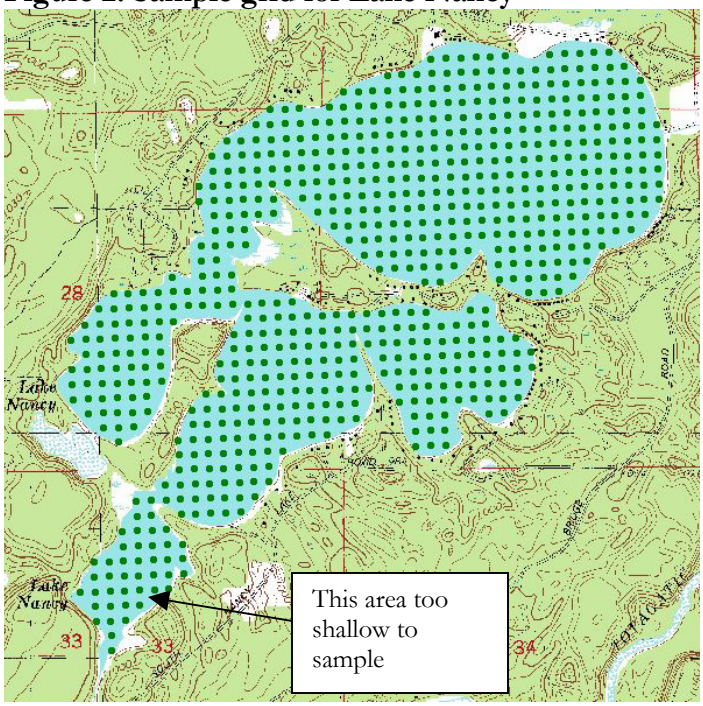
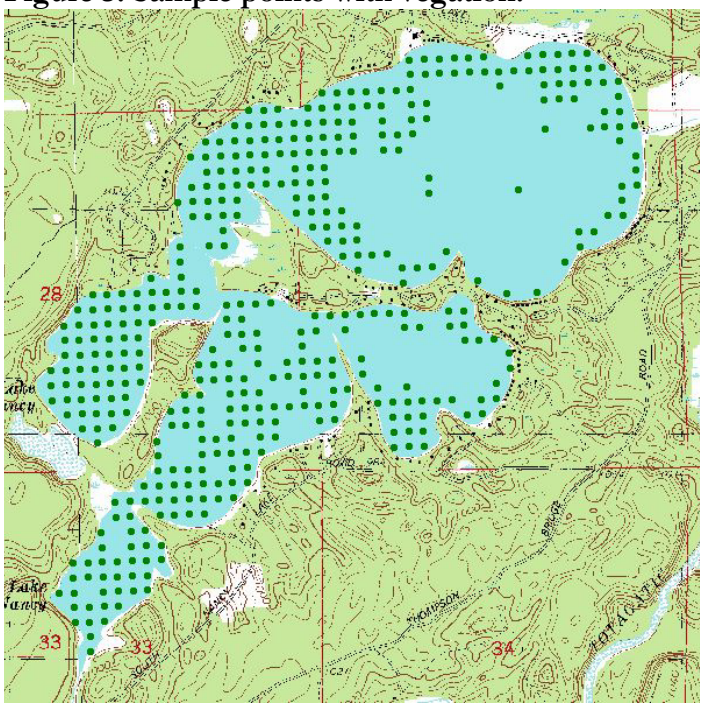


Figure 3: Sample points with vegation.



The survey data shows a very extensive, diverse plant community. Table 1 lists data from the completed survey. The number of species in Lake Nancy is high at 47 sampled species and 54 viewed species. The Simpson's diversity is also high at 0.94. It is quite rare to have this high of a Simpson's diversity index. This high index value represents tremendous diversity. The number of species per point averages 2.88. The coverage of plants is high with 73.13% of the littoral zone having plants growing and 60.6 % of entire sample grid points having plants sampled. Because the two southern bays have such high plant coverage, the percentage of coverage calculates rather high. In the main part of the lake ("Big Lake") isn't that high of coverage. All of these statistics point to a healthy, diverse plant community in Lake Nancy.

Table 1: Lake Nancy macrophyte survey statistics

Survey Statistics	
Total number of points for entire lake	**701**
Total number of sites with vegetation	**425**
Total number of sites shallower than maximum depth of plants (littoral)	**536**
Frequency of occurrence at all sites on entire lake	**60.6**
Frequency of occurrence at sites shallower than maximum depth of plants	**79.3**
Simpson Diversity Index	**0.94**
Maximum depth of plants (ft)	**24.10**
Average number of all species per site (veg. sites only)	**2.89**
Average number of native species per site (veg. sites only)	**2.79**
Species Richness	**47**
Species Richness (including visuals)	**54**

The diversity in the lake is quite widespread. The southern bays held the most diversity, however the entire lake is quite diverse as a whole. In addition, one species, Robbin's spikerush (*Eleocharis robbinsii*) is listed as species of concern. The Wisconsin DNR defines species of special concern as, *"special concern species are those species about which some problem of abundance or distribution is suspected but not yet proved. The main purpose of this category is to focus attention on certain species before they become threatened or endangered."*

Figure 4: Number of species per point distribution.

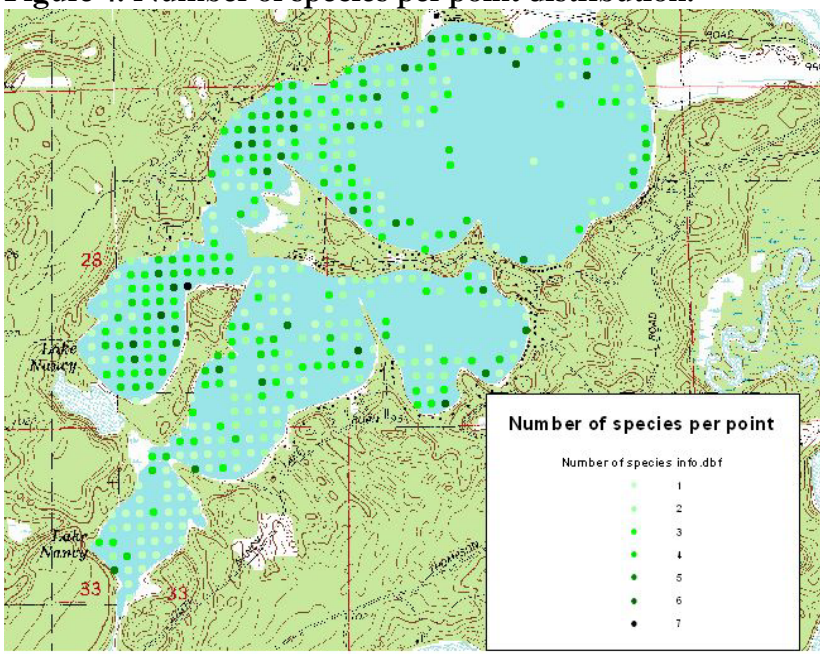


Table 2: Lake Nancy species list with statistics

Species	FOQ % Vegetated	FOQ % depth of plants	Relative Frequency (%)	Number of sites sampled	Average Rake Fullness
*Potamogeton robbinsii,*Robbins pondweed	37.91	27.80	13.12	149	1.26
Elodea canadensis,Common waterweed	30.28	22.20	10.48	119	1.18
Potamogeton amplifolius,Large-leaf pondweed	22.90	16.79	7.92	90	1.01
Najas flexilis,Bushy pondweed	21.88	16.04	7.57	86	1.01
Nymphaea odorata,White water lily	20.61	15.11	7.13	81	1.00
Brasenia schreberi,Watershield	15.27	11.19	5.28	60	1.00
Potamogeton pusillus,Small pondweed	14.25	10.45	4.93	56	1.13
Eleocharis robbinsii,,Robbin's spikerush	12.21	8.96	4.23	48	1.00
Myriophyllum spicatum,Eurasian water milfoil	9.67	7.09	3.35	38	1.53
Nuphar variegata,Spatterdock	9.16	6.72	3.17	36	1.00
Ceratophyllum demersum,Coontail	8.40	6.16	2.90	33	1.06
Potamogeton illinoensis,Illinois pondweed	7.63	5.60	2.64	30	1.00
Filamentous algae	5.34	3.92	1.85	21	1.00
Chara sp. ,Muskgrasses	5.34	3.92	1.85	21	1.00
Sagittaria sp. Arrowhead rosette	5.34	3.92	1.85	21	1.00
Vallisneria americana,Wild celery	5.34	3.92	1.85	21	1.00
*Myriophyllum tenellum,*Dwarf water milfoil	5.09	3.73	1.76	20	1.05
Nitella sp.,Nitella	5.09	3.73	1.76	20	1.10
Megalodonta beckii,Water marigold	4.83	3.54	1.67	19	1.00
Potamogeton gramineus,Variable pondweed	4.58	3.36	1.58	18	1.00
Potamogeton praelongis,White-stem pondweed	4.33	3.17	1.50	17	1.06
Potamogeton zosteriformis,Flat-stem pondweed	4.33	3.17	1.50	17	1.00
Utricularia vulgaris,Common	4.07	2.99	1.41	16	1.00
Eleocharis acicularis,needle spikerush	3.82	2.80	1.32	15	1.00

Schoenoplectus acutus,Hardstem bulrush	**2.54**	**1.87**	**0.88**	**10**	**1.00**
Pontederia cordata,Pickerelweed	**2.29**	**1.68**	**0.79**	**9**	**1.00**
Utricularia gibba,Creeping bladderwort	**2.29**	**1.68**	**0.79**	**9**	**1.00**
Sagittaria graminea,Grass-leaved arrowhead	**2.04**	**1.49**	**0.70**	**8**	**1.00**
Juncus paleocarpus f. submersus,Brown-fruited rush	**1.78**	**1.31**	**0.62**	**7**	**1.00**
Eleocharis palustris,creeping spikerush	**1.53**	**1.12**	**0.53**	**6**	**1.00**
Myriophyllum sibiricum,Northern water milfoil	**1.53**	**1.12**	**0.53**	**6**	**1.00**
Utricularia intermedia,Flat-leaf bladderwort	**1.27**	**0.93**	**0.44**	**5**	**1.00**
Aquatic moss	**1.02**	**0.75**	**0.35**	**4**	**1.00**
Potamogeton natans,Floating-leaf pondweed	**1.02**	**0.75**	**0.35**	**4**	**1.00**
Eriocaulon aquaticum,Pipewort	**0.51**	**0.37**	**0.18**	**2**	**1.00**
Ranunculus aquatilis,Stiff water crowfoot	**0.51**	**0.37**	**0.18**	**2**	**1.00**
*Juncus brevicaudatus,*narrow panicle rush	**0.51**	**0.37**	**0.18**	**2**	**1.00**
Carex comosa,bottle brush sedge	**0.25**	**0.19**	**0.09**	**1**	**1.00**
Dulichium arundinaceum,3-way sedge	**0.25**	**0.19**	**0.09**	**1**	**1.00**
Elatine minima,Waterwort	**0.25**	**0.19**	**0.09**	**1**	**1.00**
Myriophyllum alterniflorum,Alternate-leaved water milfoil	**0.25**	**0.19**	**0.09**	**1**	**1.00**
Potamogeton freisii,Fries' pondweed	**0.25**	**0.19**	**0.09**	**1**	**2.00**
Potamogeton richardsonii,Clasping-leaf pondweed	**0.25**	**0.19**	**0.09**	**1**	**1.00**
Ranunculus flammula,Creeping spearwort	**0.25**	**0.19**	**0.09**	**1**	**1.00**
*Sagittaria latifolia,*Common arrowhead	**0.25**	**0.19**	**0.09**	**1**	**1.00**
Carex sp., Sedge	**0.25**	**0.19**	**0.09**	**1**	**1.00**
Asclepias incarnata, Swamp milkweed	**0.25**	**0.19**	**0.09**	**1**	**1.00**
Hypercum boreale, Northern St. Johnswortt	**Viewed**			**1**	
Lythrum salicaria,Purple loosestrife	**Viewed**			**1**	
Polygonum amphibium,Water smartweed	**Viewed**			**3**	
Potamogeton epihydrus,Ribbon-leaf pondweed	**Viewed**			**1**	
*Schoenoplectus tabernaemontani,*Softstem bulrush	**Viewed**			**1**	
Sparganium natans ,Small bur-reed	**Viewed**			**1**	
*Typha latifolia,*Broad-leaved cattail	**Viewed**			**1**	

Figure 5: Distribution map of Robbins pondweed-most abundant plant species

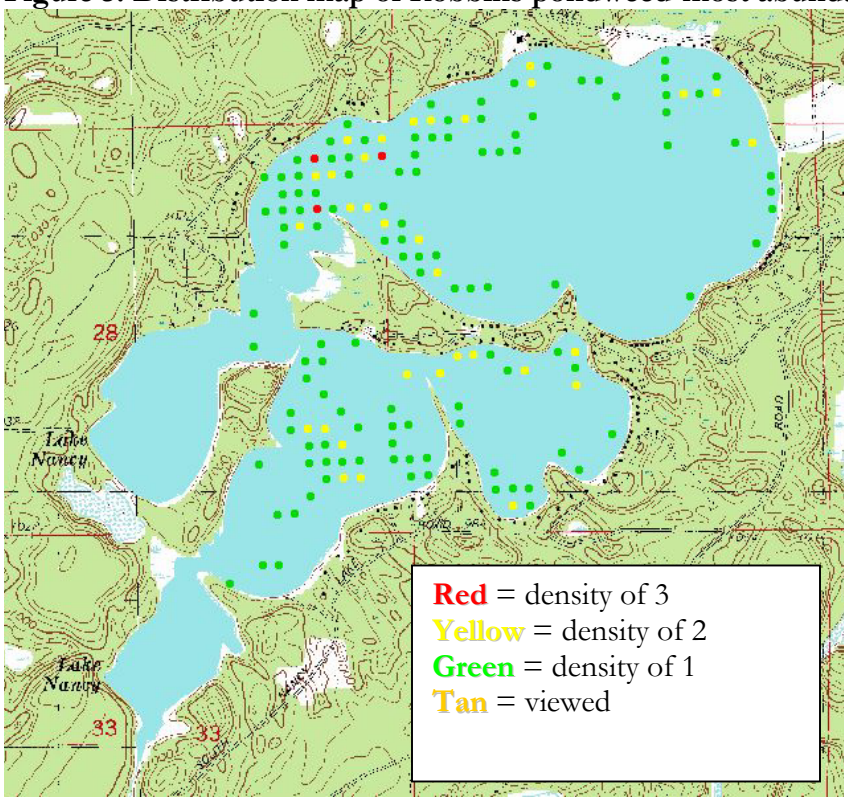


Figure 6: Distribution map of Common waterweed-second most abundant species

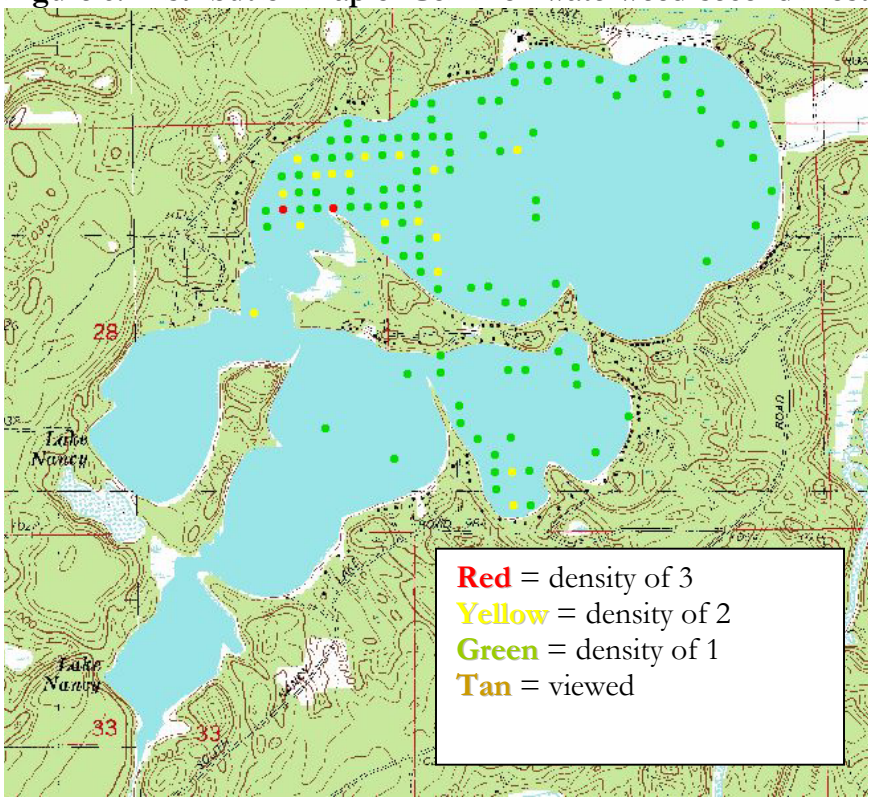
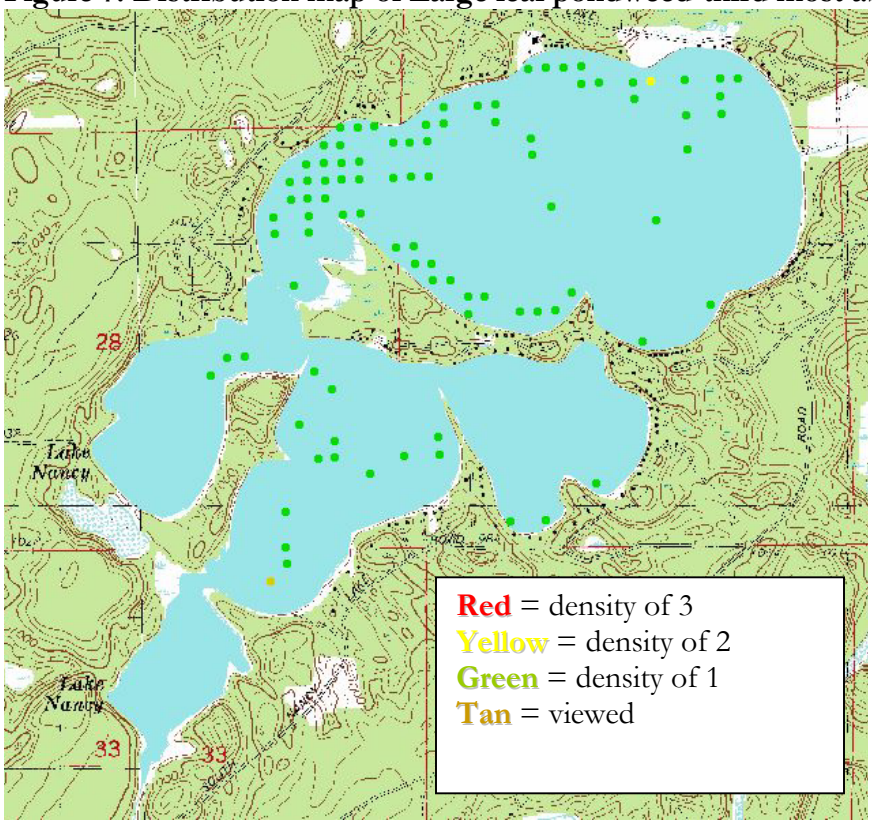


Figure 7: Distribution map of Large leaf pondweed-third most abundant species

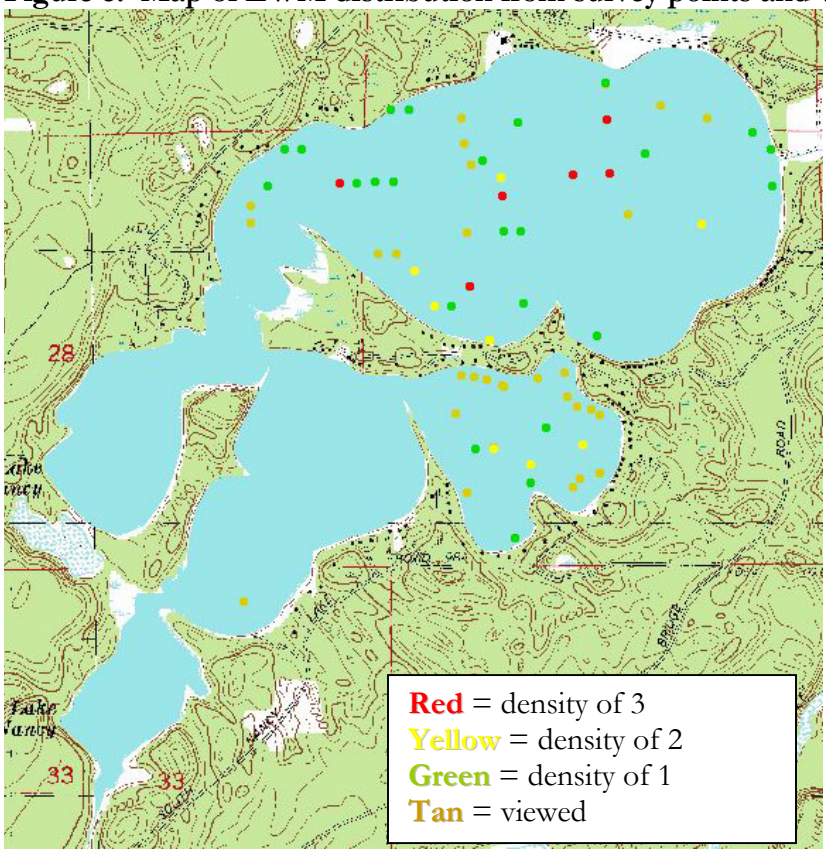


The relative frequency of Robbin's pondweed, common waterweed, and large-leaf pondweed is 13.2%, 10.5% and 7.9% respectively. This indicates that no species dominates the plant community showing a diverse native plant community. All three of these species are very desirable plants to have in a lake ecosystem by providing key habitat for fish and invertebrates.

Invasive species

Two species of non-native plants were surveyed in Lake Nancy. These are Eurasian watermilfoil, (*Myriophyllum spicatum*) and Purple loosestrife (*Lythrum salicaria*). Eurasian watermilfoil (EWM) was sampled and viewed at numerous locations. Any plants or clumps of plants viewed while navigating were marked by GPS coordinates. In the point intercept survey, EWM was sampled at 38 points with a frequency of occurrence of 9.7% (and viewed at 7 locations from survey points). More points were entered as EWM was encountered and is shown in the distribution map in Figure 7. Nearly all EWM is contained in 4 to 10 feet of water in the two areas of the lake that have fairly deep water. This includes the area of the map adjacent to the boat landing and the largest portion of the lake to the north (Big Lake). Some areas had large beds that were quite dense. In the northern portion of the lake, some EWM beds are near the middle portions of the lake. None of the shallow, heavily vegetated bays in the southern areas of the lake contained EWM except for one location. This was a small bed in the southeast bay.

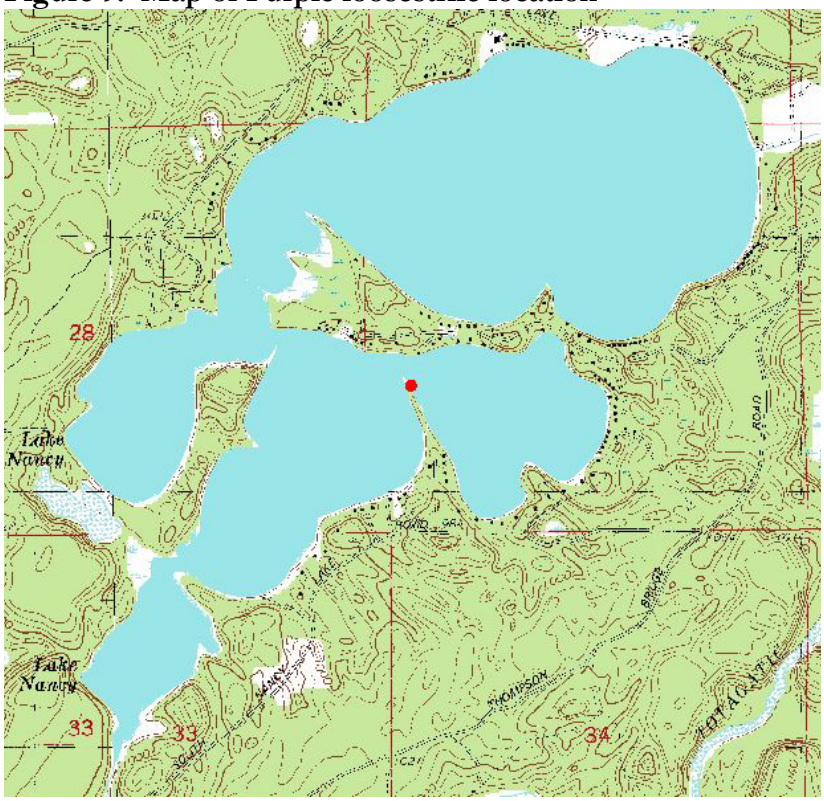
Figure 8: Map of EWM distribution from survey points and viewed



It was pointed out by the Lake Nancy Association that EWM had been treated prior to the survey. This could have affected the results of the EWM sampled and/or viewed in this survey.

Purple loosestrife was sampled in only one location along the narrow point straight west of the boat landing. There were approximately 12 plants present. All of these plants were pulled and removed from the lake. This area should be checked to make sure no plants return (if any rhizome was missed). It appeared all plants were successfully removed but again the area should be checked.

Figure 9: Map of Purple loosestrife location



Floristic quality index

The floristic quality index reflects the potential affect of human activities on the plant community. The FQI of Lake Nancy is very high. This is due both to the high number of species sampled in Lake Nancy and the high mean conservatism values of the plants sampled. There were 44 species sampled and used to calculate the FQI (not all species surveyed are necessarily used in the FQI) .

Table 3: FQI species and conservatism values

Species	Common Name	C
Brasenia schreberi	**Watershield**	**7**
Carex comosa	**Bottle brush sedge**	**5**
Ceratophyllum demersum	**Coontail**	**3**
Chara sp.	**Muskgrasses**	**7**
Dulichium arundinaceum	**Three-way sedge**	**9**
Elatine minima	**Waterwort**	**9**
Eleocharis acicularis	**Needle spikerush**	**5**
Eleocharis palustris	**Creeping spikerush**	**6**
Elodea canadensis	**Common waterweed**	**3**
Eriocaulon aquaticum	**Pipewort**	**9**
Juncus palocarpus f. submersus	**Brown-fruited rush**	**8**

FBI species continued		
Megalodonta beckii	**Water marigold**	**8**
Myriophyllum alterniflorum	**Alternate-flowered water-milfoil**	**10**
Myriophyllum sibericum	**Northern water-milfoil**	**7**
Myriophyllum tenellum	**Dwarf water-milfoil**	**10**
Najas flexilis	**Bushy pondweed**	**6**
Najas gracillima	**Slender water-nymph**	**7**
Nitella sp	**Nitella**	**7**
Nuphar variegata	**Spatterdock**	**6**
Nymphaea odorata	**White water lily**	**6**
Polygonum amphibium	**Water smartweed**	**5**
Pontederia cordata	**Pickerelweed**	**9**
Potamogeton amplifolius	**Large-leaf pondweed**	**7**
Potamogeton epihydrus	**Ribbon-leaf pondweed**	**8**
Potamogeton friesii	**Fries' pondweed**	**8**
Potamogeton gramineus	**Variable pondweed**	**7**
Potamogeton illinoensis	**Illinois pondweed**	**6**
Potamogeton natans	**Floating-leaf**	**5**
Potamogeton praelongis	**White-stem pondweed**	**8**
Potamogeton pusillus	**Small pondweed**	**7**
Potamogeton richardsonii	**Clasping-leaf pondweed**	**5**
Potamogeton robbinsii	**Robbins pondweed**	**8**
Potamogeton zosteriformis	**Flat-stem pondweed**	**6**
Ranunculus aquatilis	**Stiff water crowfoot**	**7**
Ranunculus flammula	**Creeping spearwort**	**9**
Sagittaria graminea	**Grass-leaved arrowhead**	**9**
Sagittaria latifolia	**Common arrowhead**	**3**
Schoenoplectus acutus	**Hardstem bulrush**	**5**
Schoenoplectus tabernaemontani	**Softstem bulrush**	**4**
Typha latifolia	**Broad-leaved cattail**	**1**
Utricularia intermedia	**Flat-leaf bladderwort**	**9**
Utricularia gibba	**Creeping bladderwort**	**9**
Utricularia vulgaris	**Common bladderwort**	**7**
Vallisneria americana	**Wild celery**	**6**

The FQI of Lake Nancy is 44.62. This value is very high for a lake. An FQI such as this (over 44) indicates that the plant community is healthy and has changed little in response to human impact on water quality and habitat (sediment) changes. This may represent similar habitat to pre-development times. One must use caution when using the FQI as a major water quality indicator as high nutrients may not be reflected in the FQI and yet may contribute to reduced water quality.

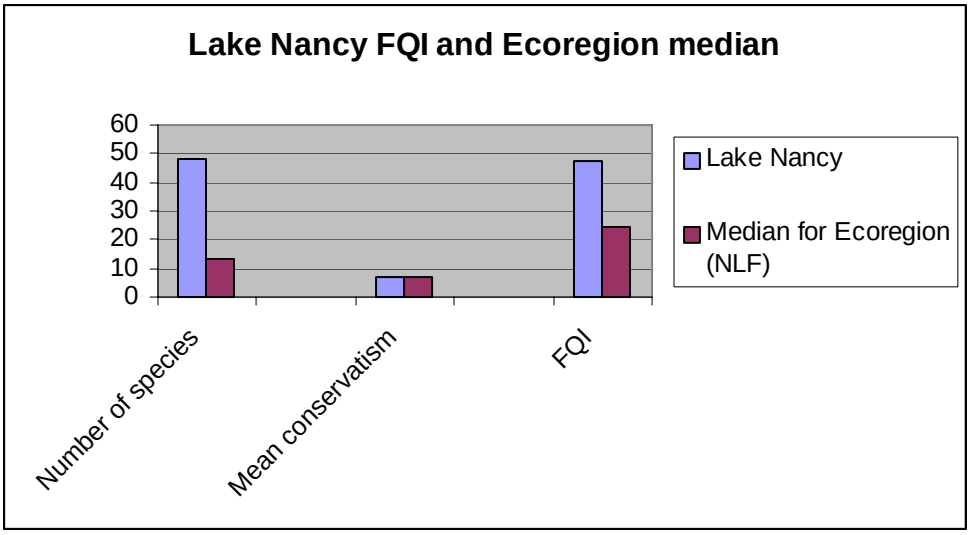
The high FQI in Lake Nancy is due both to high species richness and a rather high mean conservatism value (Table 4).

Table 4: Floristic Quality Index Values-Lake Nancy and Eco-region.

Floristic Quality Values	Lake Nancy	Eco-region
Number of species	**44**	**13**
Mean Conservatism	**6.73**	**6.7**
FQI	**44.62**	**24.3**

The Lake Nancy FQI values are also high when compared to the median values for lakes in this ecoregion (Northern Lakes and Forests)(Nichols 1999). Figure 9 shows this comparison graphically.

Figure 10: Comparison of Lake Nancy FQI values and median for eco-region lakes



Preservation of the native plant community in Lake Nancy is paramount. This community is healthy, diverse, and an integral component of the Lake Nancy ecosystem. Any management of invasive plants needs to target those plants only.

References

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Crow, Garrett E. and C. Barre Hellquist. *Aquatic and Wetland Plants of Northeastern North America*. The University of Wisconsin Press. Madison, Wisconsin. Volumes 1 and 2. 2000. 880p.

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Nichols, Stanley A. *Distribution and Habitat Descriptions of Wisconsin Lake Plants*. Wisconsin Geological and Natural History Survey. Bulletin 96. Madison Wisconsin. 1999. 266 p.

Nichols, Stanley A. 1999. *Floristic Quality Assessment of Wisconsin Lake Plant Communities with Example Applications*. Journal of Lake and Reservoir Management 15 (2): 133-141.

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Appendix A

Glossary

Community-Different populations interacting.

Ecosystem-Any complex of living organisms together with all biotic and abiotic (non-living) factors which affect them.

Emergent plant-Aquatic plants that are rooted or anchored in sediment and have stems and leaves extending well above the water surface.

Floating-leafed plant-Plants with leaves floating on the water surface and are rooted or attached to sediments by long, flexible stems.

Habitat-The physical place where an organism lives.

Herbarium-A collection of plants sampled.

Littoral zone-The region of a body of water extending from the shoreline outward to the greatest depth occupied by rooted aquatic plants.

Macrophyte-Large, rooted or floating aquatic plants that may bear flowers and seeds. Some plants are free floating and are not attached to the bottom.

Nutrient-Any chemical element, ion or compound required by an organism for the continuation of growth, reproduction, and other life processes.

Photosynthesis-Production of organic matter (carbohydrate) from inorganic carbon and water in the presence of light.

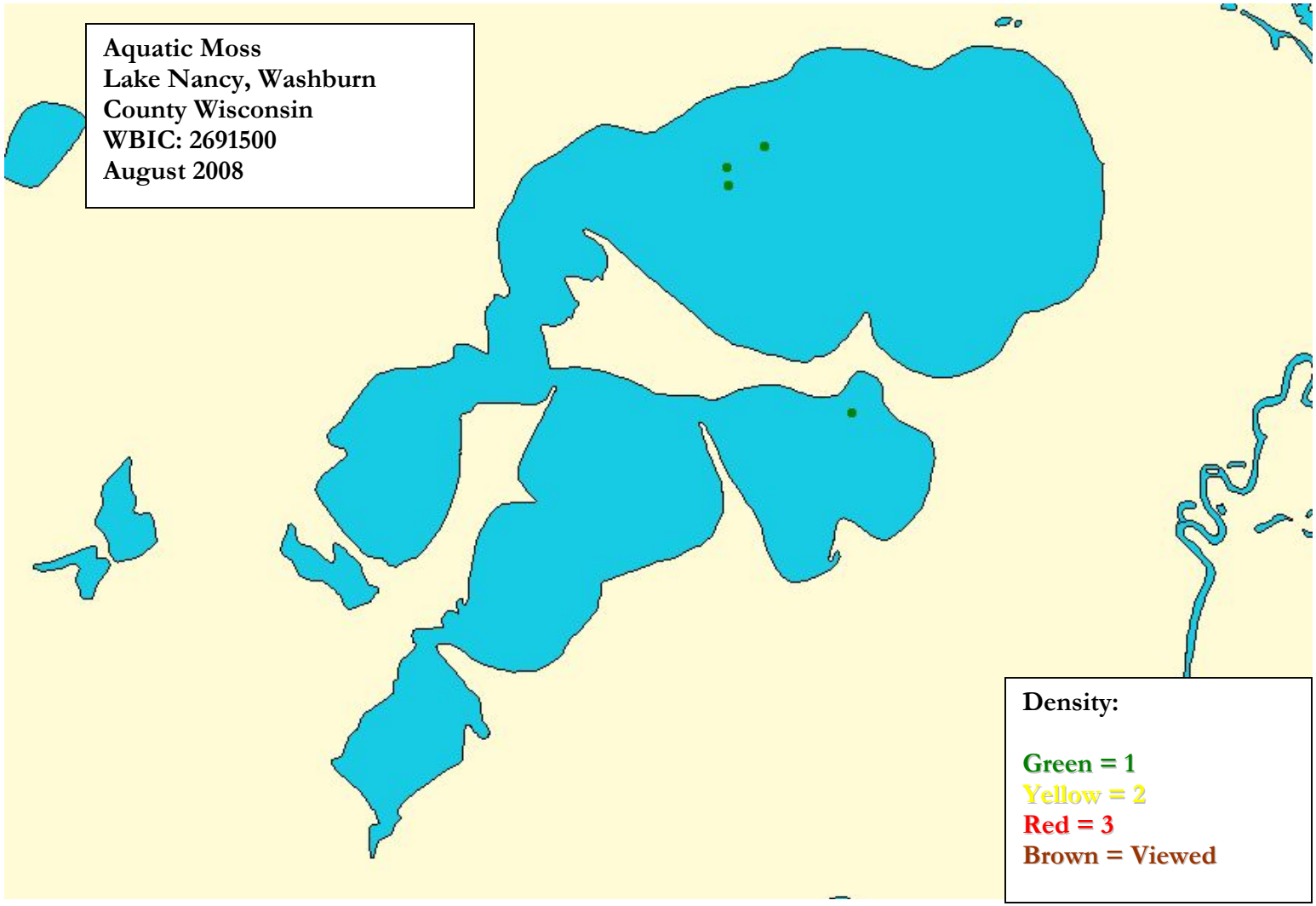
Sediment-Solid material deposited in the bottom of a basin.

Submergent plant-Aquatic plant that grows with all or most of its stems and leaves below the water surface.

Voucher-A collection of specimens sampled in a particular location.

Watershed-The entire surface landscape that contributes water to a lake or river.

Appendix B- Maps of each species sampled.


Aquatic Moss
Lake Nancy, Washburn
County Wisconsin
WBIC: 2691500
August 2008
Density:
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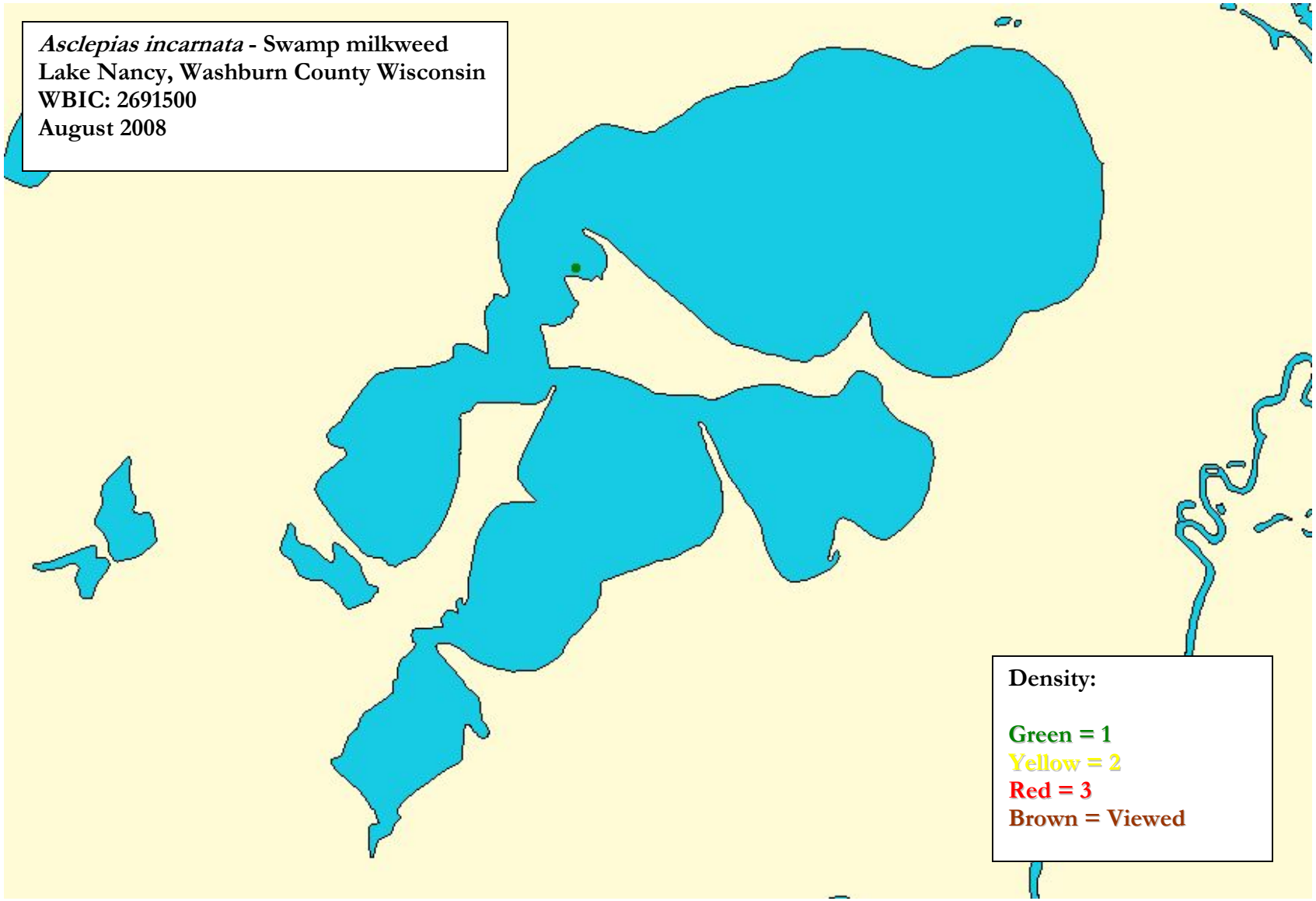
Yellow = 2
Red = 3
Brown = Viewed


Asclepias incarnata - Swamp milkweed
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WBIC: 2691500
August 2008
Density:
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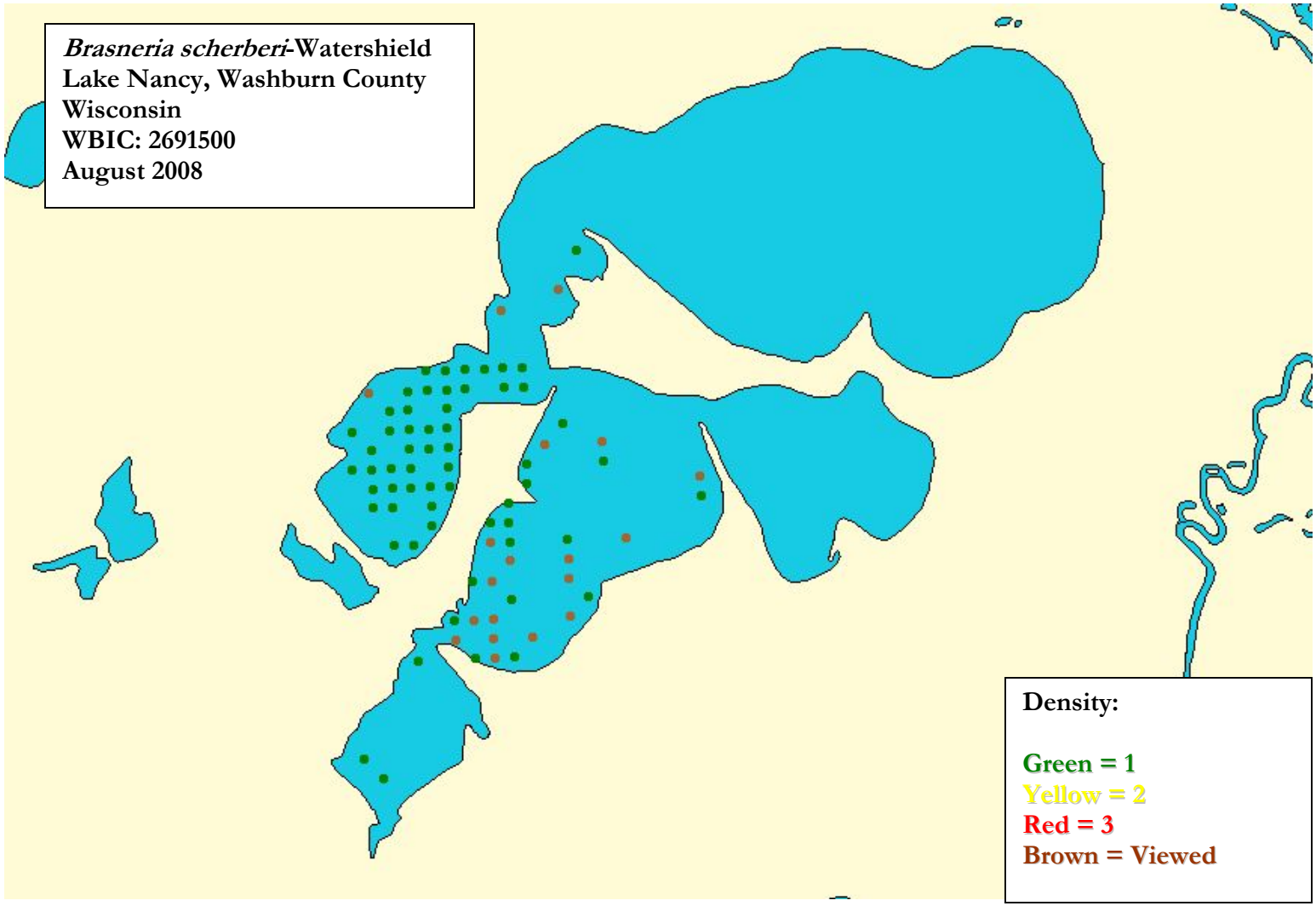
Yellow = 2
Red = 3
Brown = Viewed


Brasneria scherberi-Watershield
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Wisconsin
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August 2008
Density:
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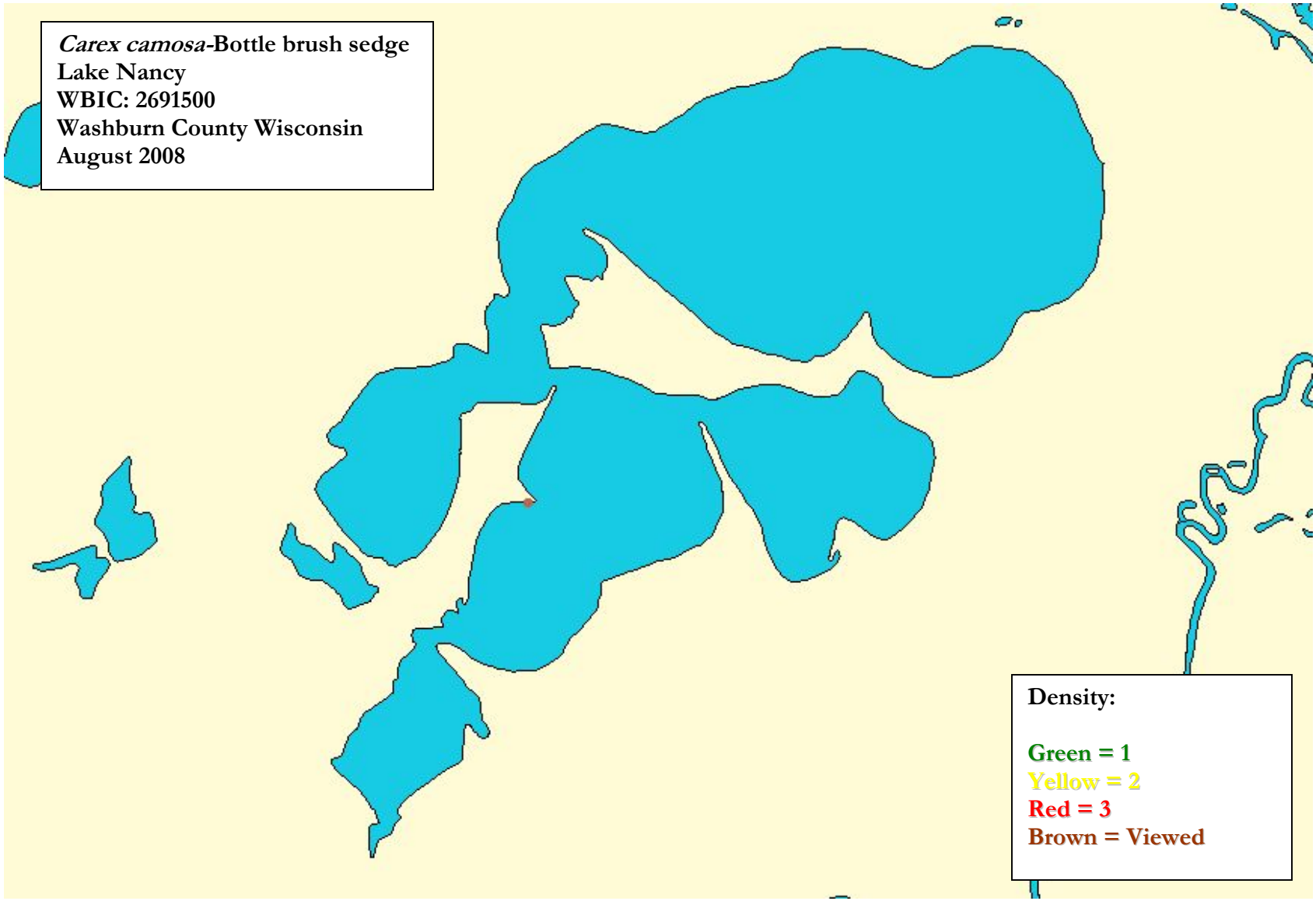
Yellow = 2
Red = 3
Brown = Viewed


Carex camosa-Bottle brush sedge
Lake Nancy
WBIC: 2691500
Washburn County Wisconsin
August 2008
Density:
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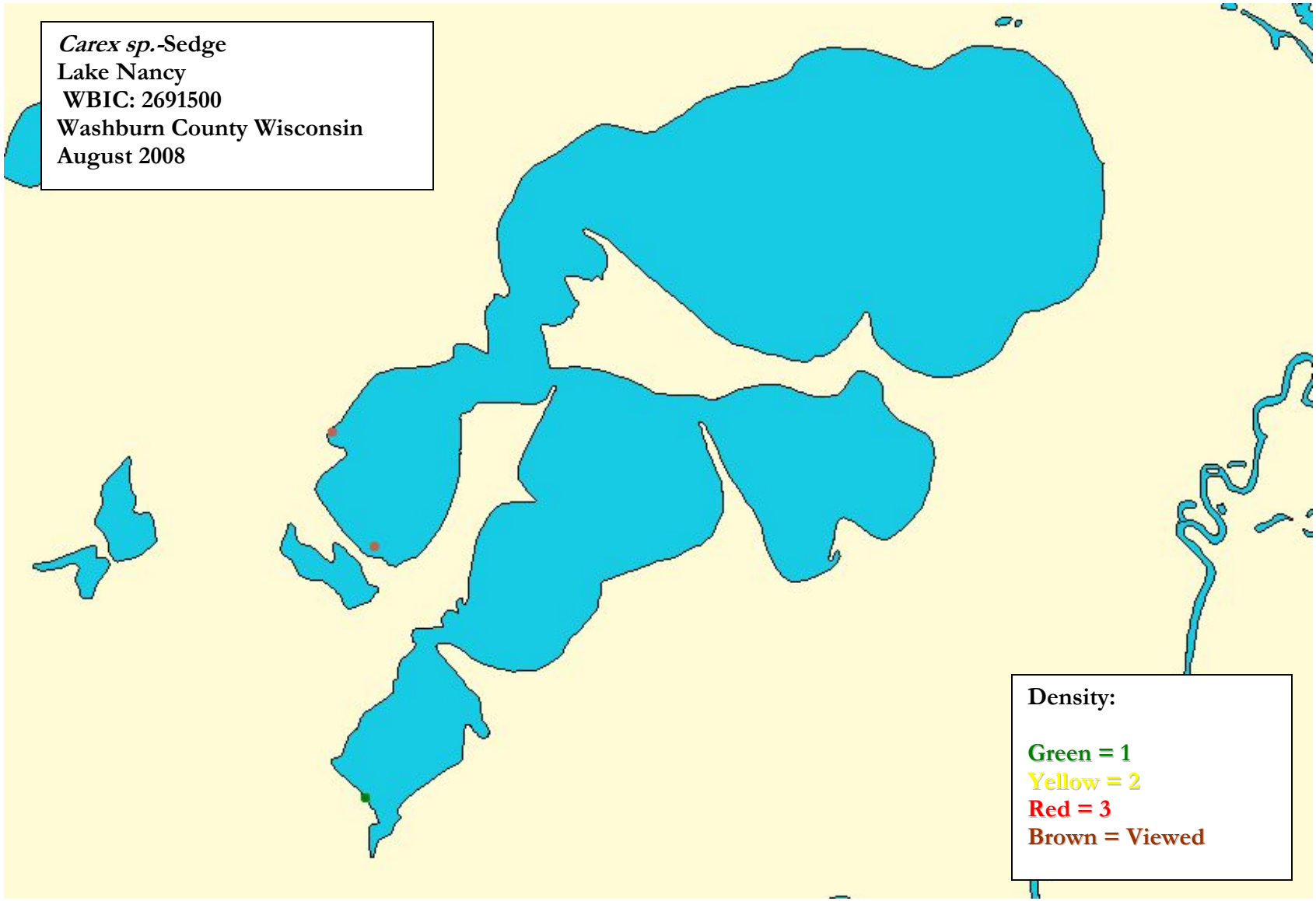
Yellow = 2
Red = 3
Brown = Viewed


Carex sp.-Sedge
Lake Nancy
WBIC: 2691500
Washburn County Wisconsin
August 2008
Density:
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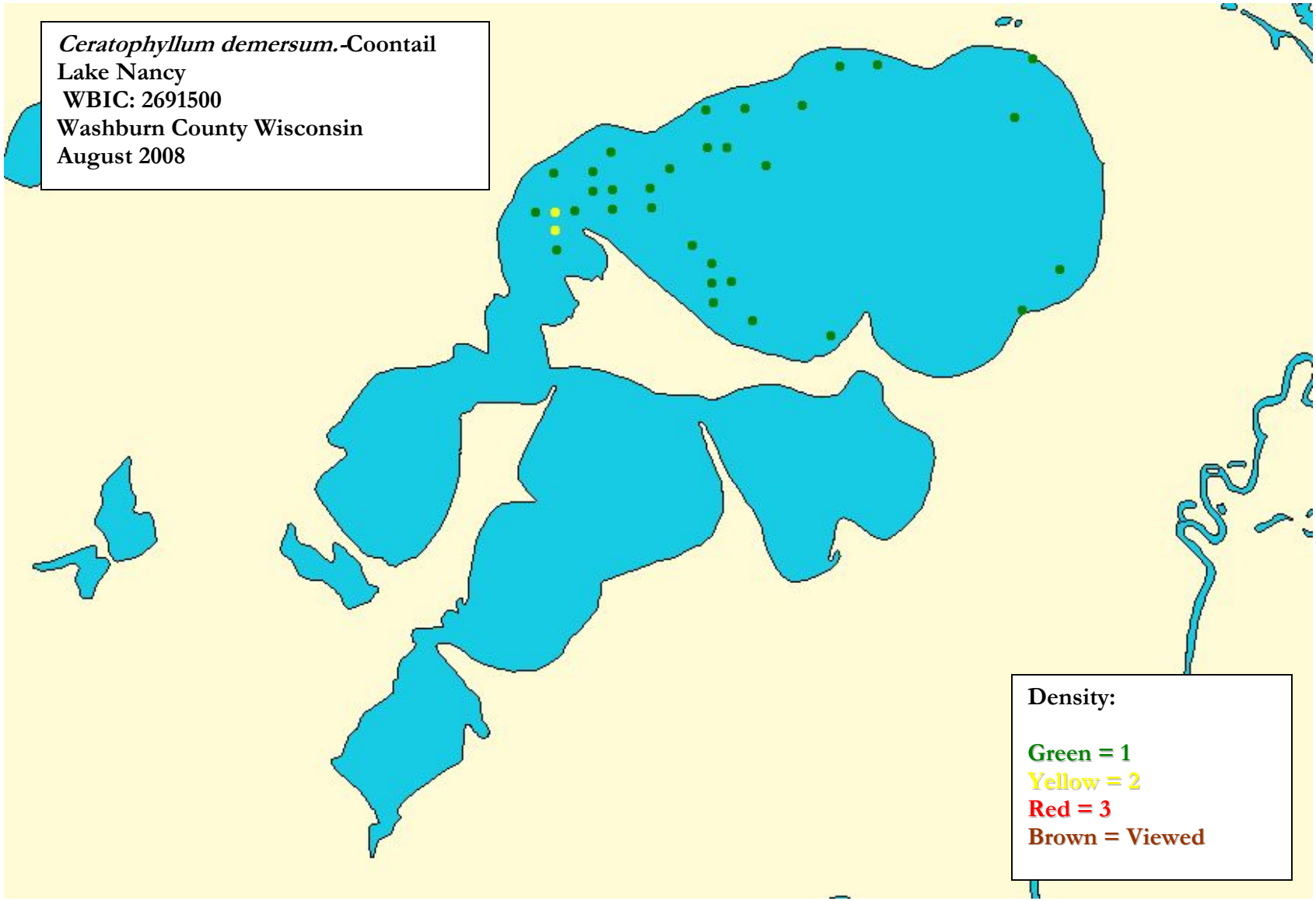
Yellow = 2
Red = 3
Brown = Viewed


Ceratophyllum demersum.-Coontail
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Washburn County Wisconsin
August 2008
Density:
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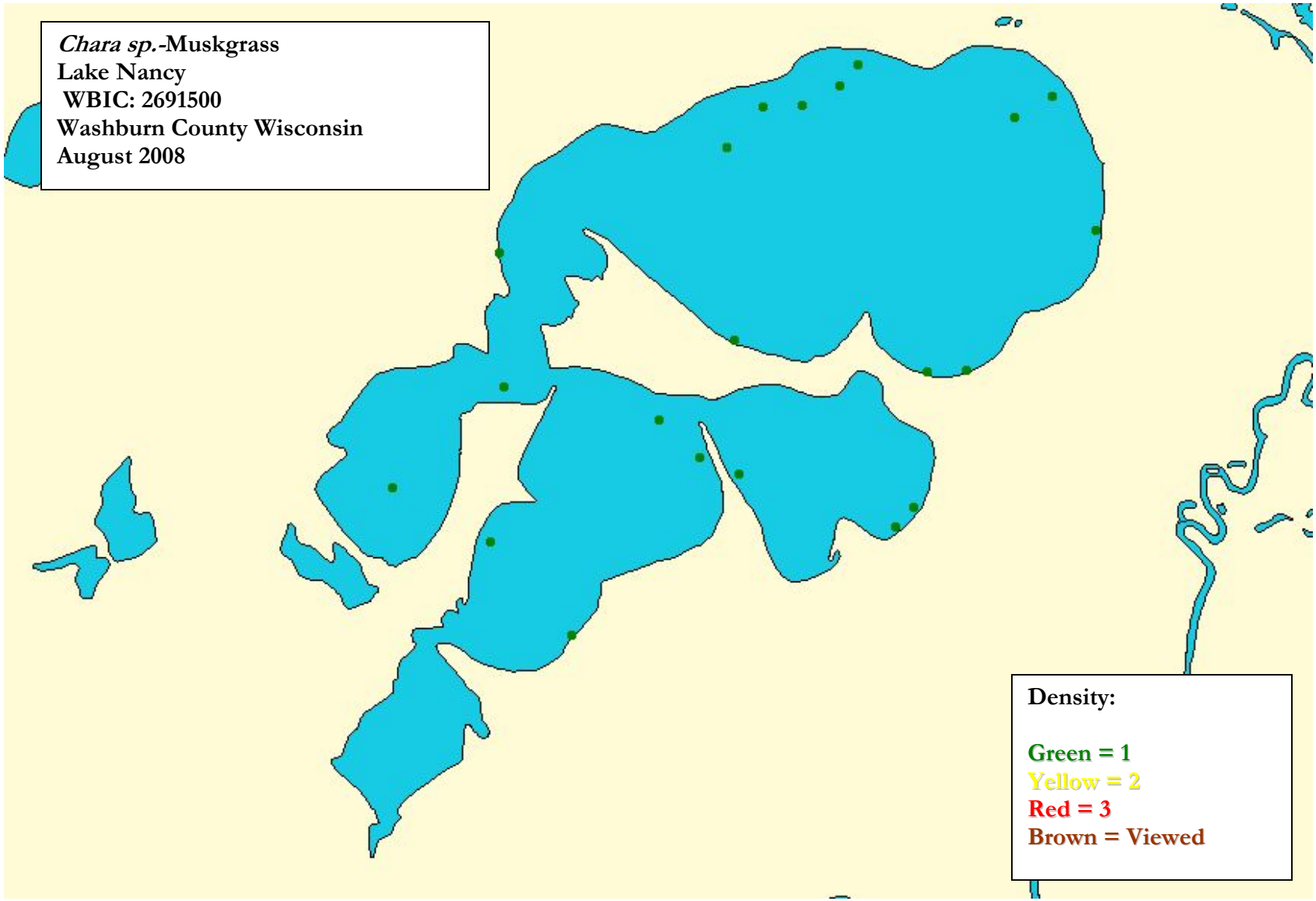
Yellow = 2
Red = 3
Brown = Viewed


Chara sp.-Muskgrass
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Washburn County Wisconsin
August 2008
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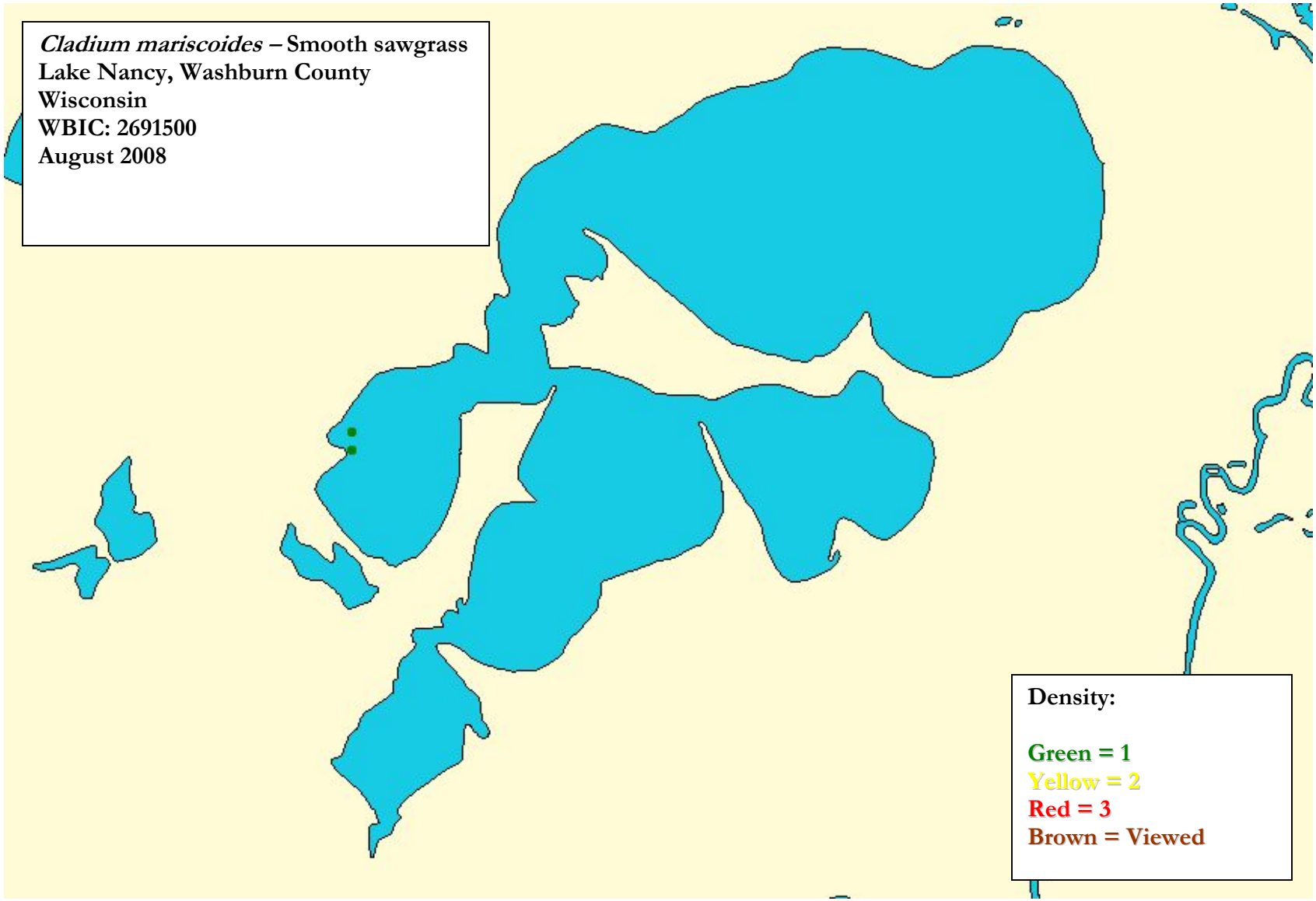
Red = 3
Brown = Viewed


Cladium mariscoides – Smooth sawgrass
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Wisconsin
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August 2008
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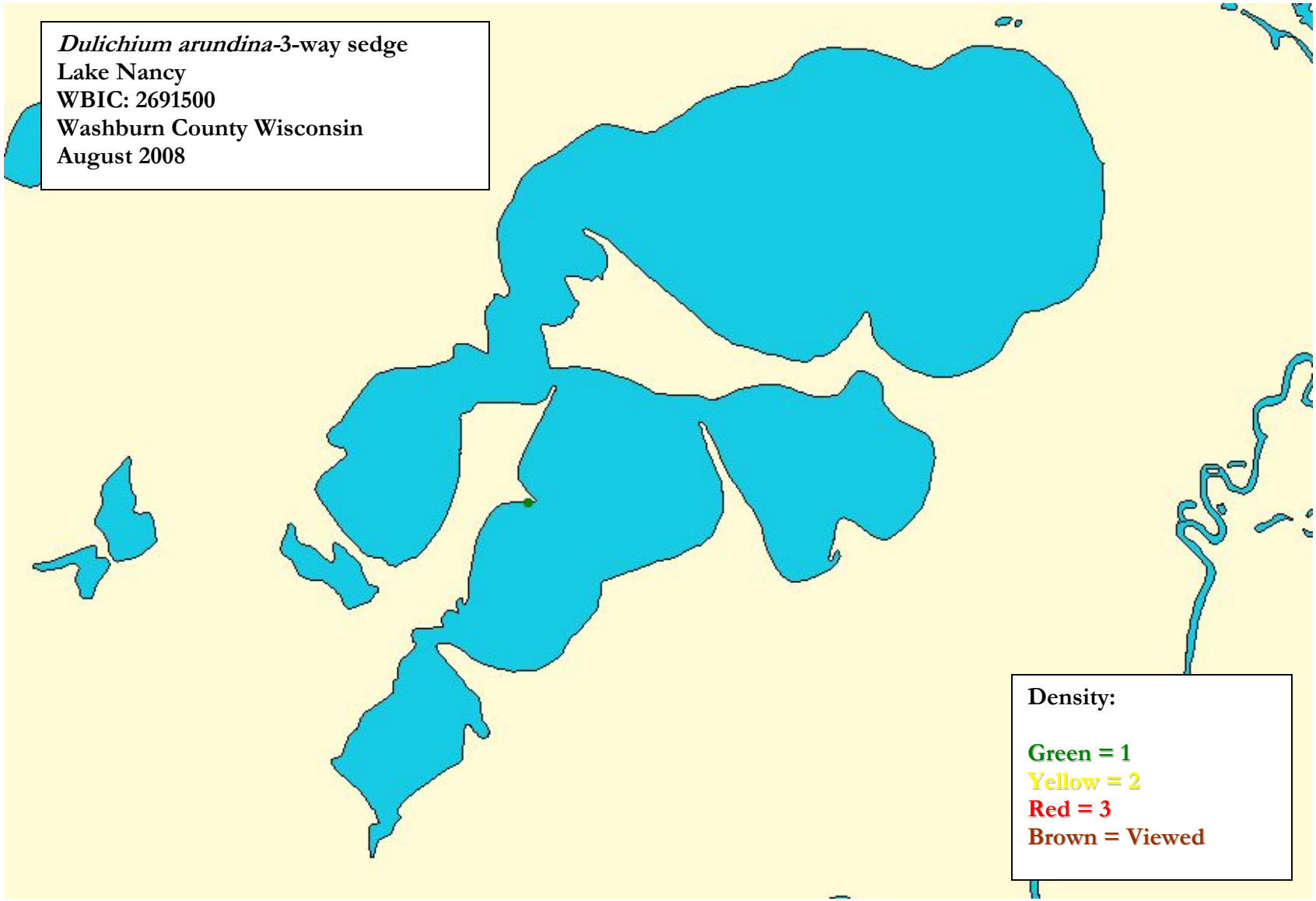
Yellow = 2
Red = 3
Brown = Viewed


Dulichium arundina-3-way sedge
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Washburn County Wisconsin
August 2008
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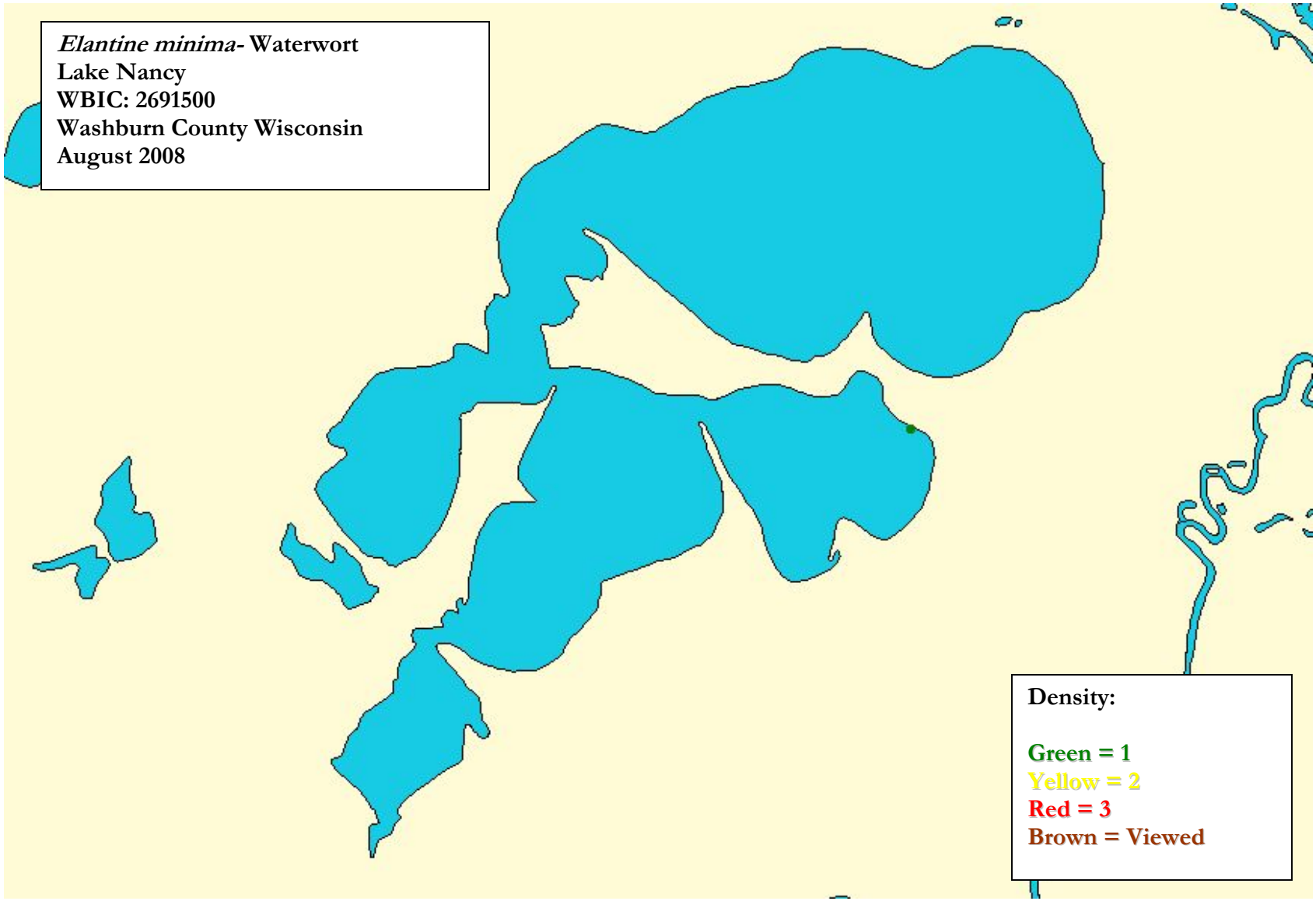
Brown = Viewed


Elantine minima- Waterwort
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Washburn County Wisconsin
August 2008
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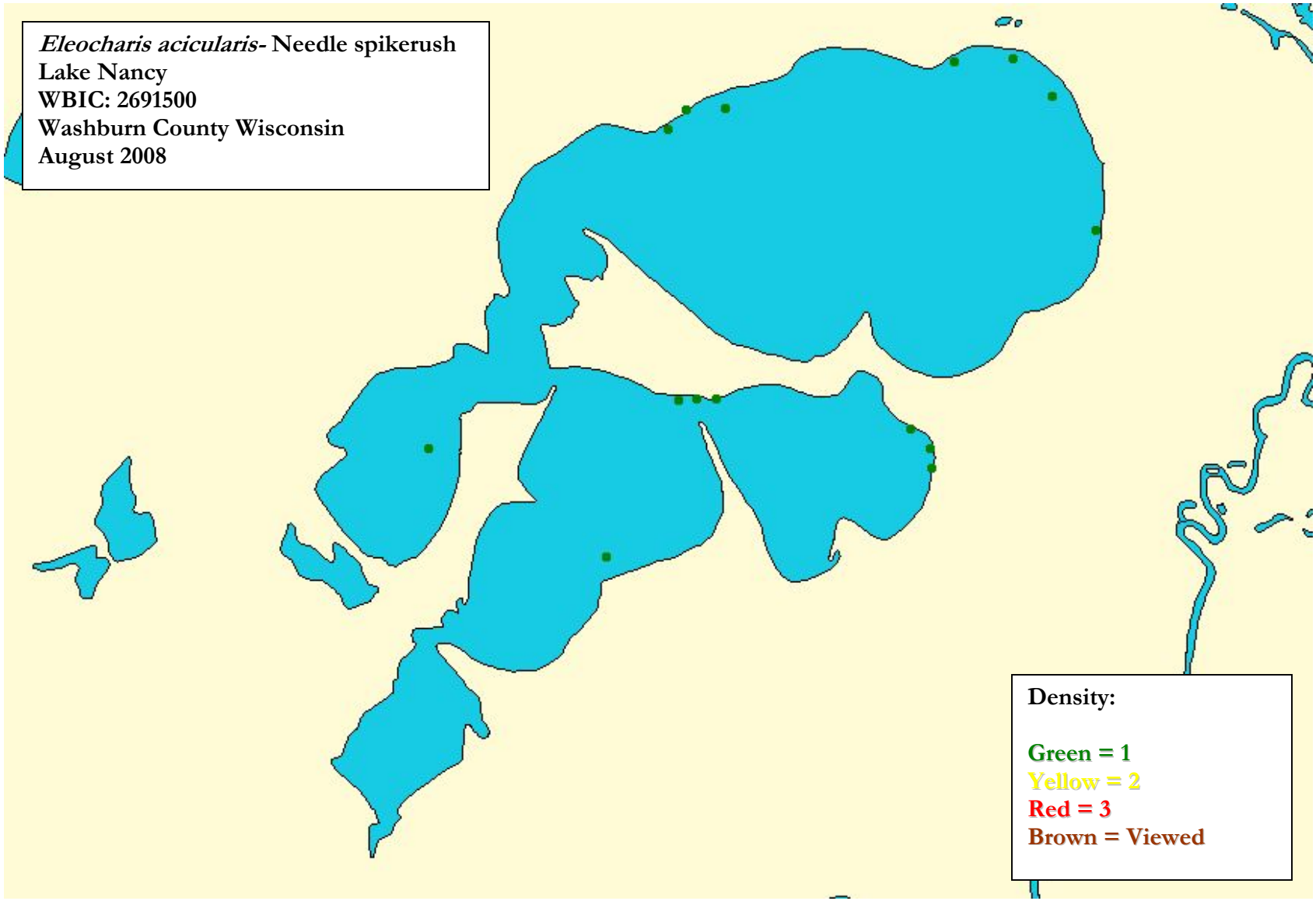
Brown = Viewed


Eleocharis acicularis- Needle spikerush
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Washburn County Wisconsin
August 2008
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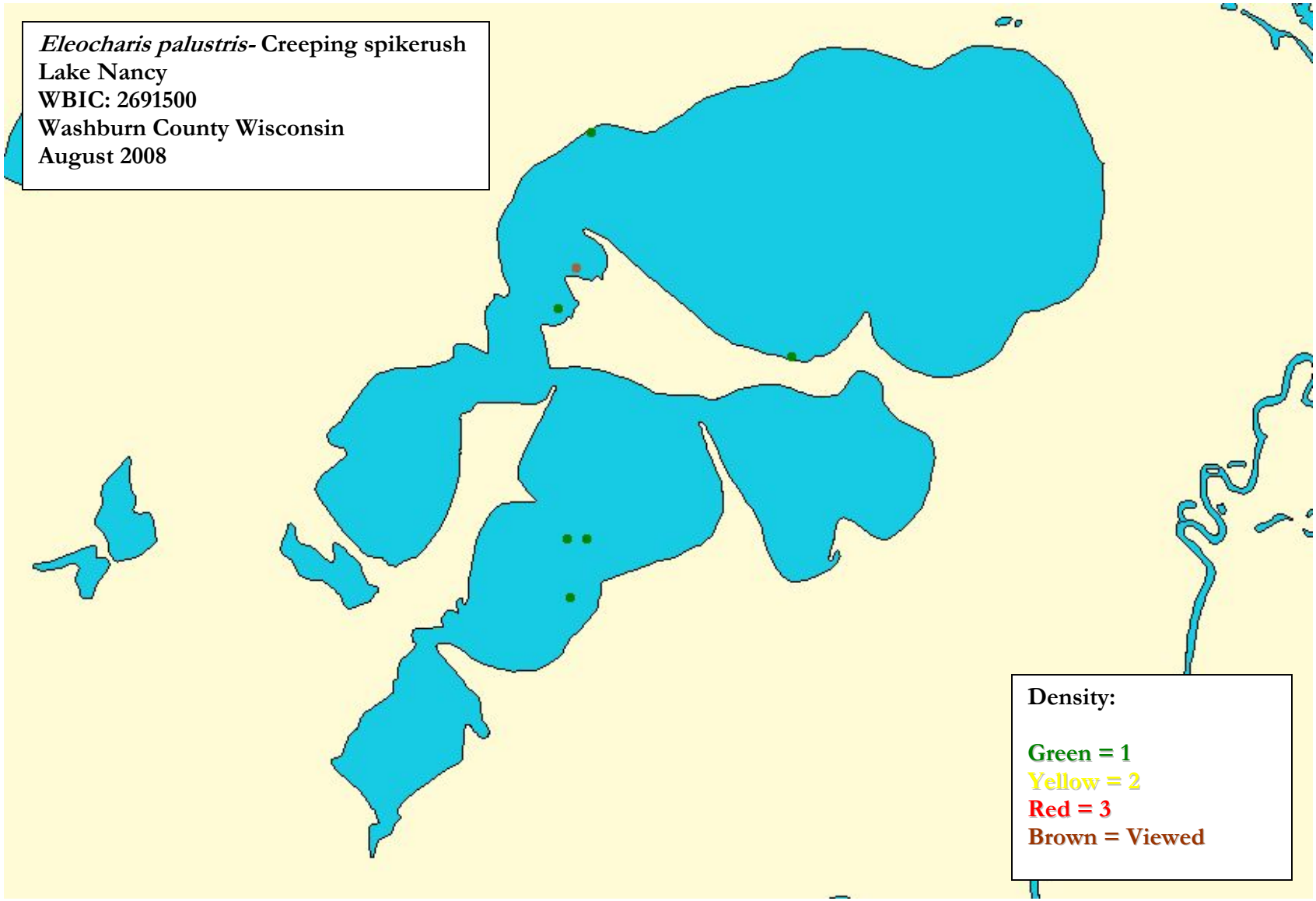
Yellow = 2
Red = 3
Brown = Viewed


Eleocharis palustris- Creeping spikerush
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Washburn County Wisconsin
August 2008
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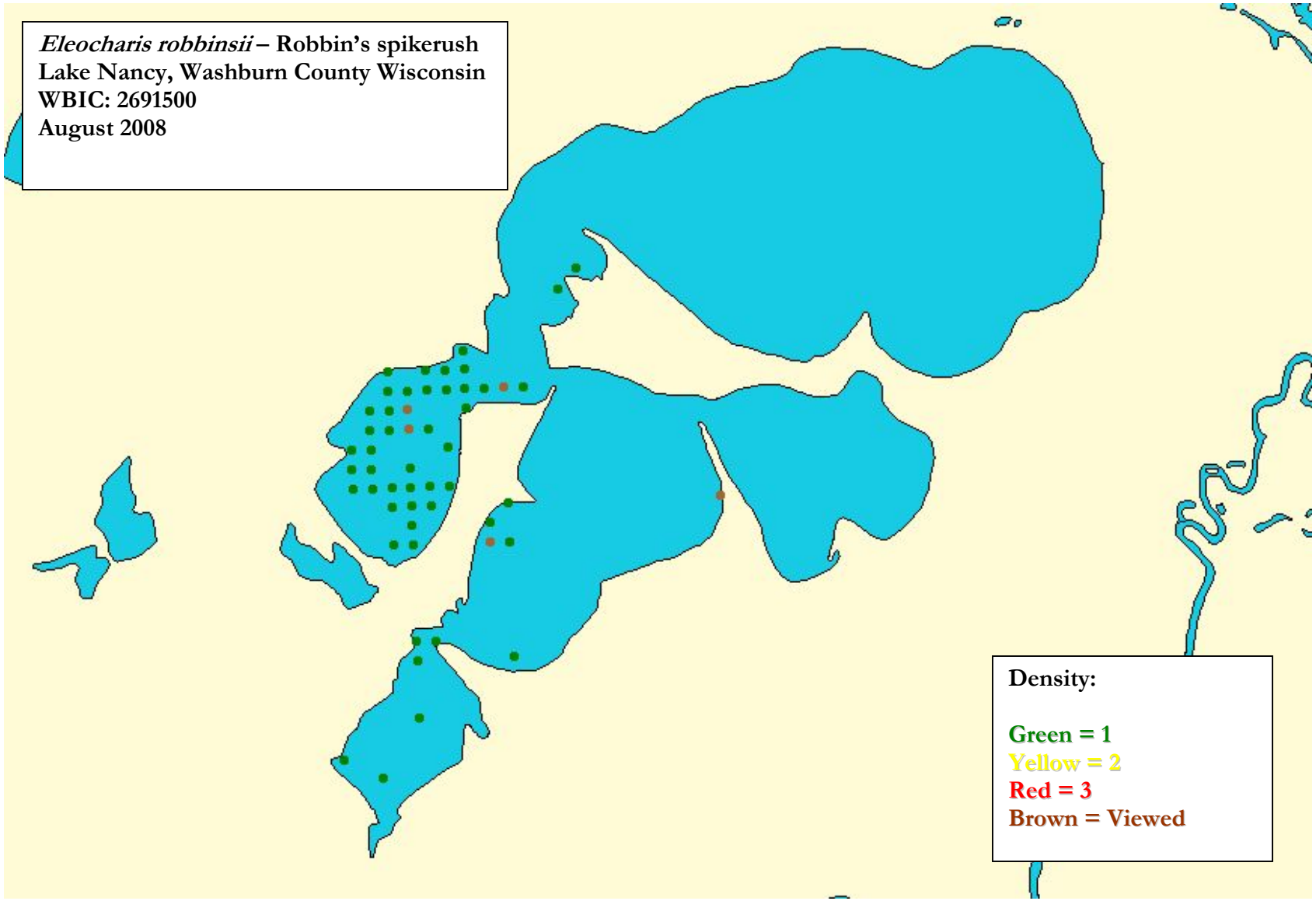
Eleocharis robbinsii – Robbin's spikerush
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August 2008
Density:
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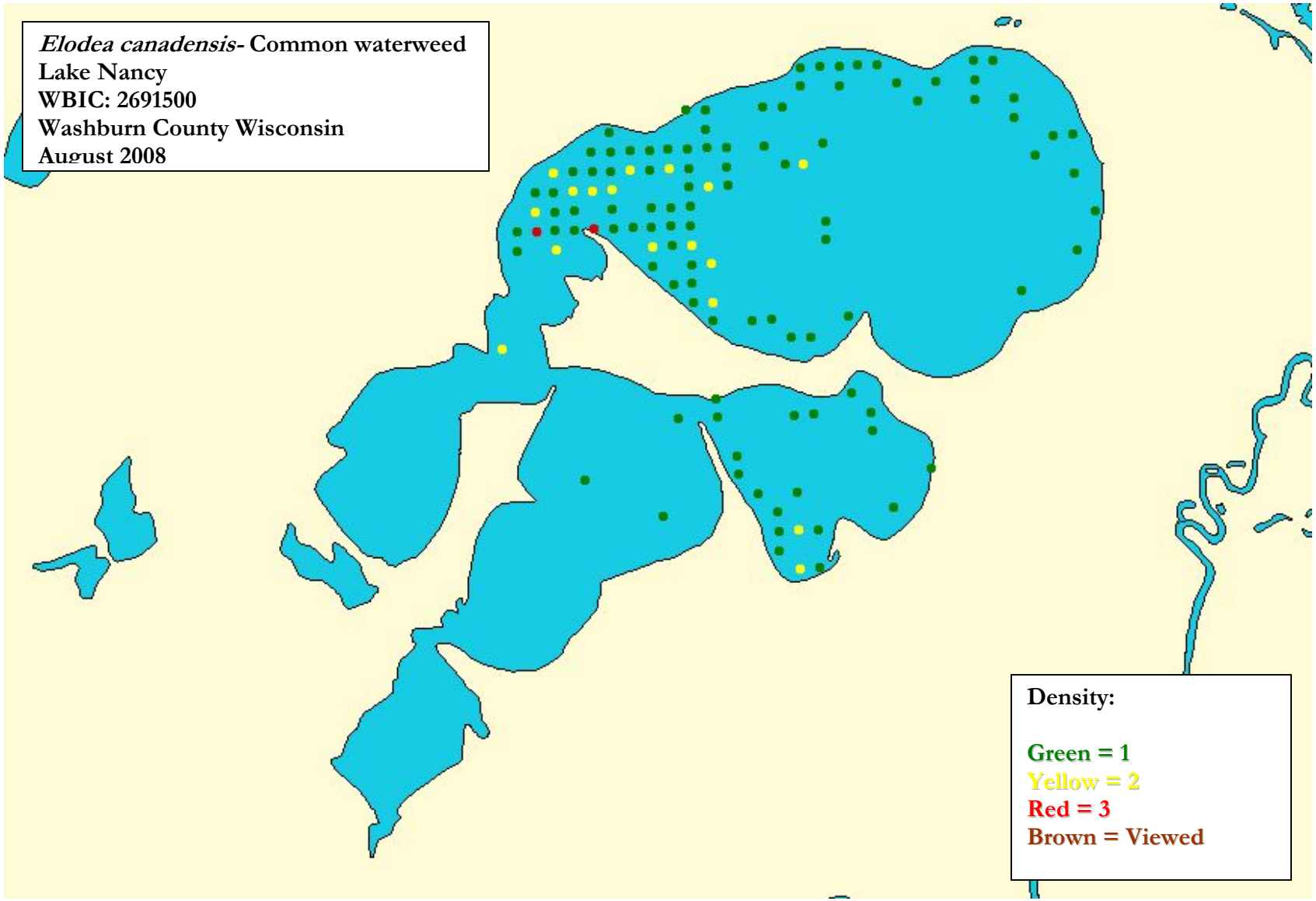
Brown = Viewed


Elodea canadensis- Common waterweed
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August 2008
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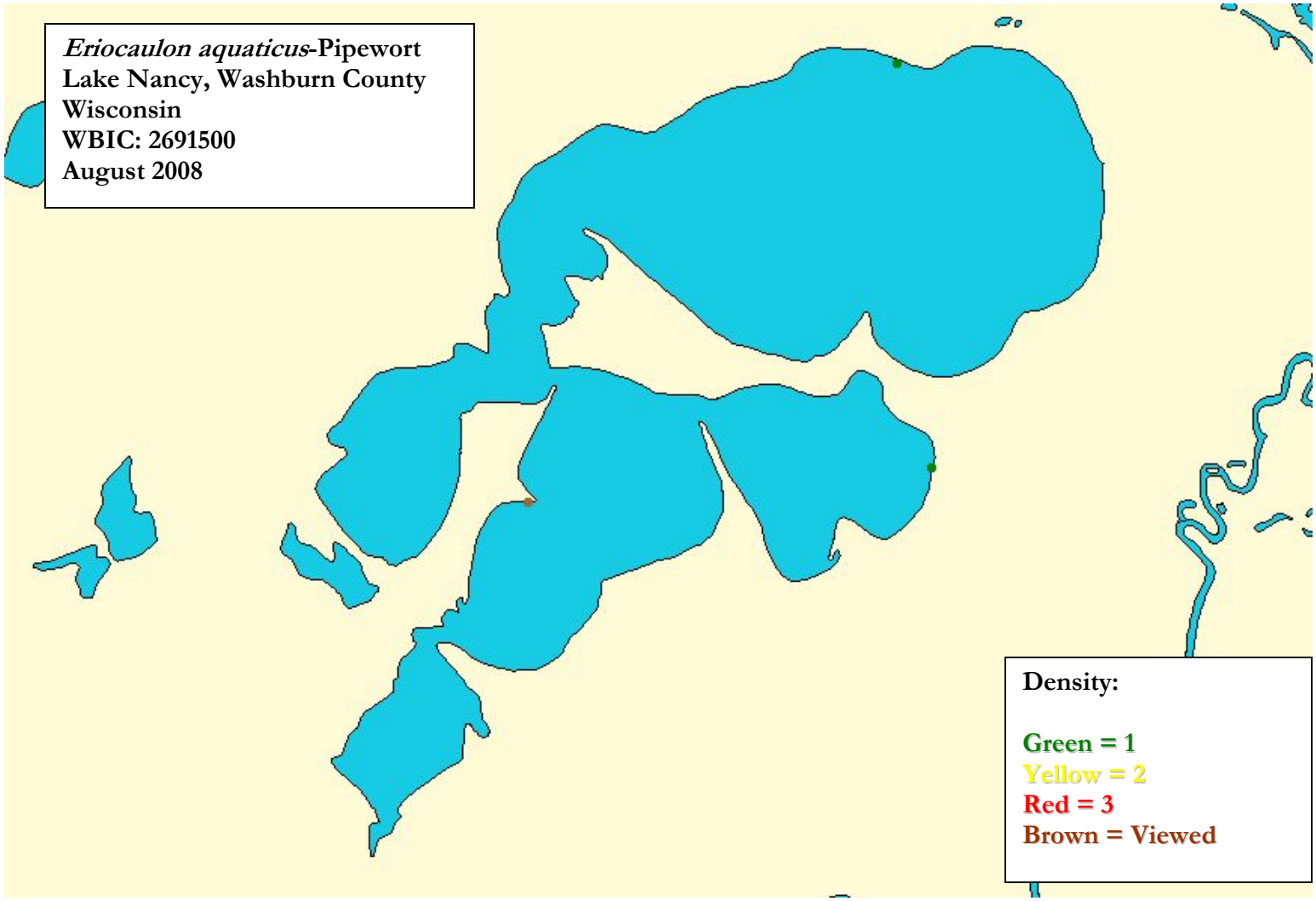
Eriocaulon aquaticus-Pipewort
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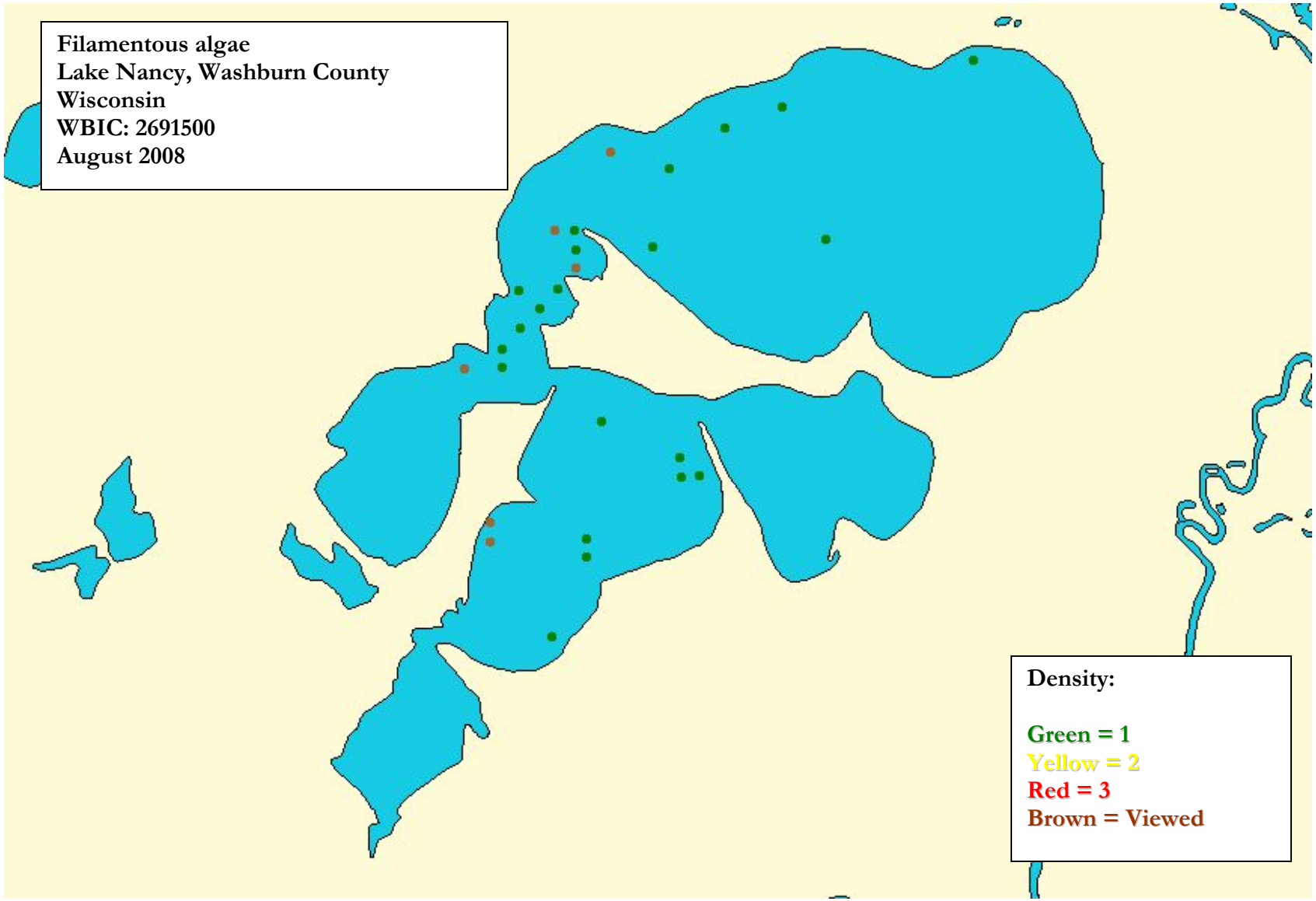
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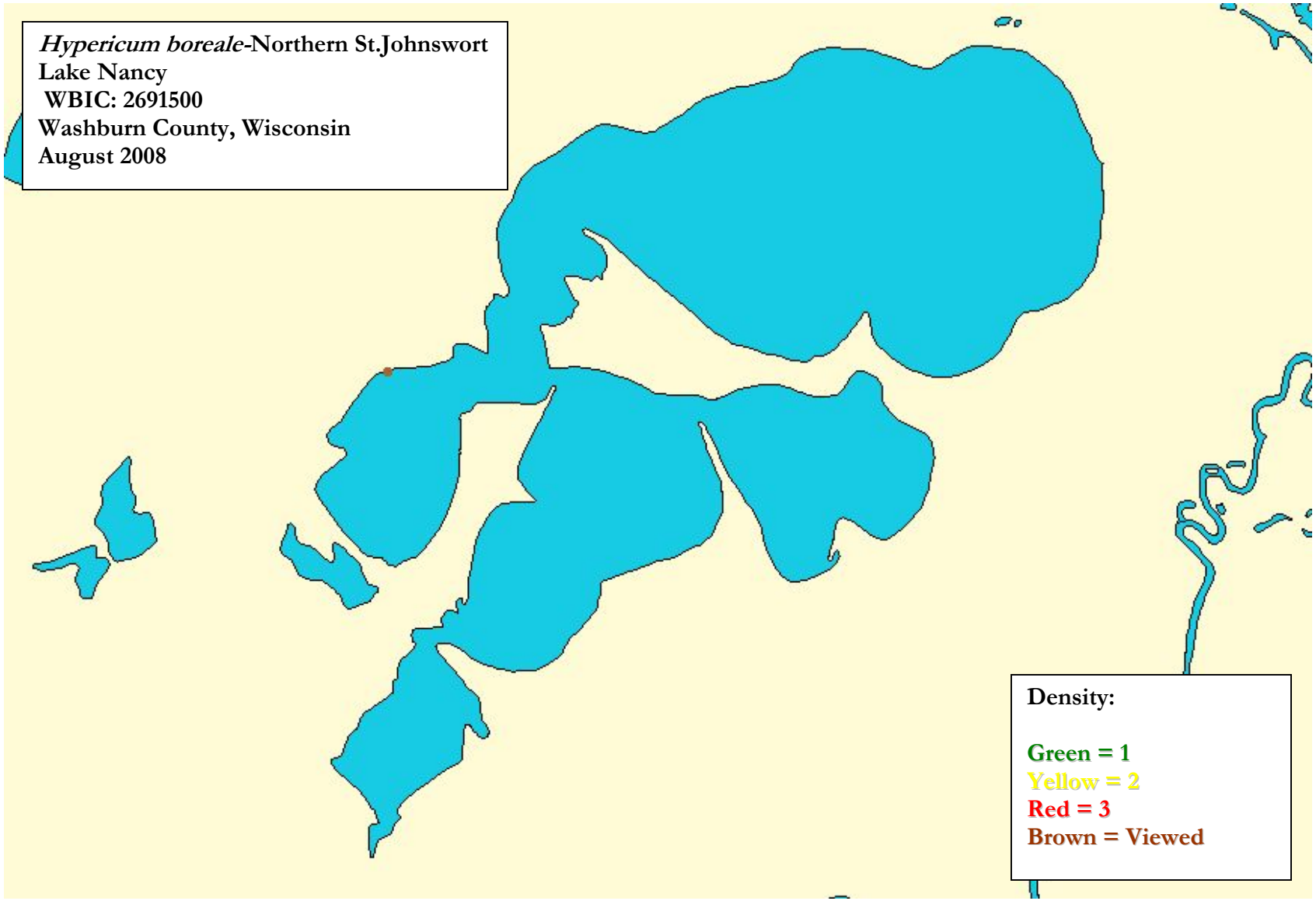
Hypericum boreale-Northern St.Johnswort
Lake Nancy
WBIC: 2691500
Washburn County, Wisconsin
August 2008
Density:
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Yellow = 2
Red = 3
Brown = Viewed


Juncus palocarpus f. submersus-Brown fruited rush
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Wisconsin
WBIC: 2691500
August 2008
Density:
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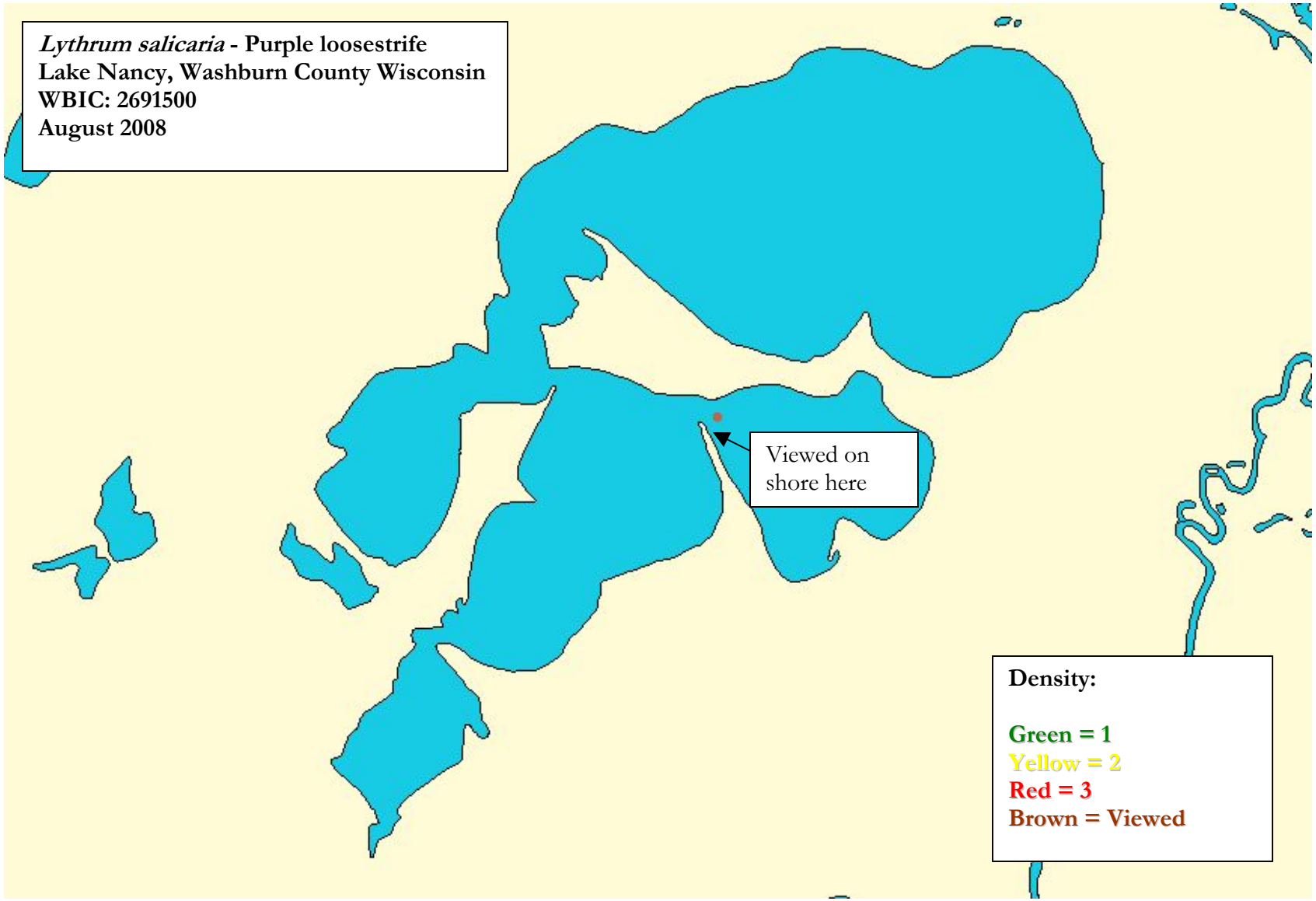
Red = 3
Brown = Viewed


Lythrum salicaria - Purple loosestrife
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WBIC: 2691500
August 2008
Viewed on shore here
Density:
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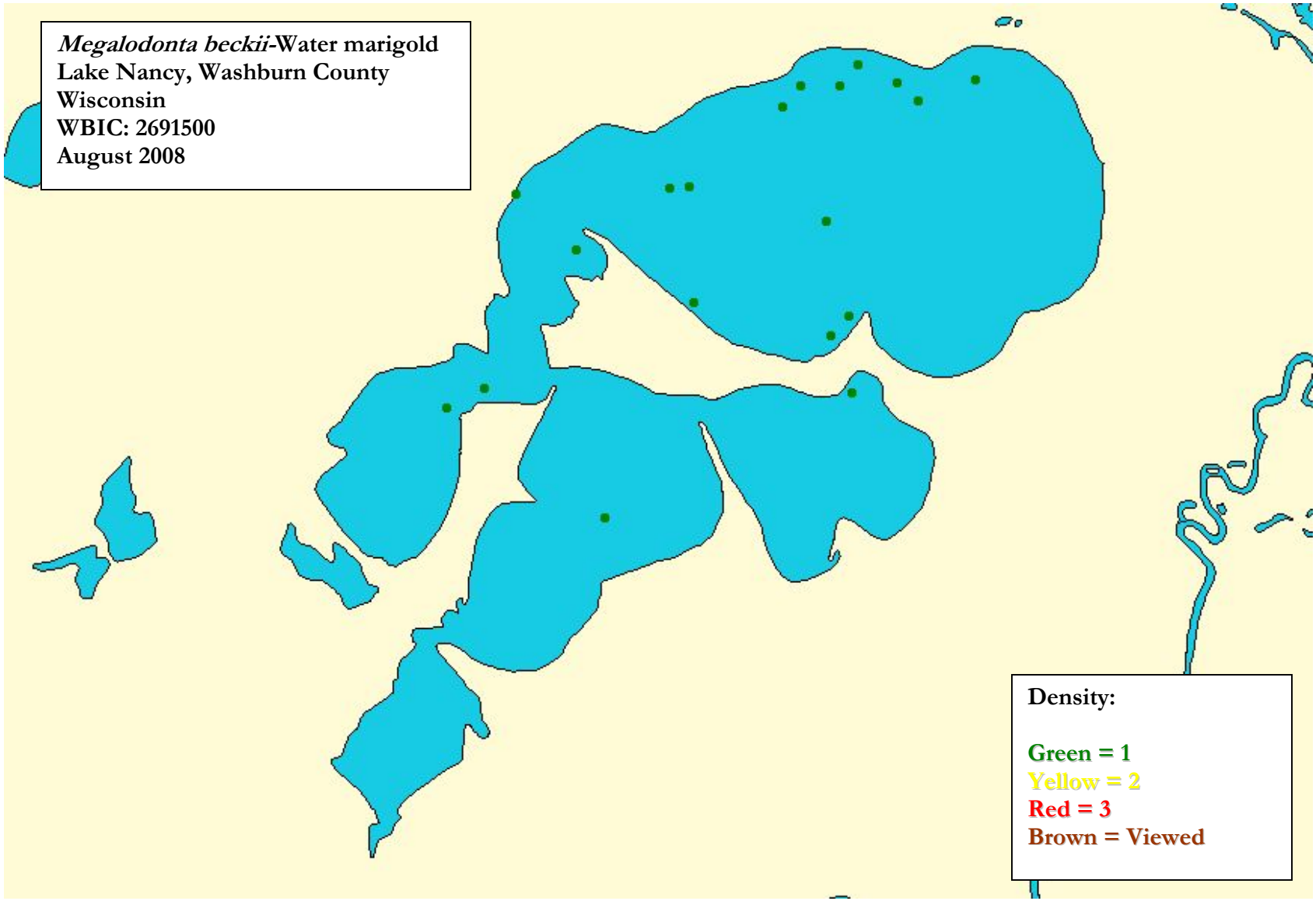
Yellow = 2
Red = 3
Brown = Viewed


Megalodonta beckii-Water marigold
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Wisconsin
WBIC: 2691500
August 2008
Density:
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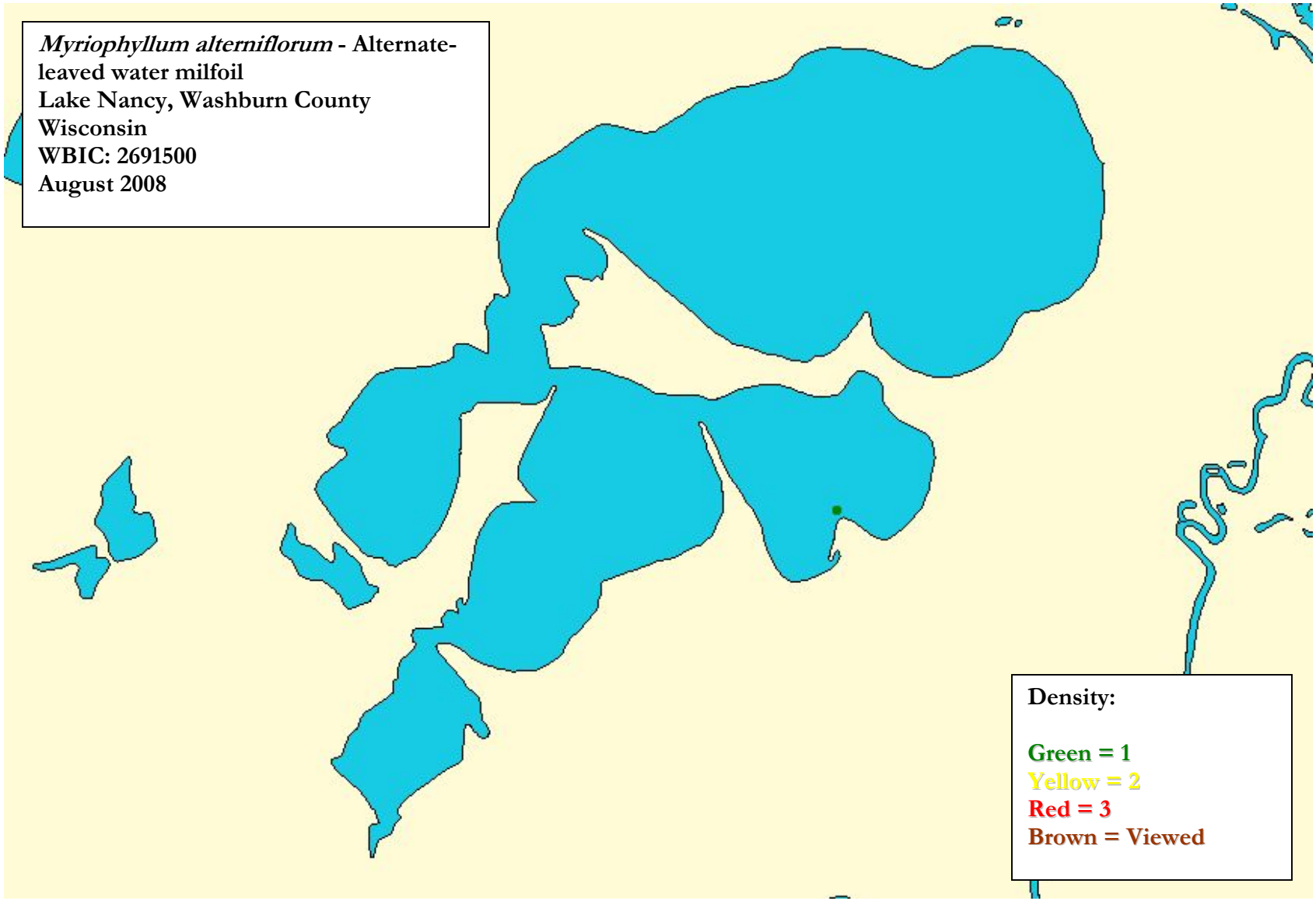
Red = 3
Brown = Viewed


Myriophyllum alterniflorum - Alternate-leaved water milfoil
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Wisconsin
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August 2008
Density:
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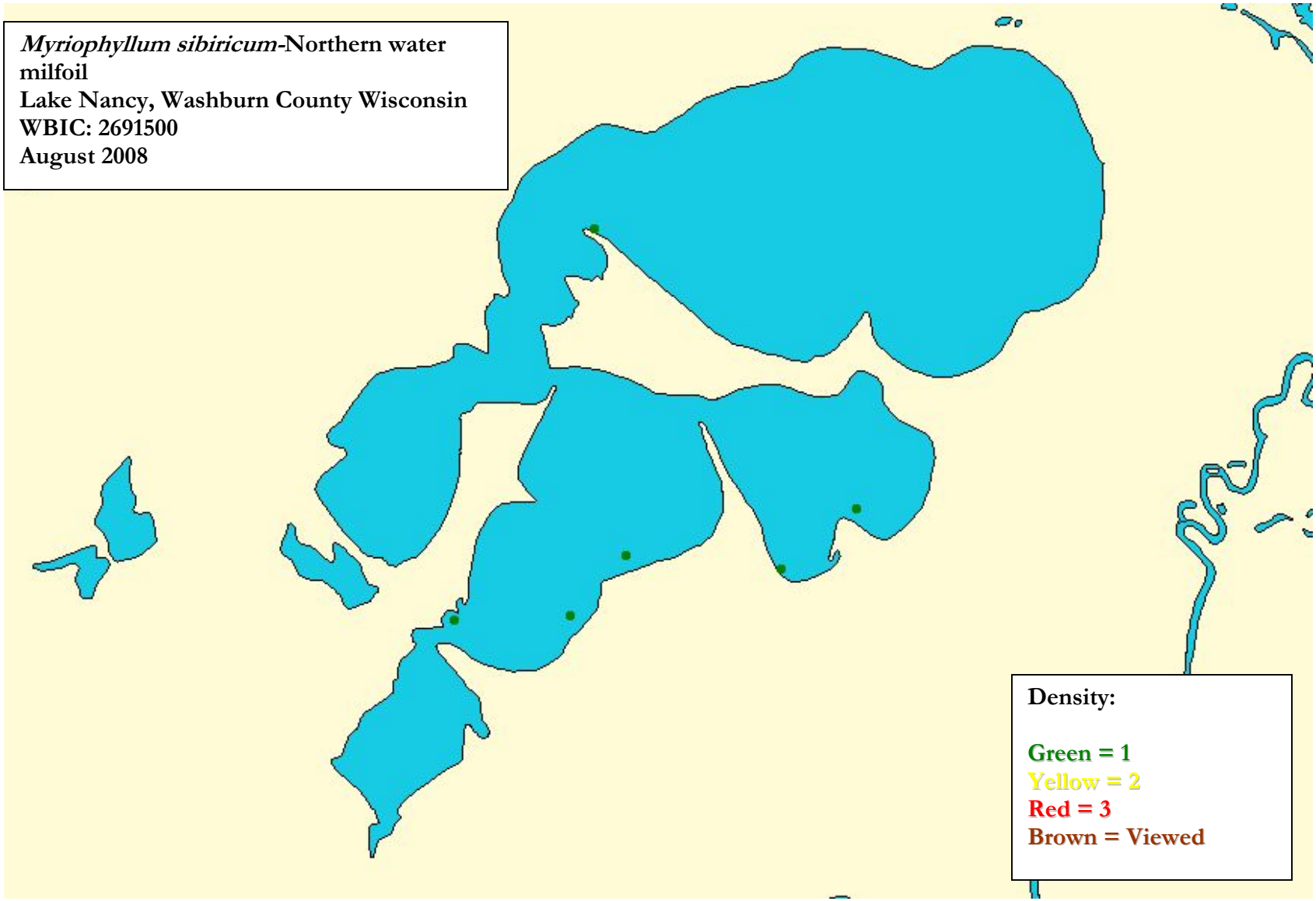
Myriophyllum sibiricum-Northern water milfoil
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August 2008
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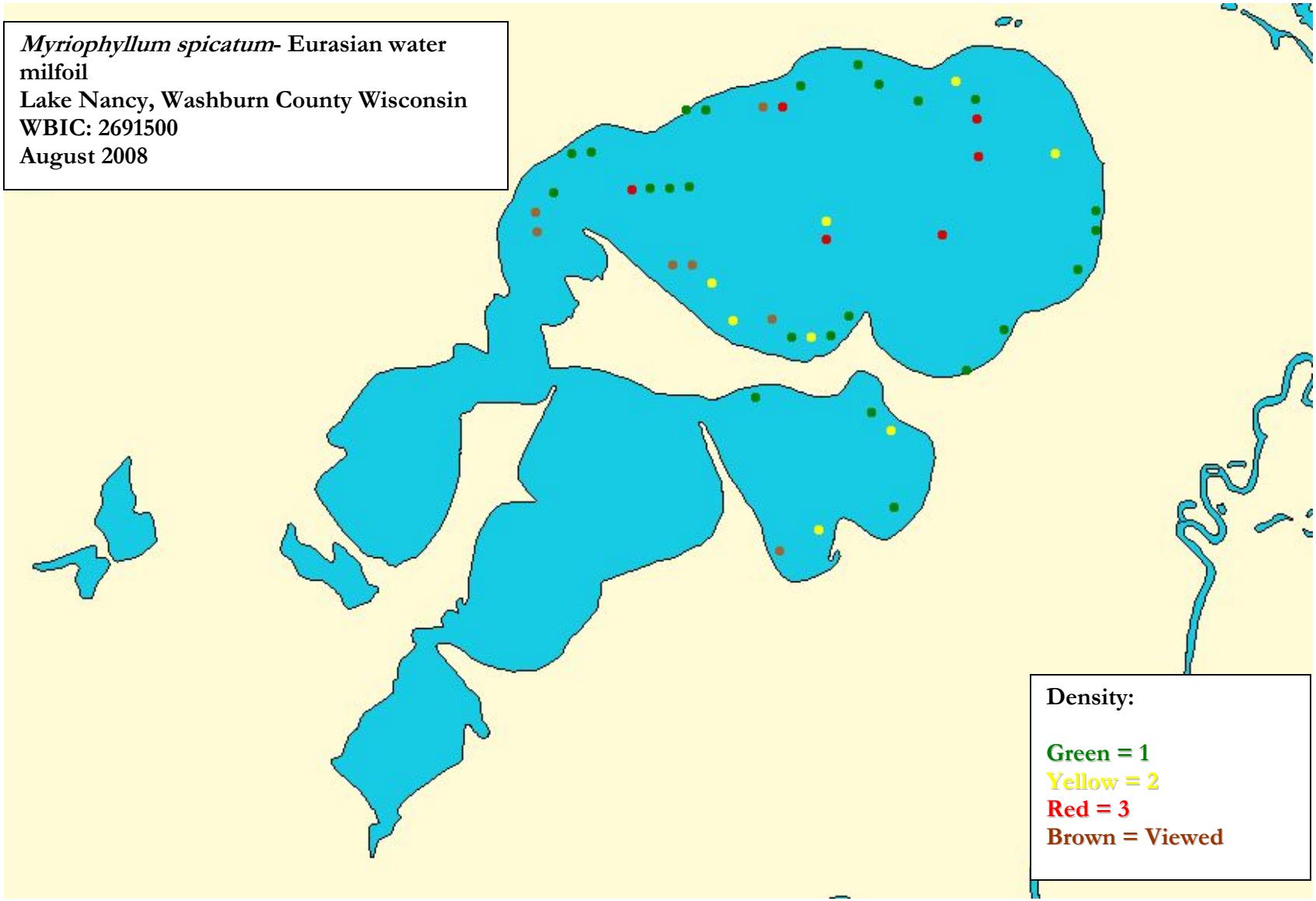
Myriophyllum spicatum- Eurasian water milfoil
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August 2008
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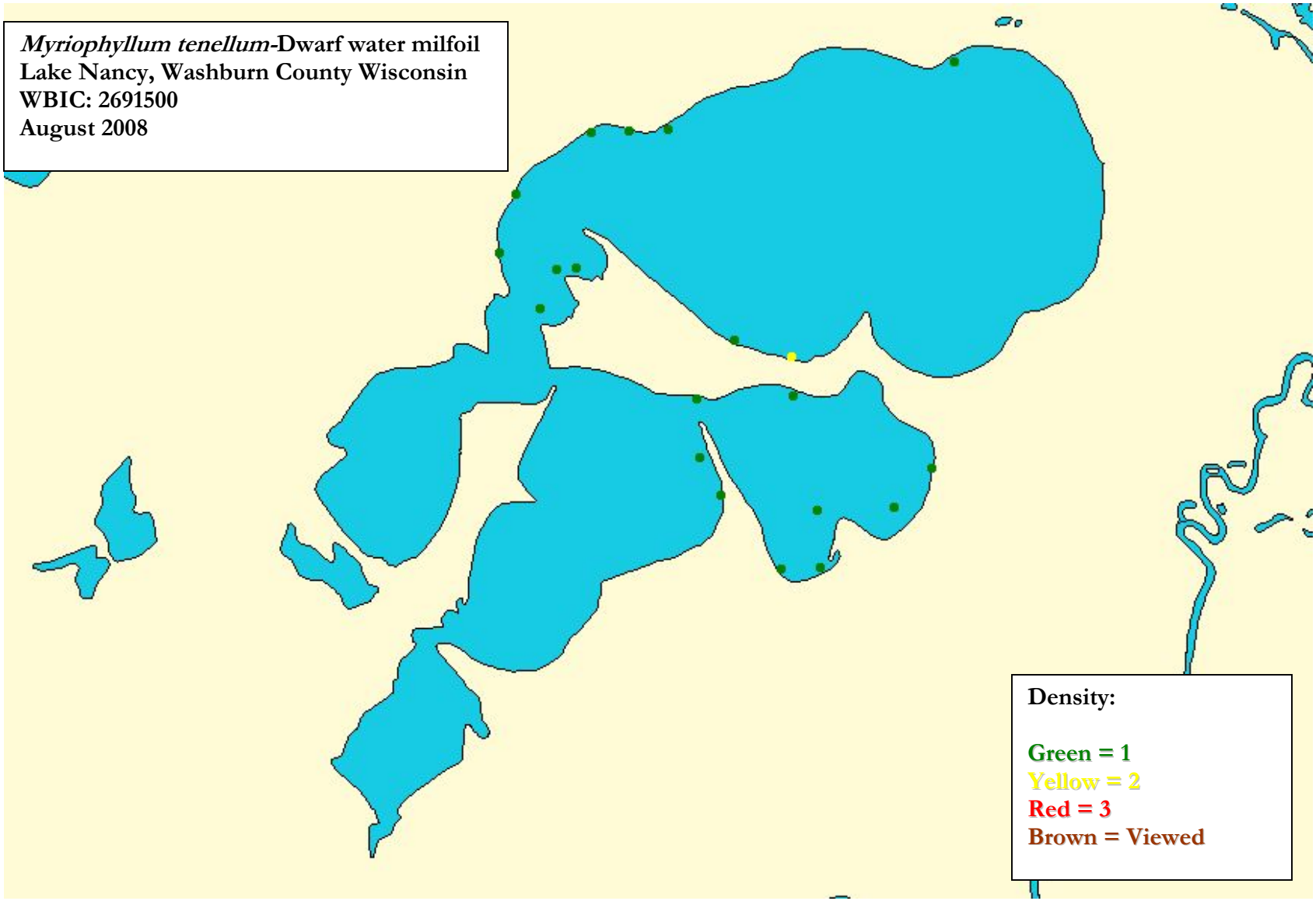
Myriophyllum tenellum-Dwarf water milfoil
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August 2008
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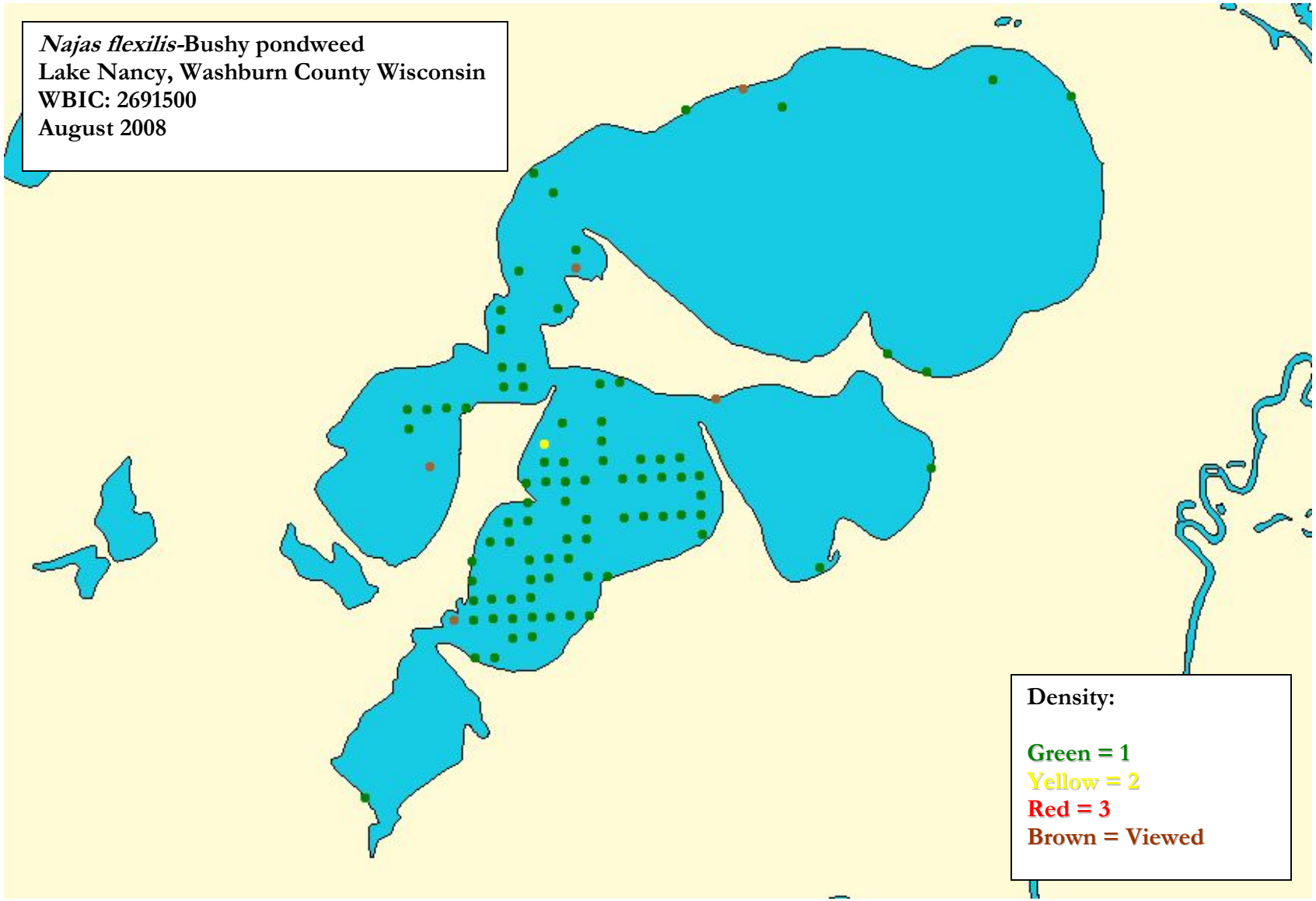
Najas flexilis-Bushy pondweed
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August 2008
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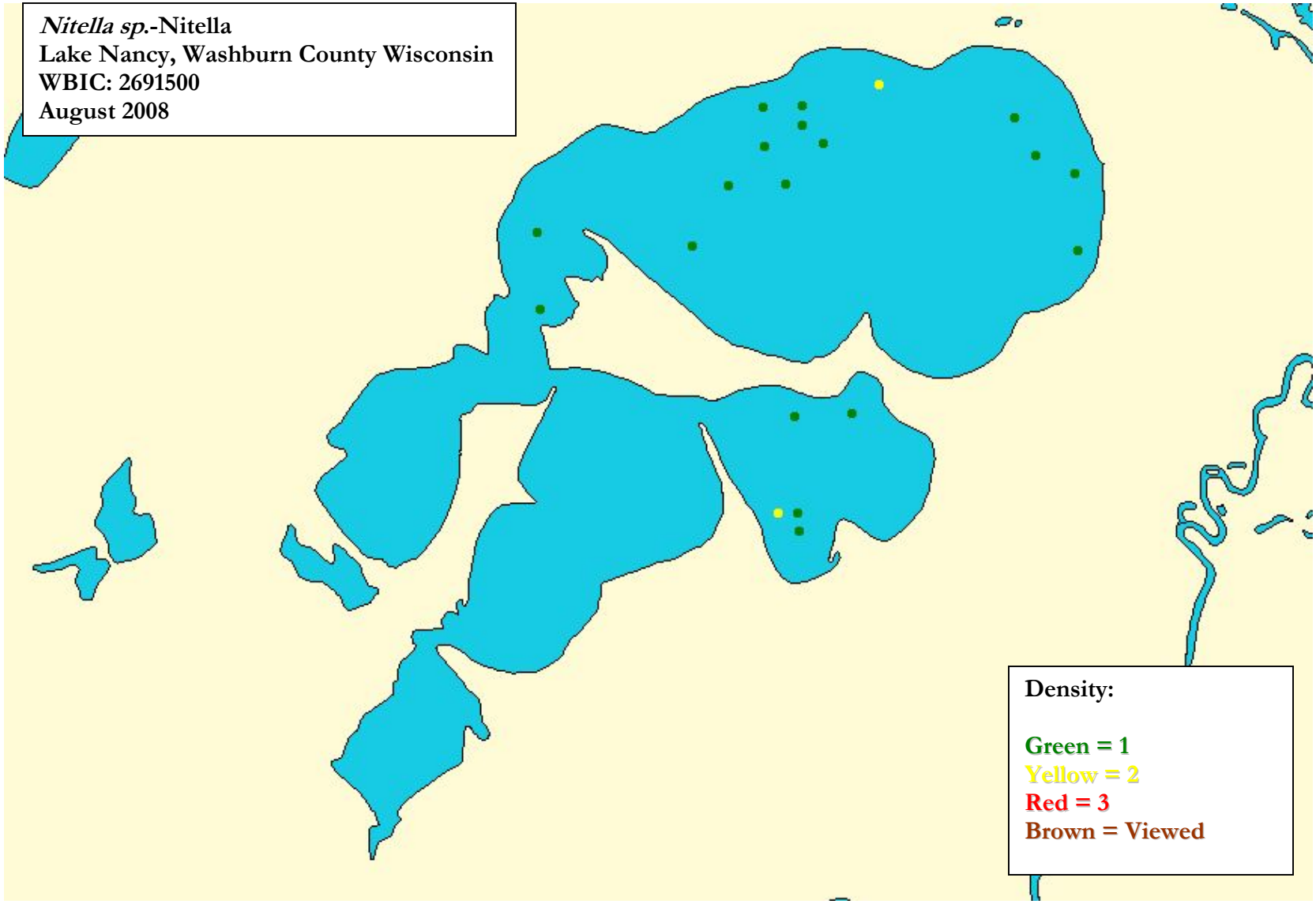
Nitella sp.-Nitella
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WBIC: 2691500
August 2008
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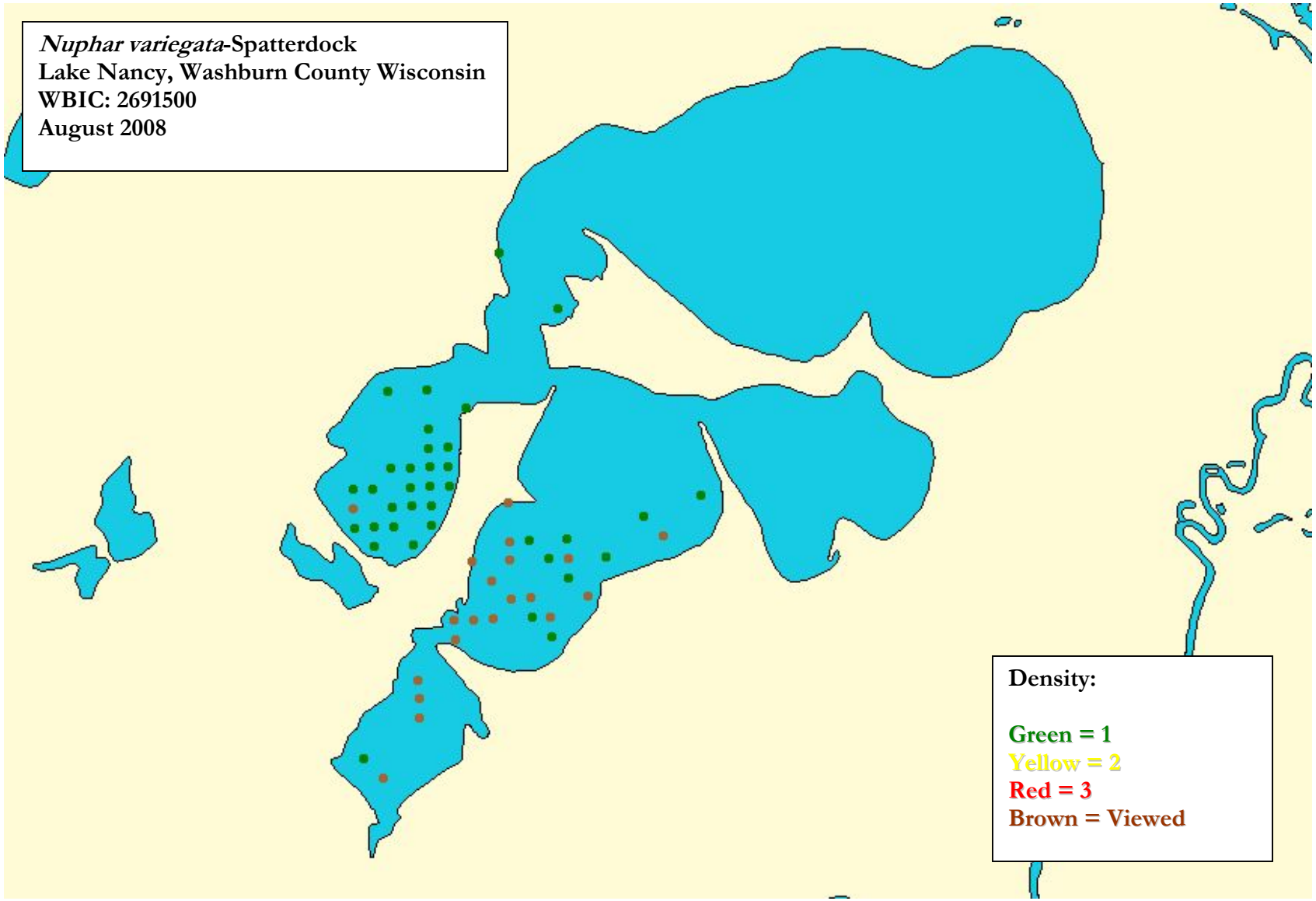
Nuphar variegata-Spatterdock
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WBIC: 2691500
August 2008
Density:
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Red = 3
Brown = Viewed


Nymphaea odorata-White water lily
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August 2008
Density:
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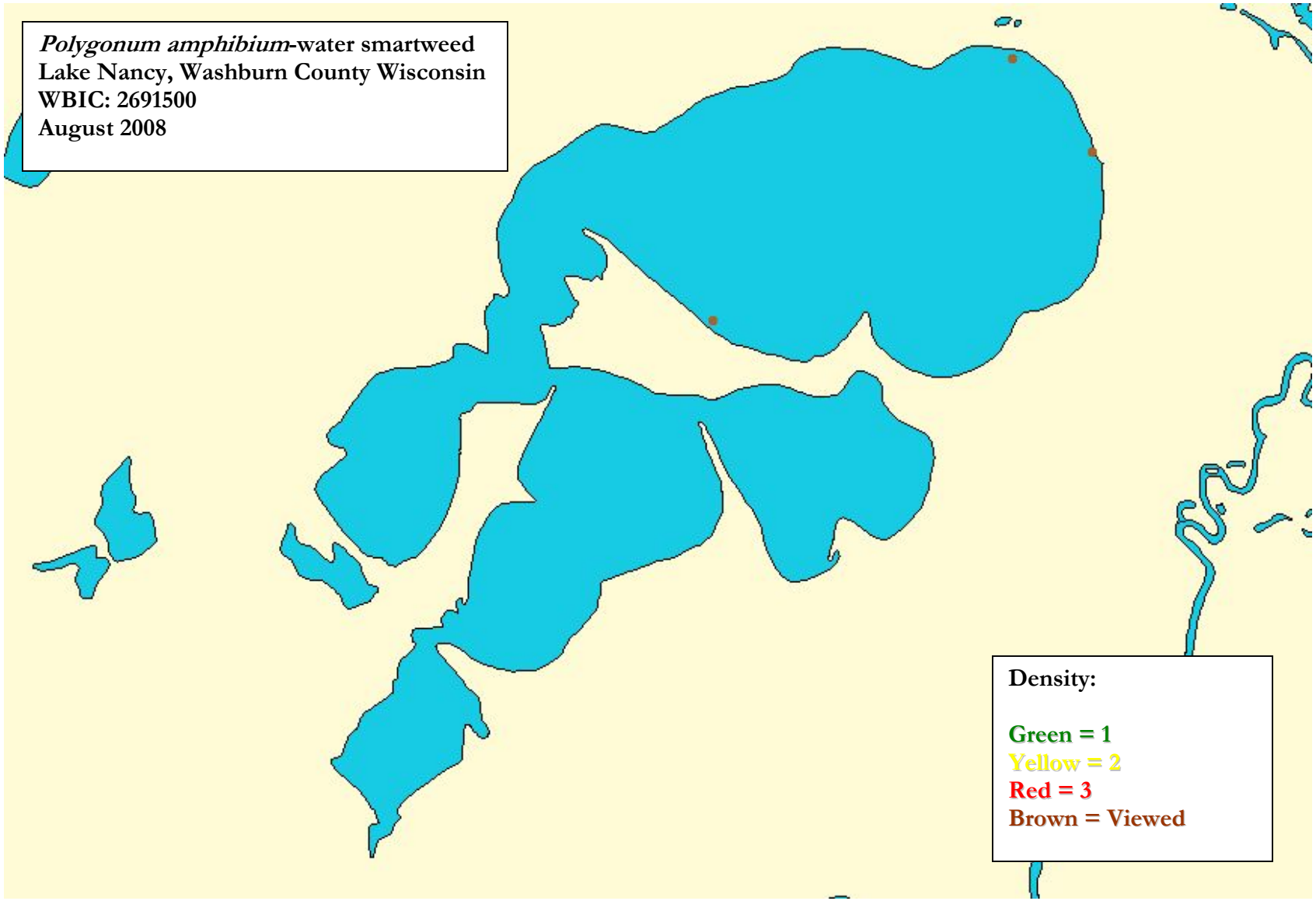
Polygonum amphibium-water smartweed
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August 2008
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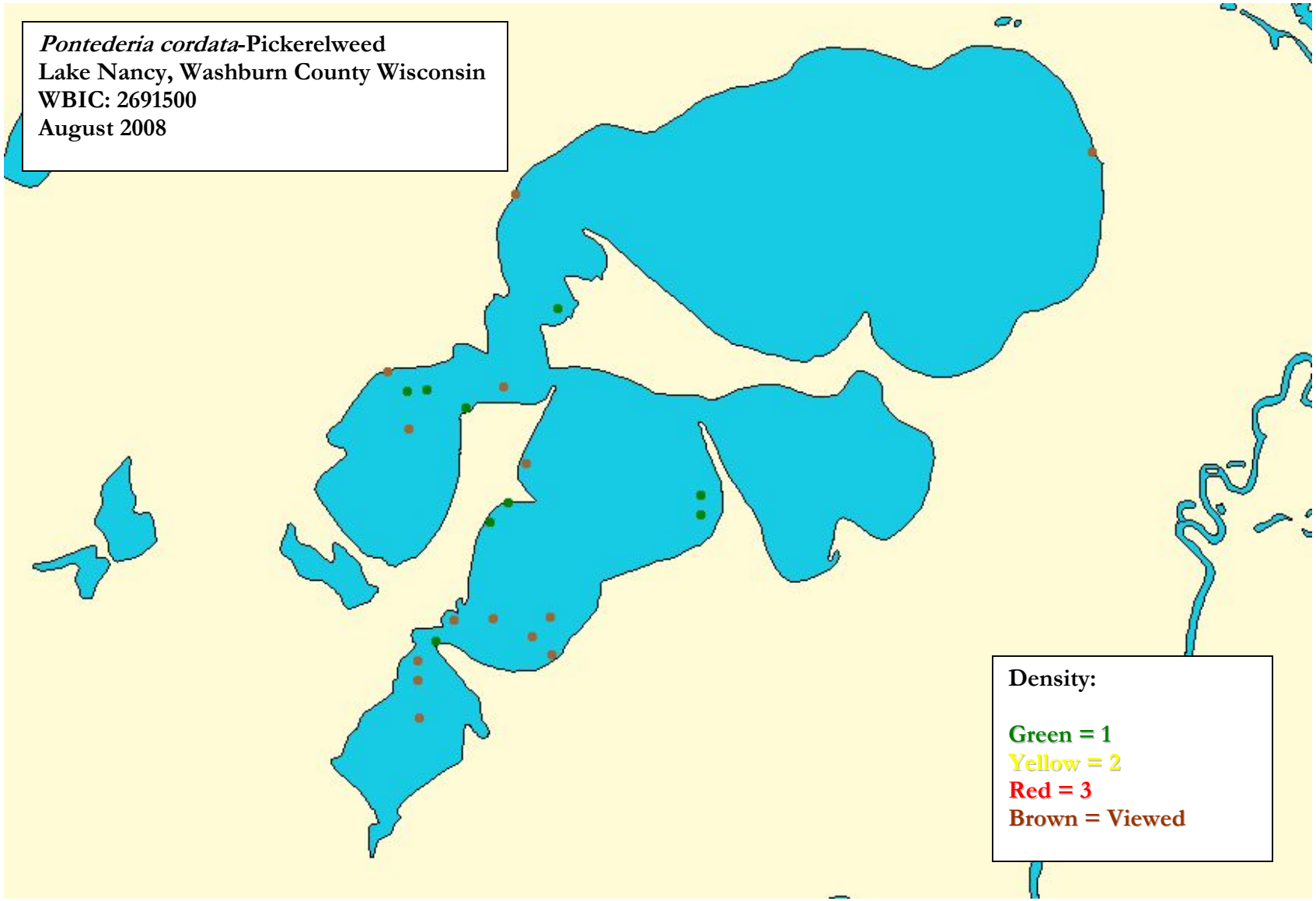
Pontederia cordata-Pickerelweed
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August 2008
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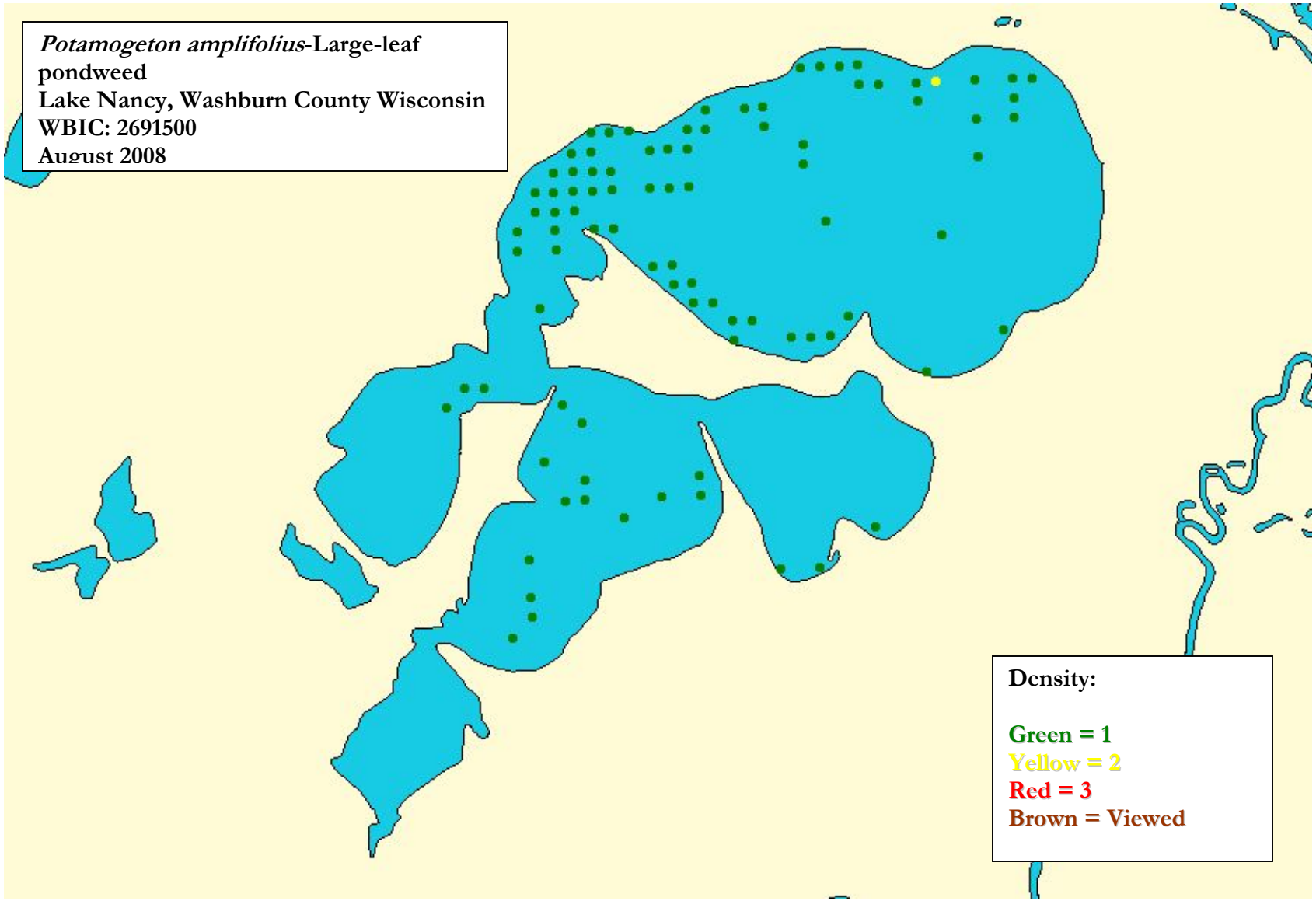
Potamogeton amplifolius-Large-leaf pondweed
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August 2008
Density:
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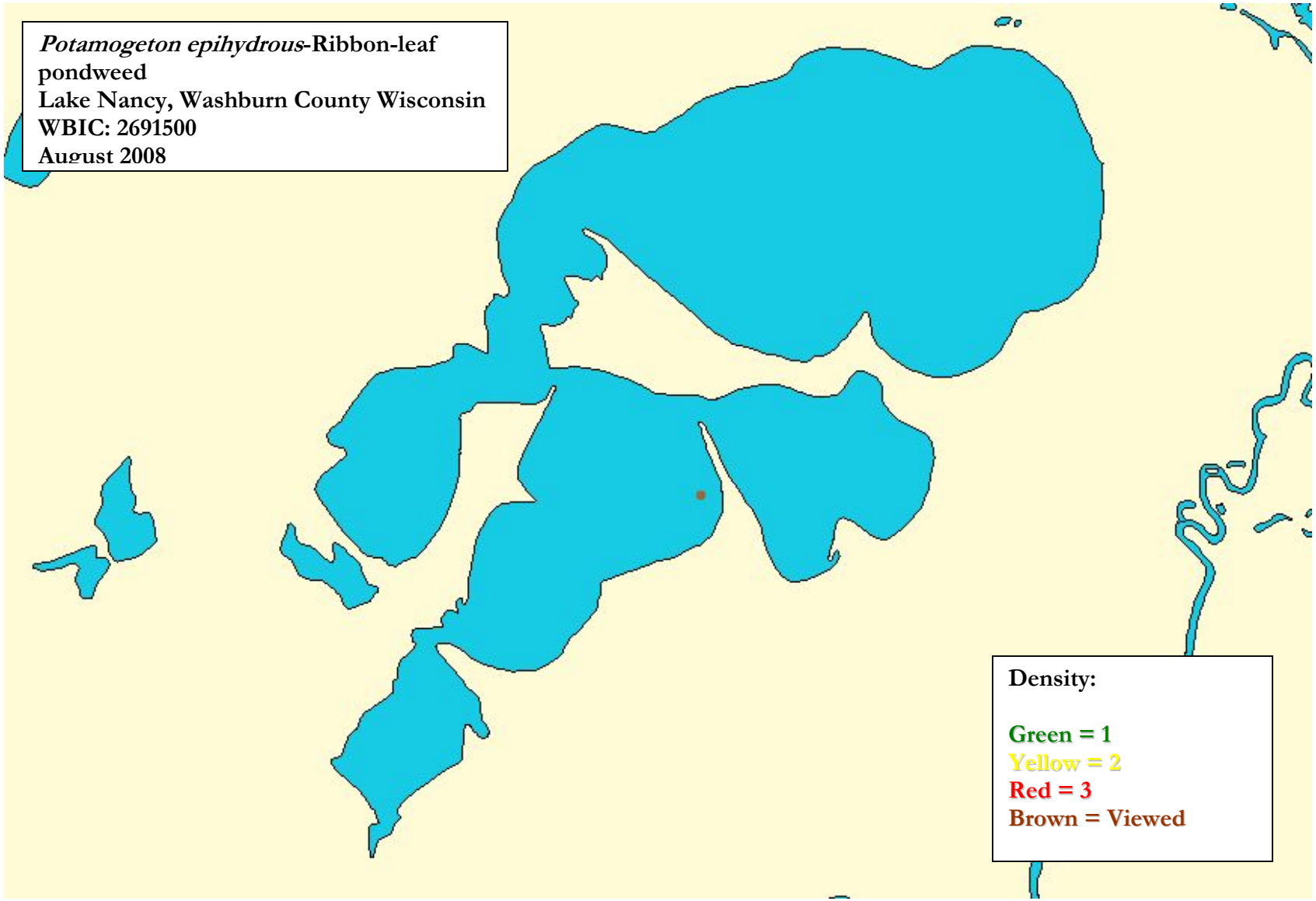
Red = 3
Brown = Viewed


Potamogeton epihydrous-Ribbon-leaf pondweed
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August 2008
Density:
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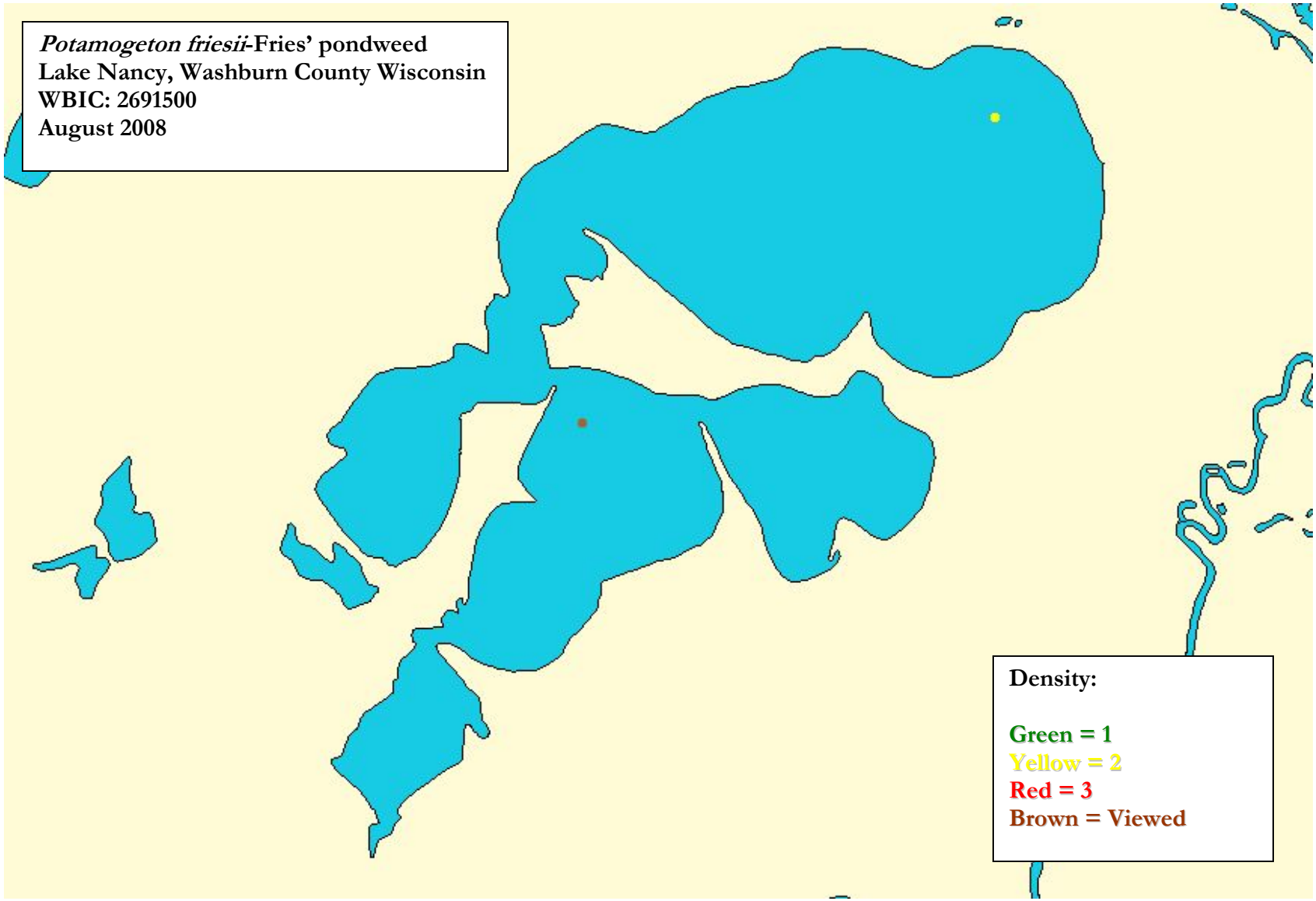
Yellow = 2
Red = 3
Brown = Viewed


Potamogeton friesii-Fries' pondweed
Lake Nancy, Washburn County Wisconsin
WBIC: 2691500
August 2008
Density:
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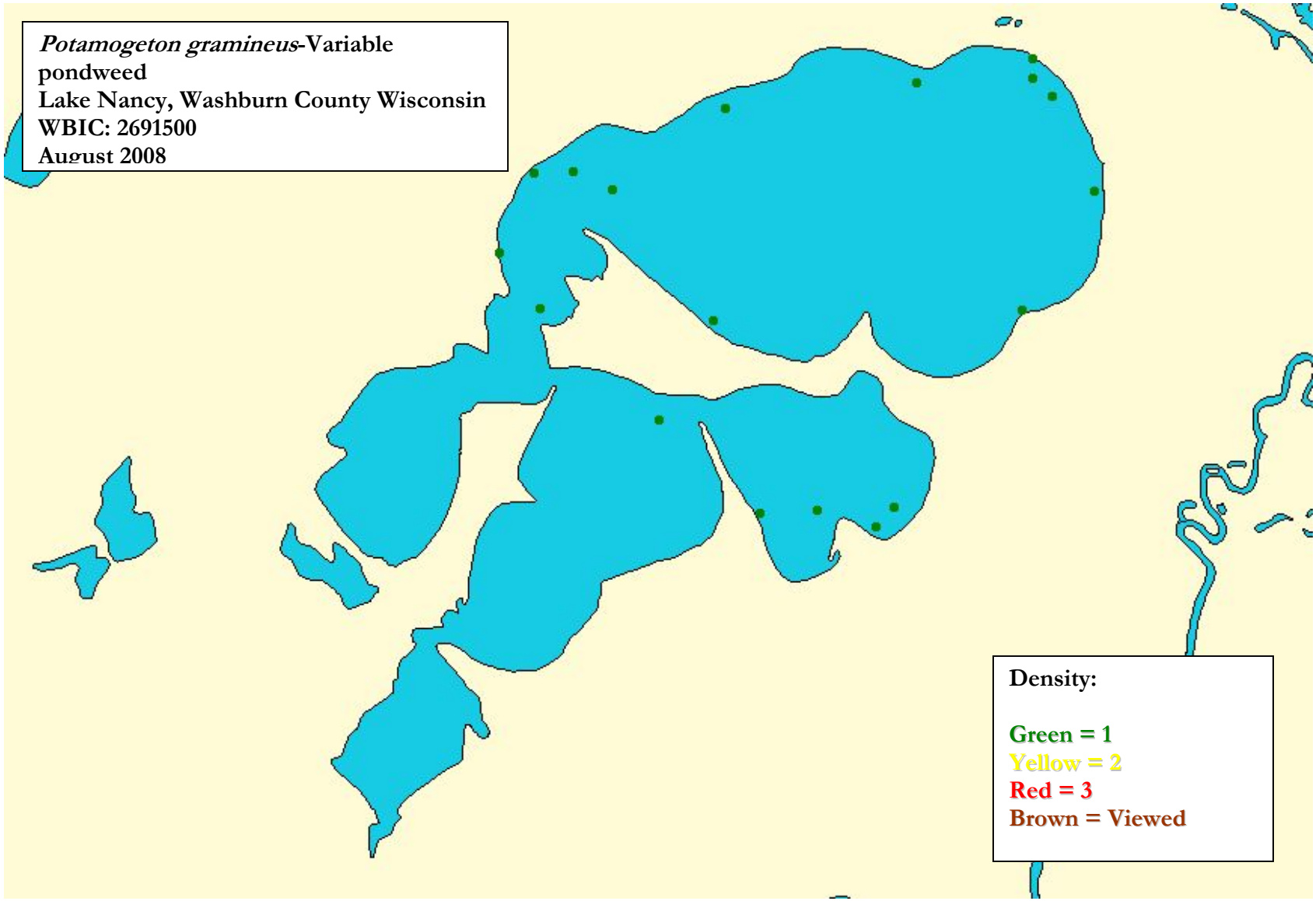
Yellow = 2
Red = 3
Brown = Viewed


Potamogeton gramineus-Variable pondweed
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August 2008
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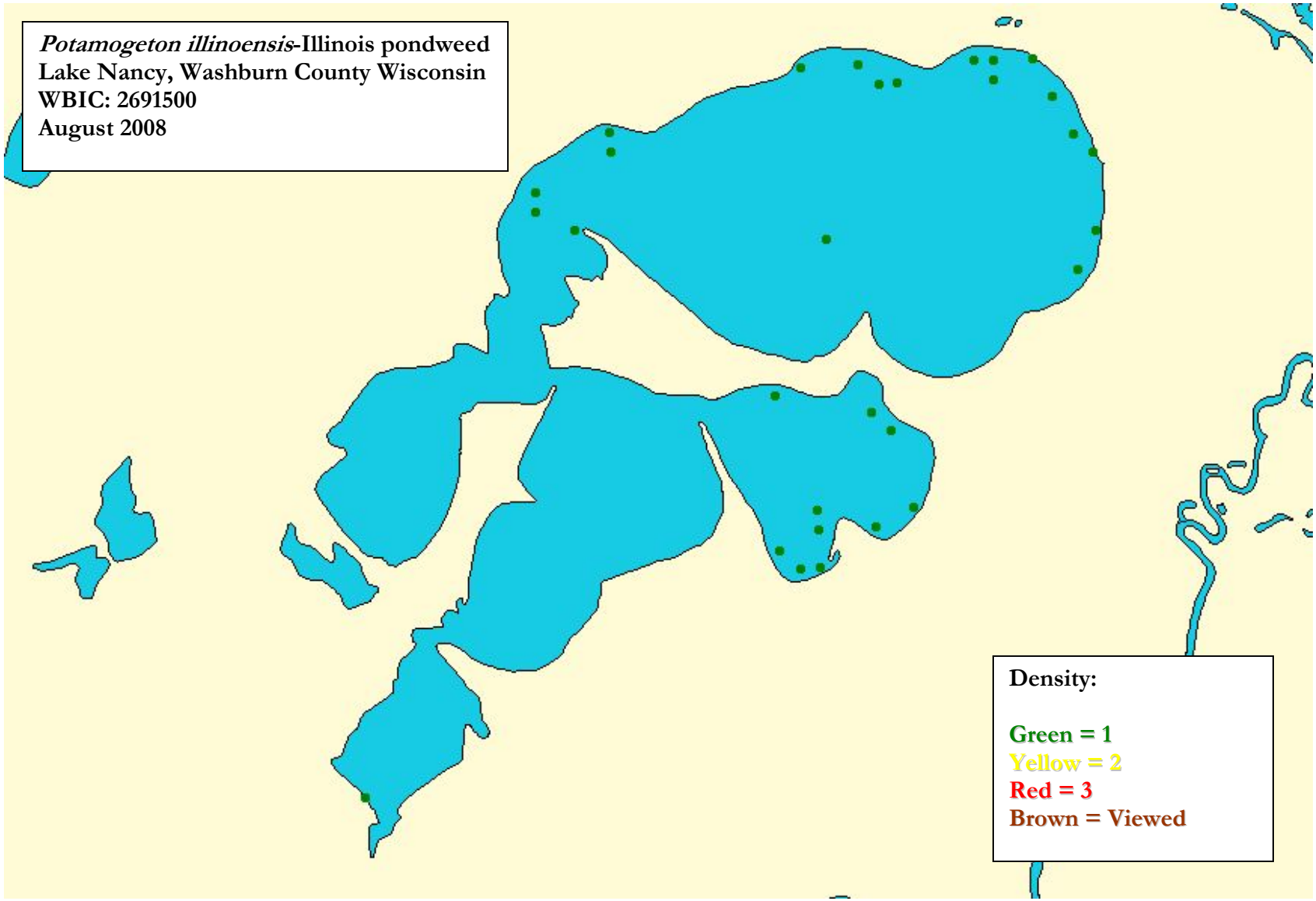
Potamogeton illinoensis-Illinois pondweed
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August 2008
Density:
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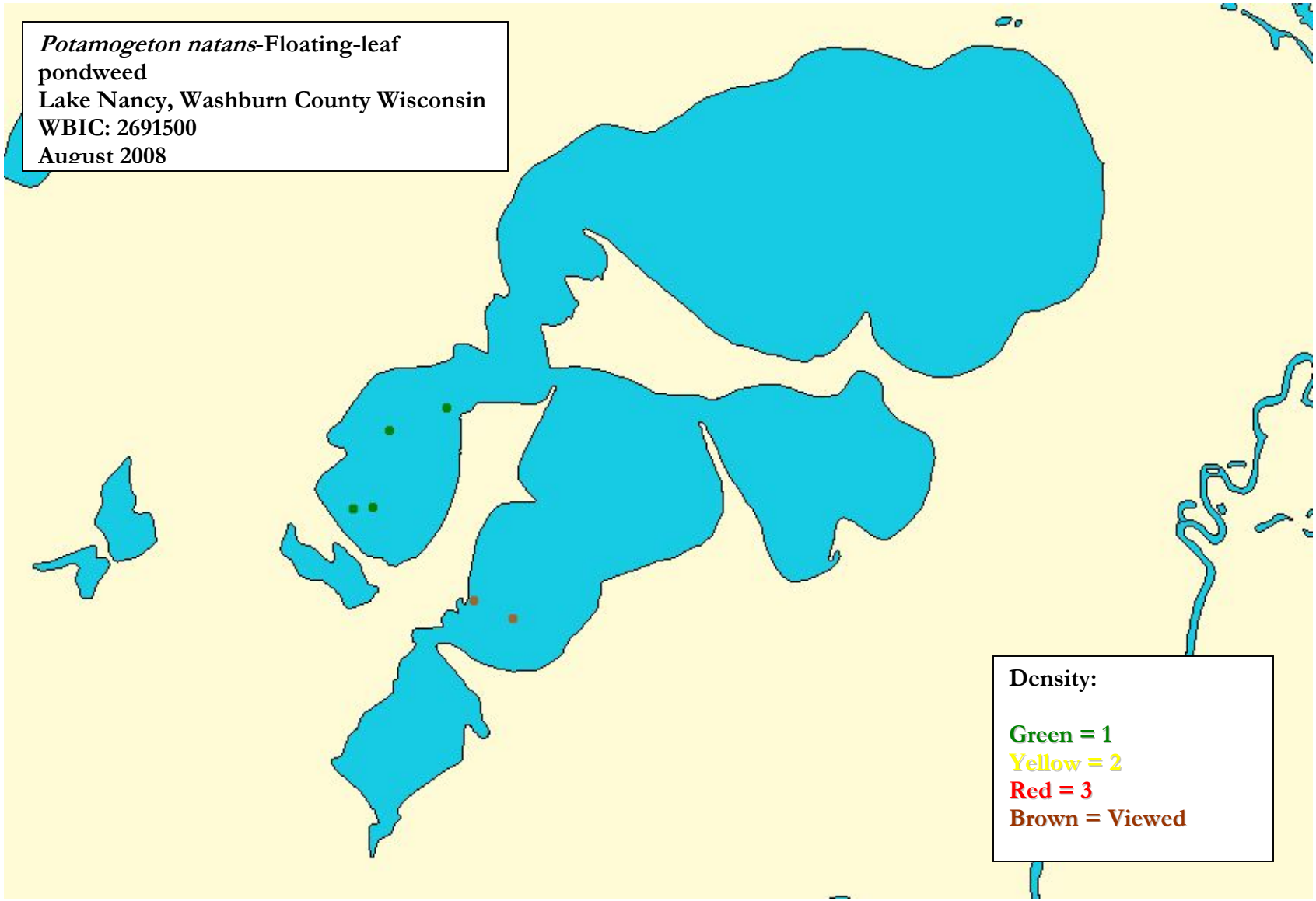
Potamogeton natans-Floating-leaf pondweed
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August 2008
Density:
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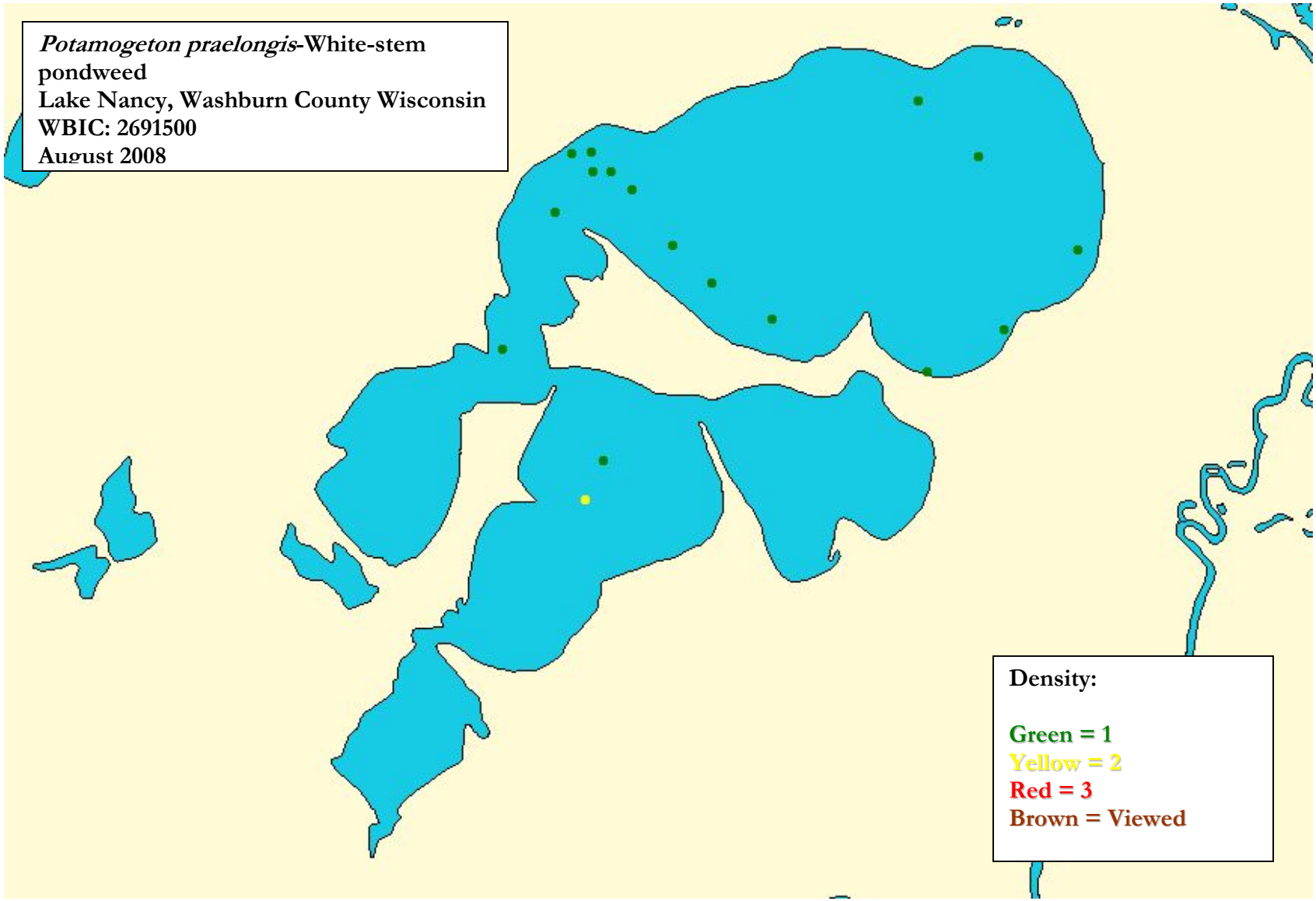
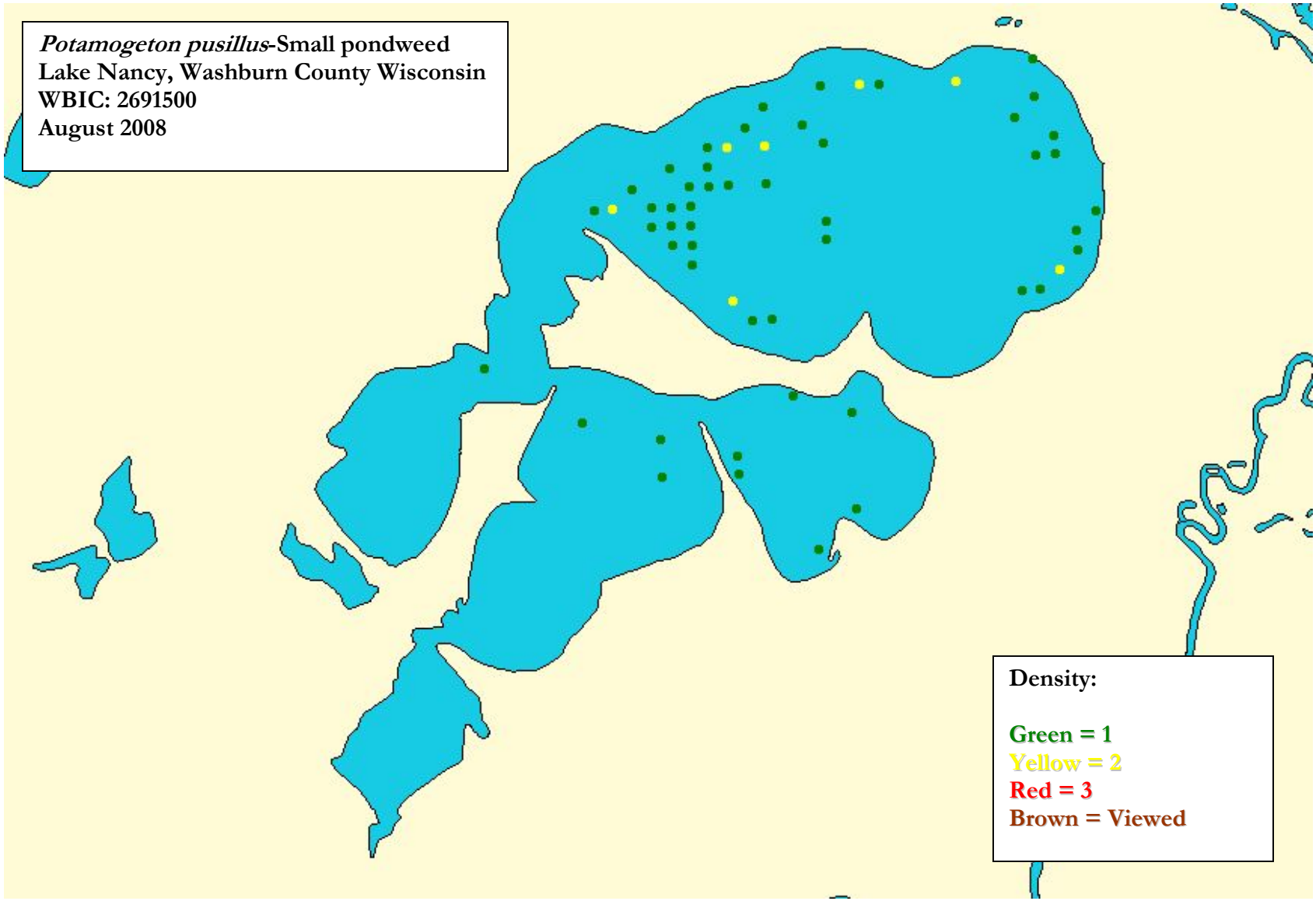
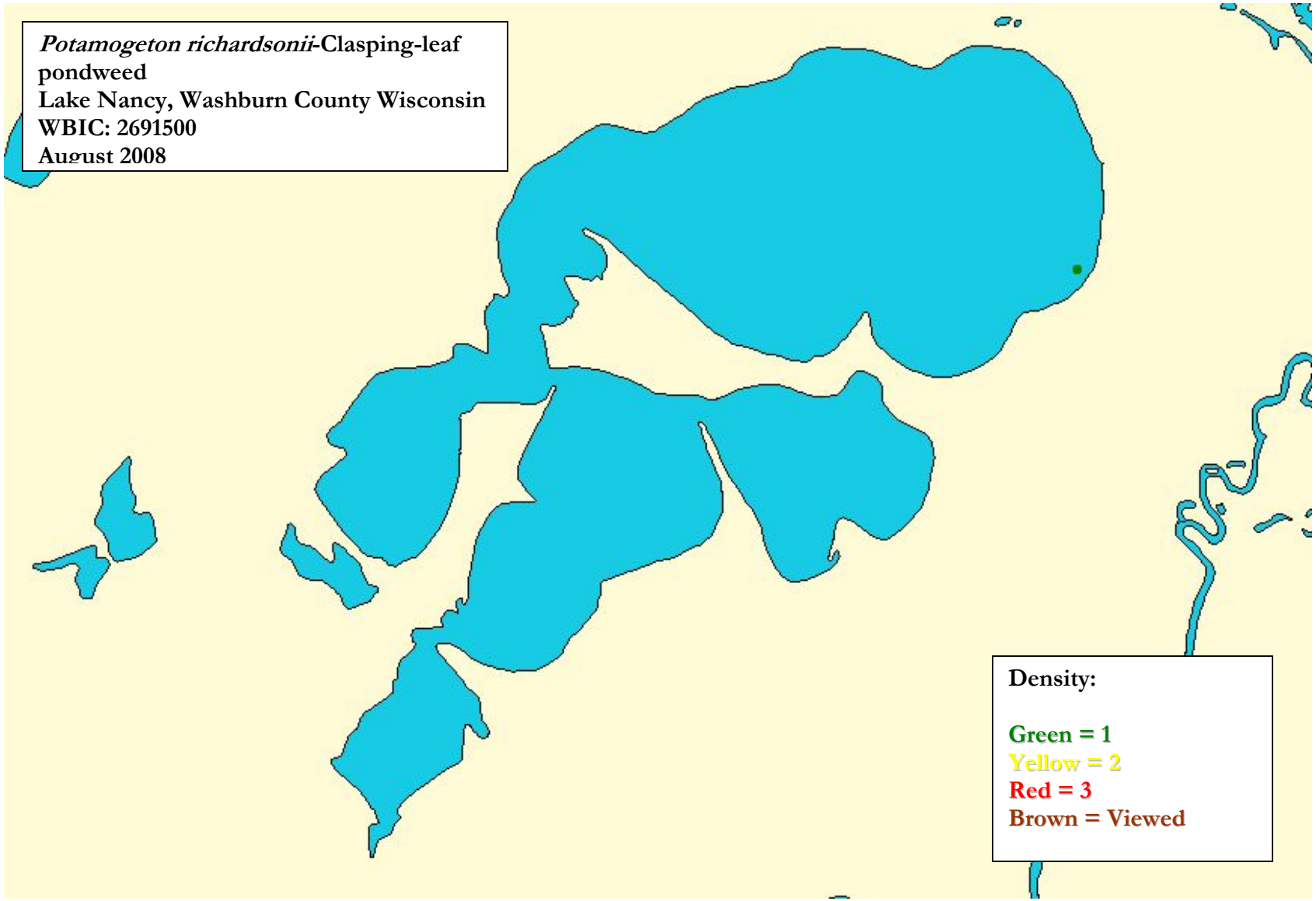
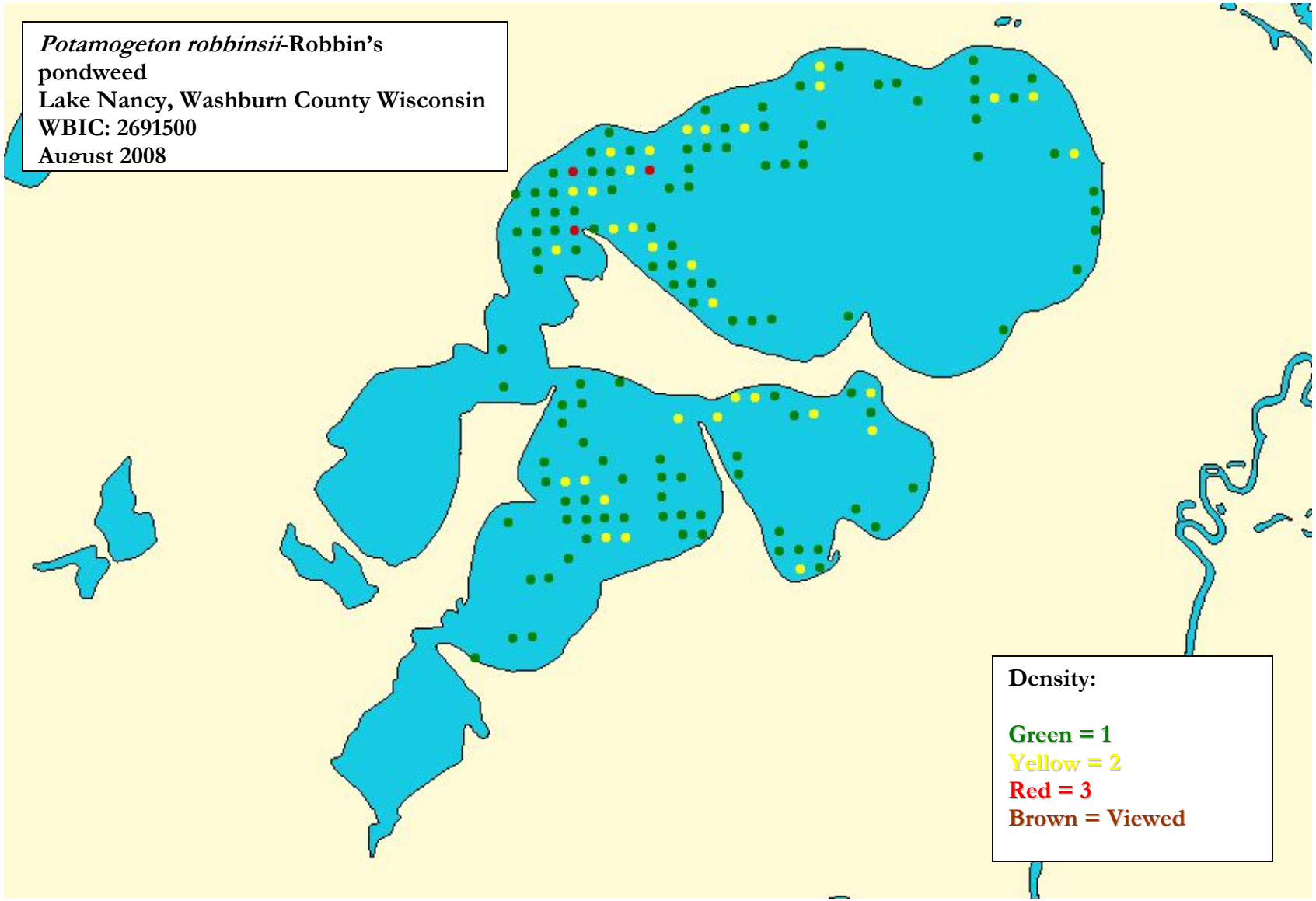
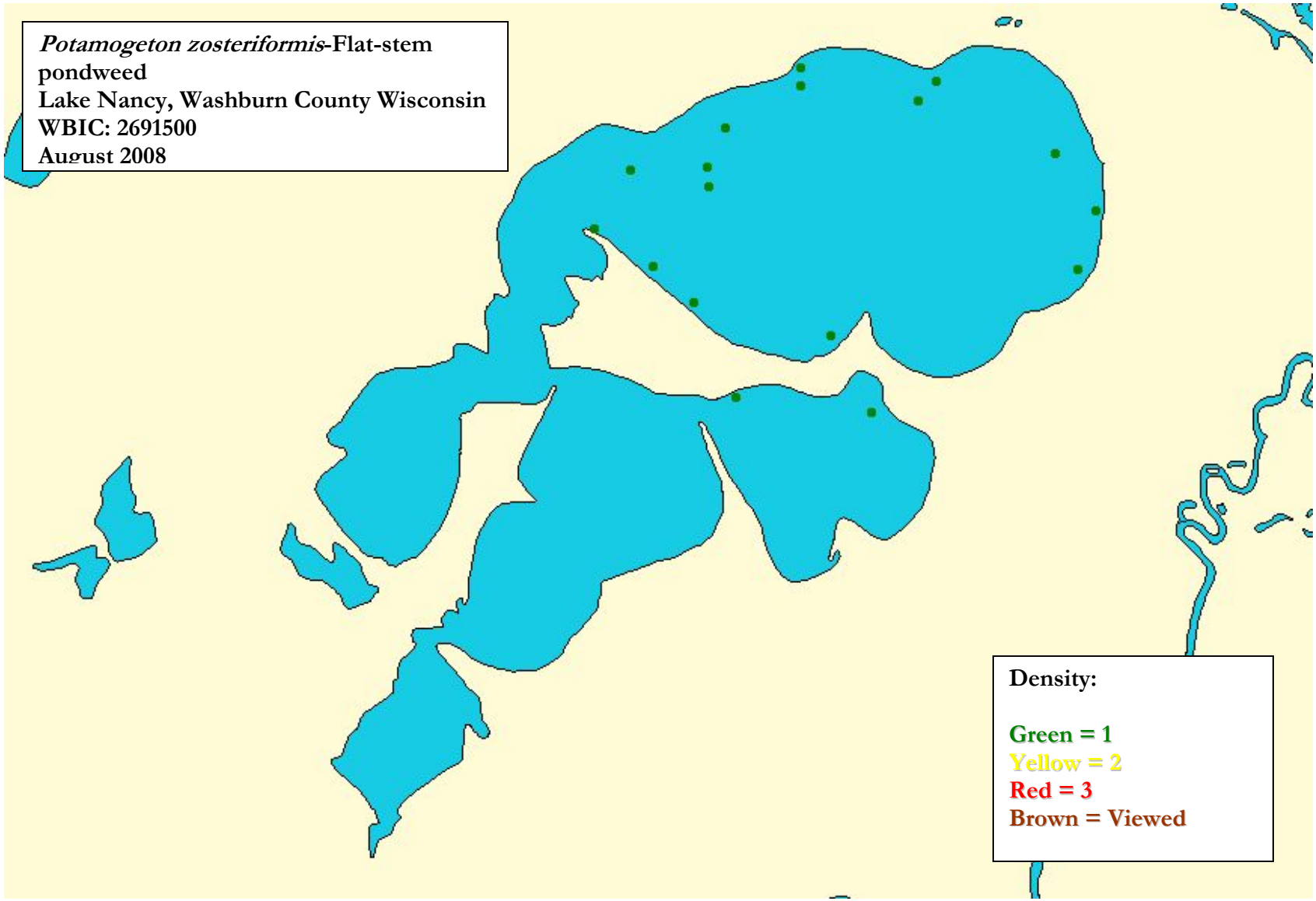
Red = 3
Brown = Viewed

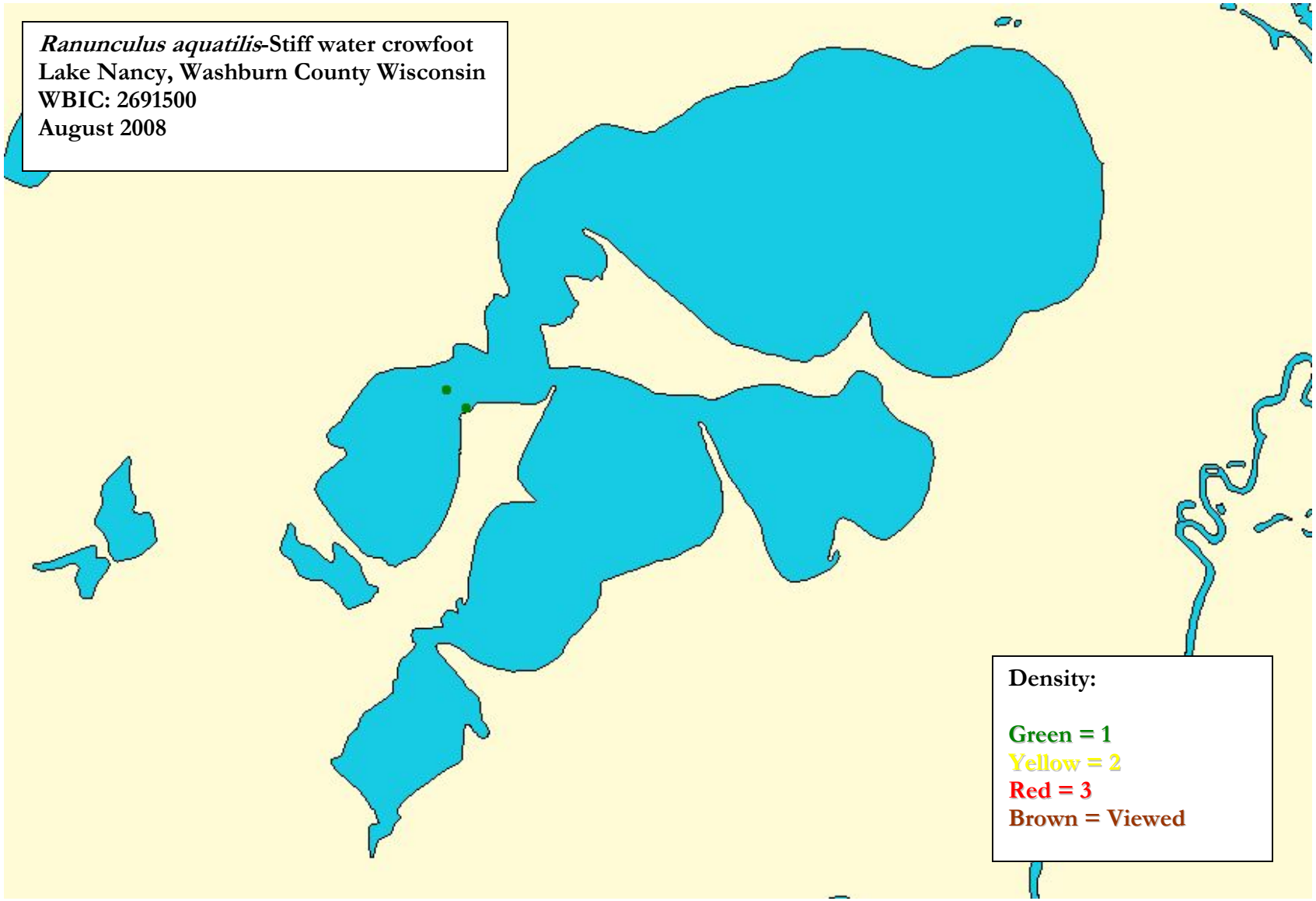

Potamogeton praelongis-White-stem pondweed
Lake Nancy, Washburn County Wisconsin
WBIC: 2691500
August 2008
Density:
Green = 1
Yellow = 2
Red = 3
Brown = Viewed

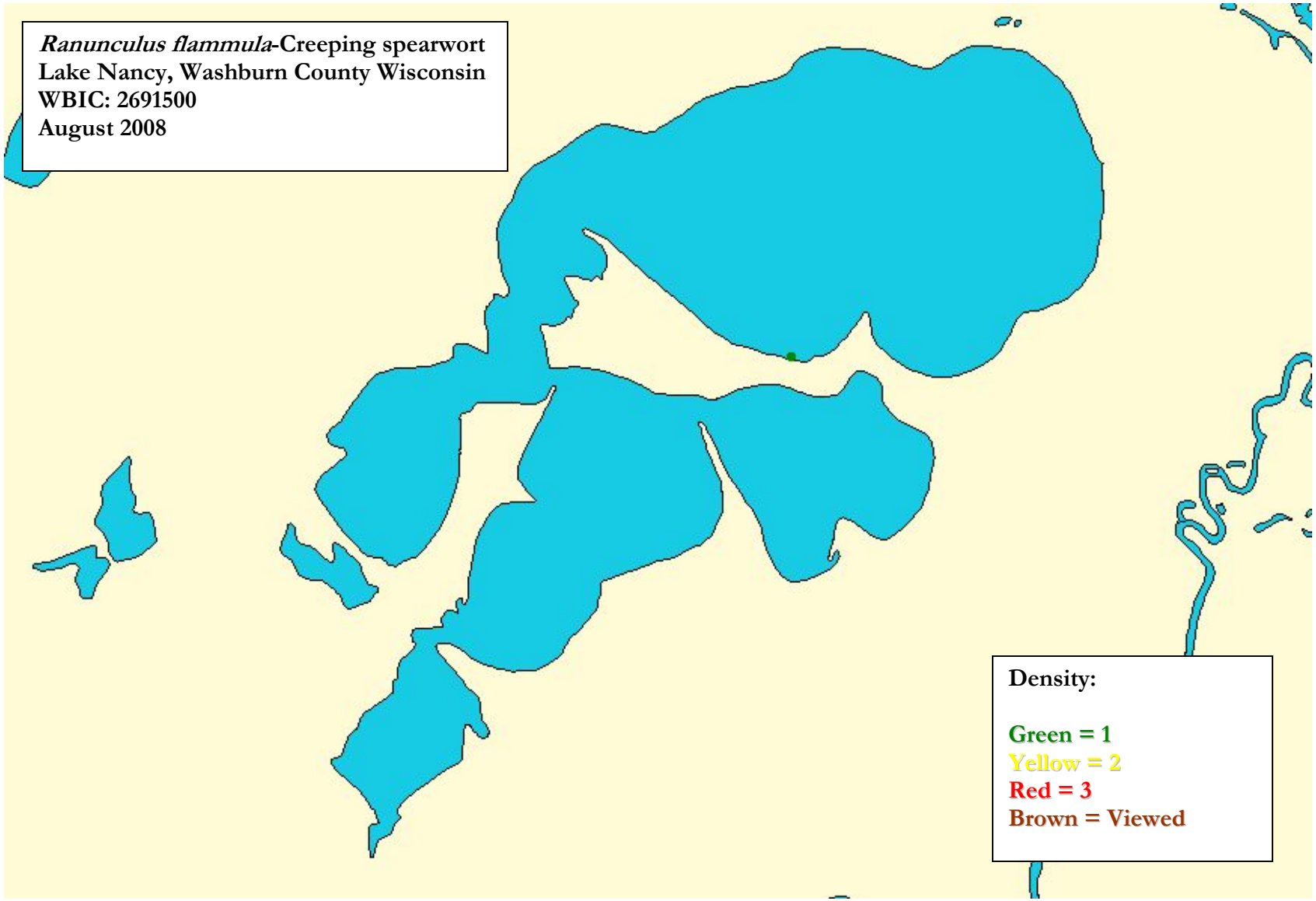

Potamogeton pusillus-Small pondweed
Lake Nancy, Washburn County Wisconsin
WBIC: 2691500
August 2008
Density:
Green = 1
Yellow = 2
Red = 3
Brown = Viewed


Potamogeton richardsonii-Clasping-leaf pondweed
Lake Nancy, Washburn County Wisconsin
WBIC: 2691500
August 2008
Density:
Green = 1
Yellow = 2
Red = 3
Brown = Viewed

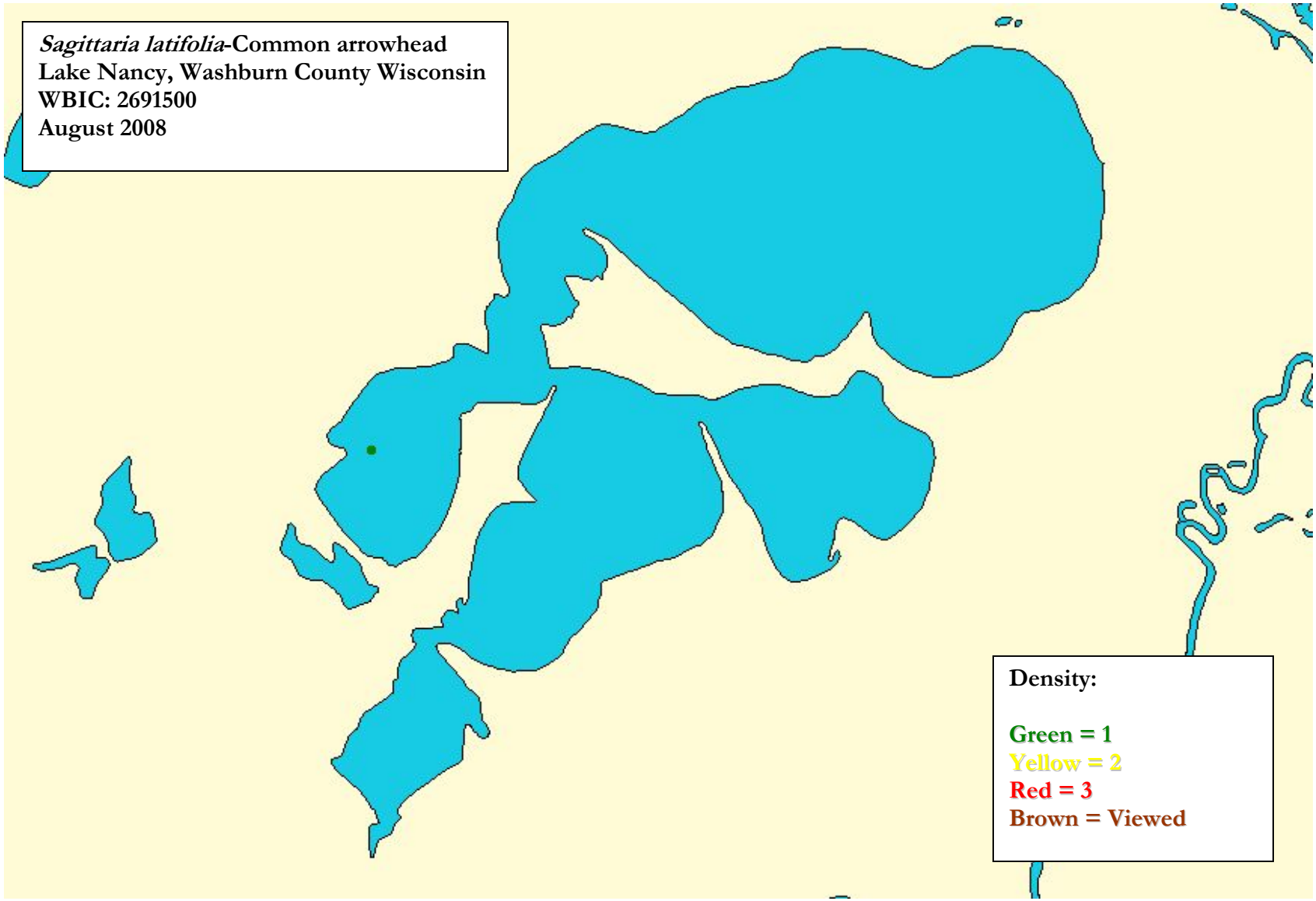

Potamogeton robbinsii-Robbin's pondweed
Lake Nancy, Washburn County Wisconsin
WBIC: 2691500
August 2008
Density:
Green = 1
Yellow = 2
Red = 3
Brown = Viewed

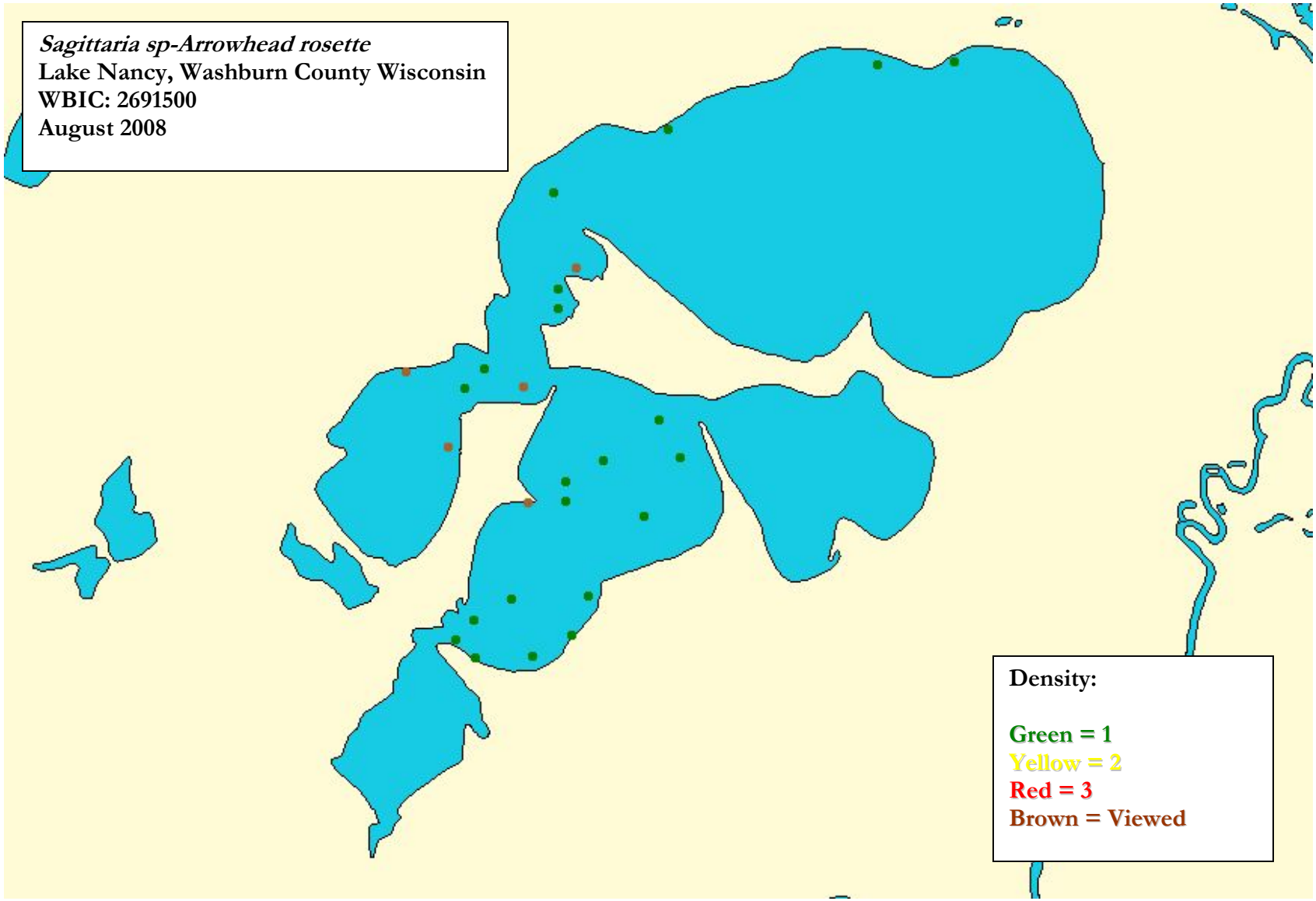

Potamogeton zosteriformis-Flat-stem pondweed
Lake Nancy, Washburn County Wisconsin
WBIC: 2691500
August 2008
Density:
Green = 1
Yellow = 2
Red = 3
Brown = Viewed

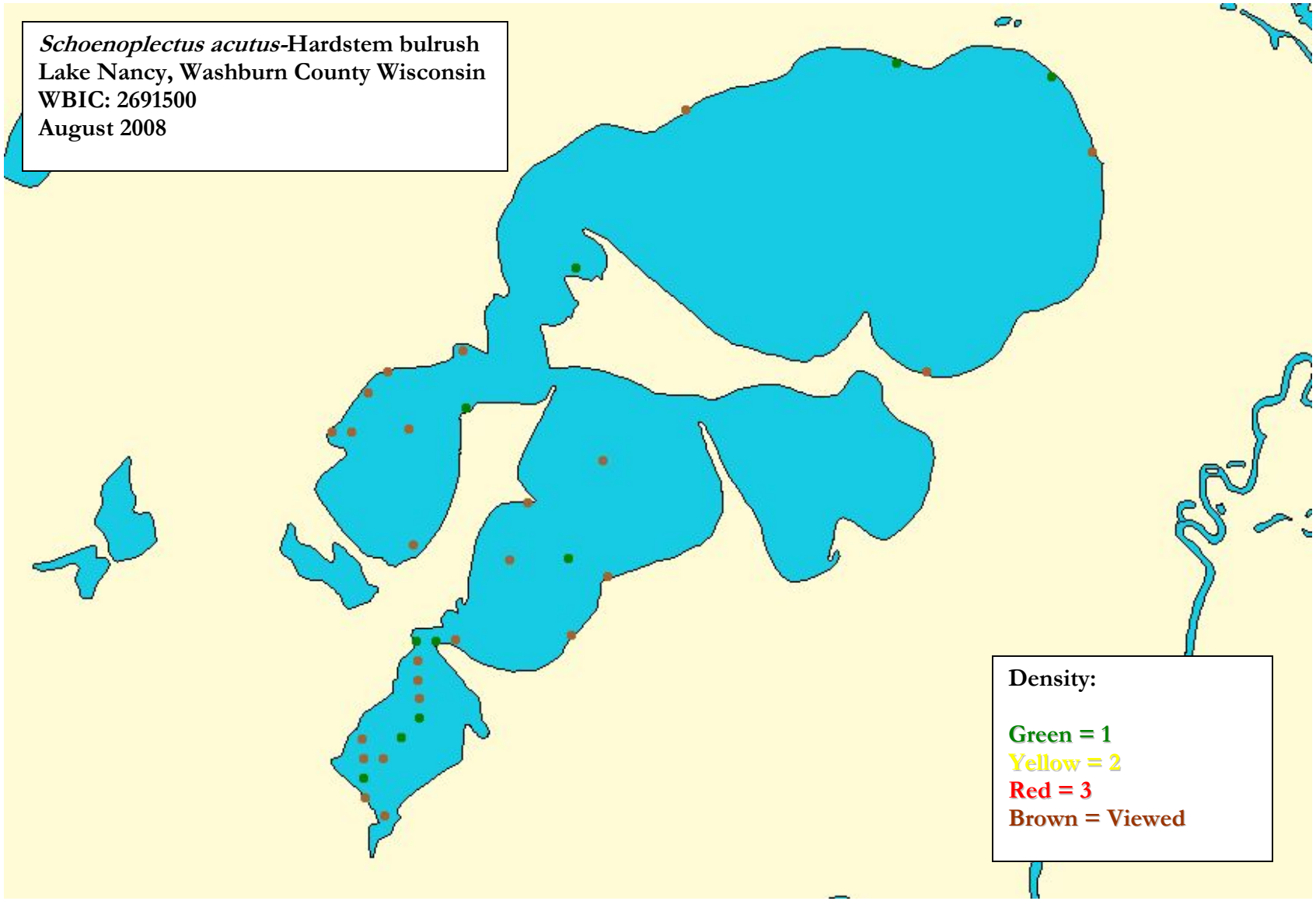

Ranunculus aquatilis-Stiff water crowfoot
Lake Nancy, Washburn County Wisconsin
WBIC: 2691500
August 2008
Density:
Green = 1
Yellow = 2
Red = 3
Brown = Viewed

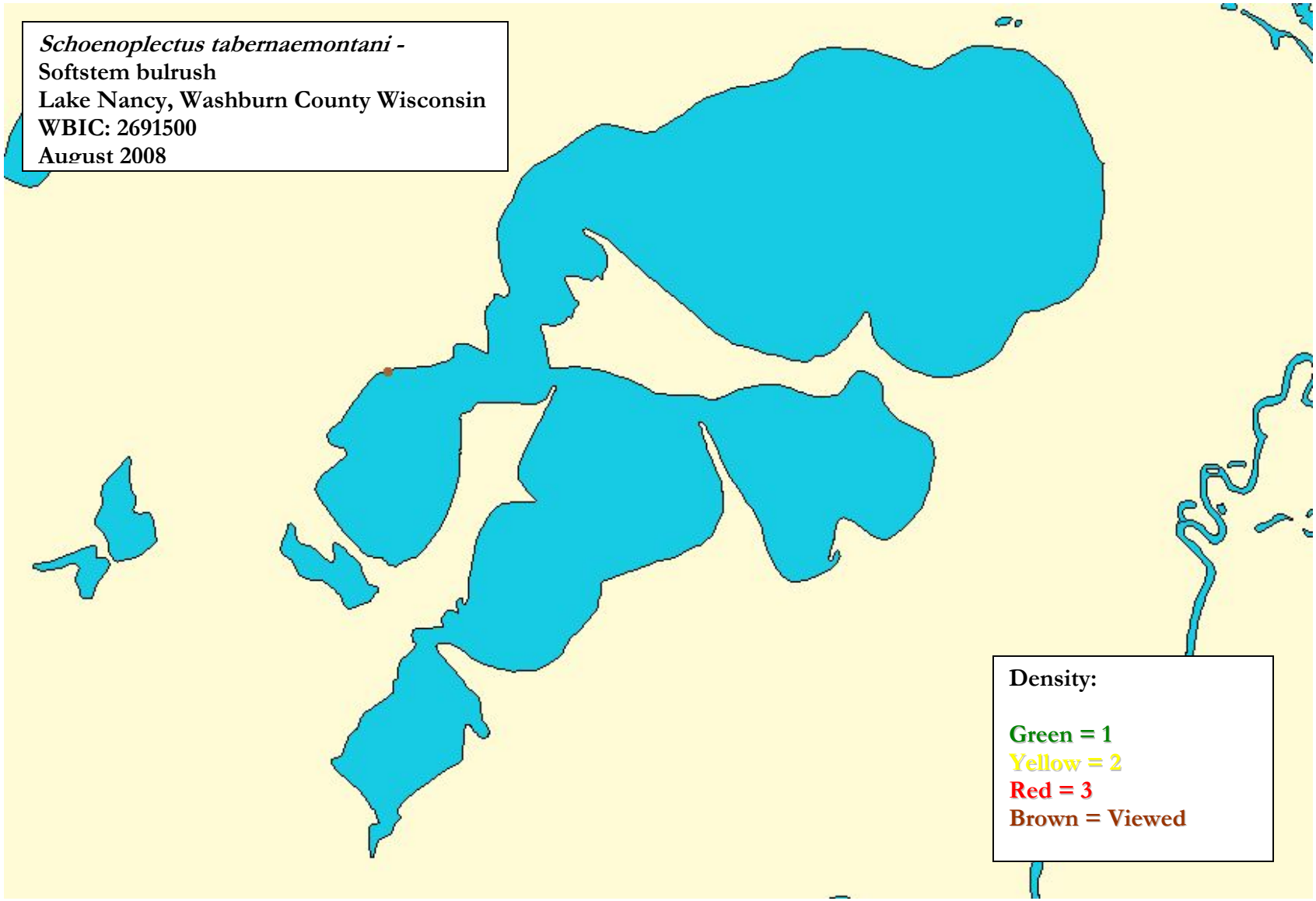

Ranunculus flammula-Creeping spearwort
Lake Nancy, Washburn County Wisconsin
WBIC: 2691500
August 2008
Density:
Green = 1
Yellow = 2
Red = 3
Brown = Viewed

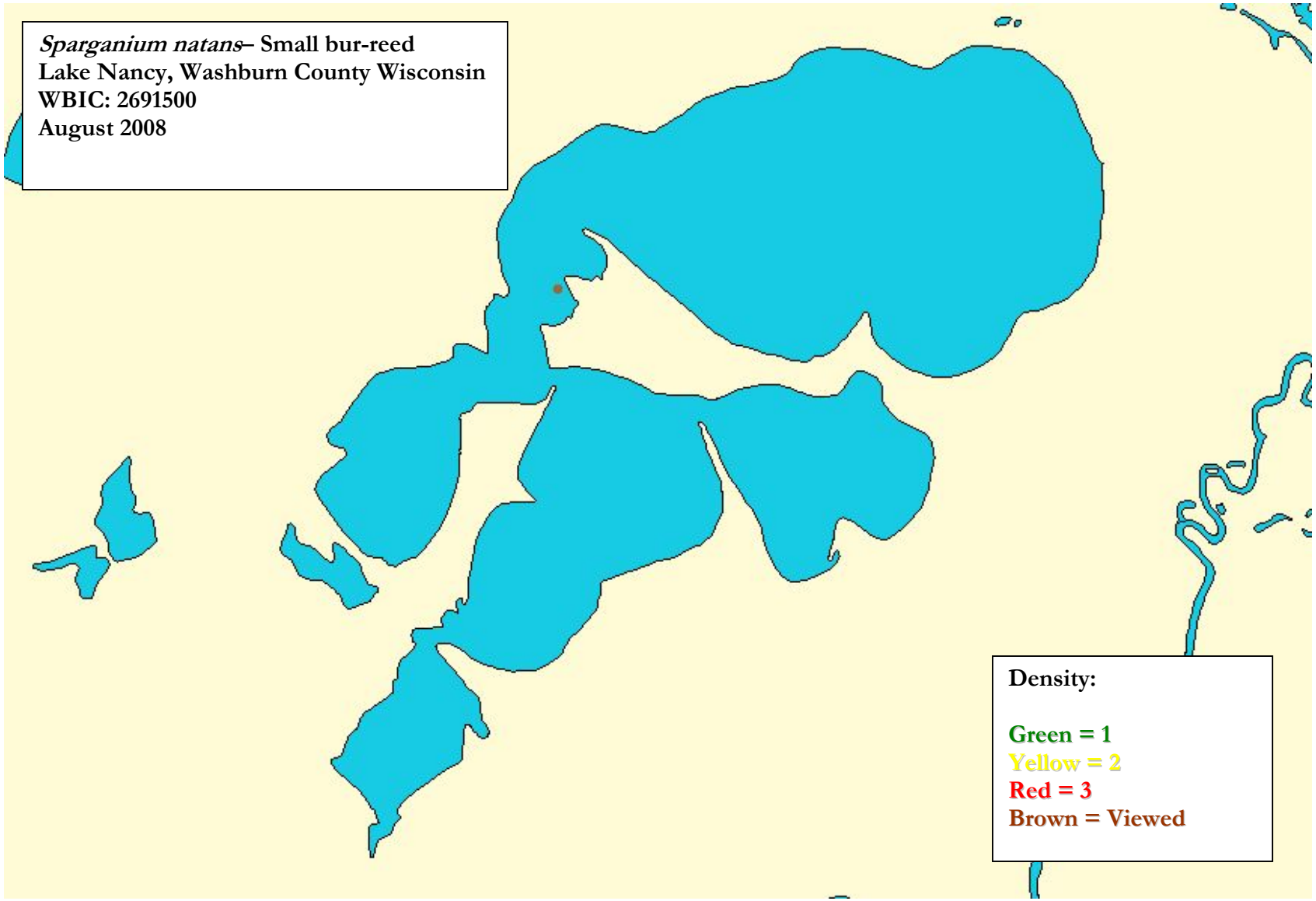

Sagittaria graminea-Grass-leaved arrowhead
Lake Nancy, Washburn County Wisconsin
WBIC: 2691500
August 2008
Density:
Green = 1
Yellow = 2
Red = 3
Brown = Viewed

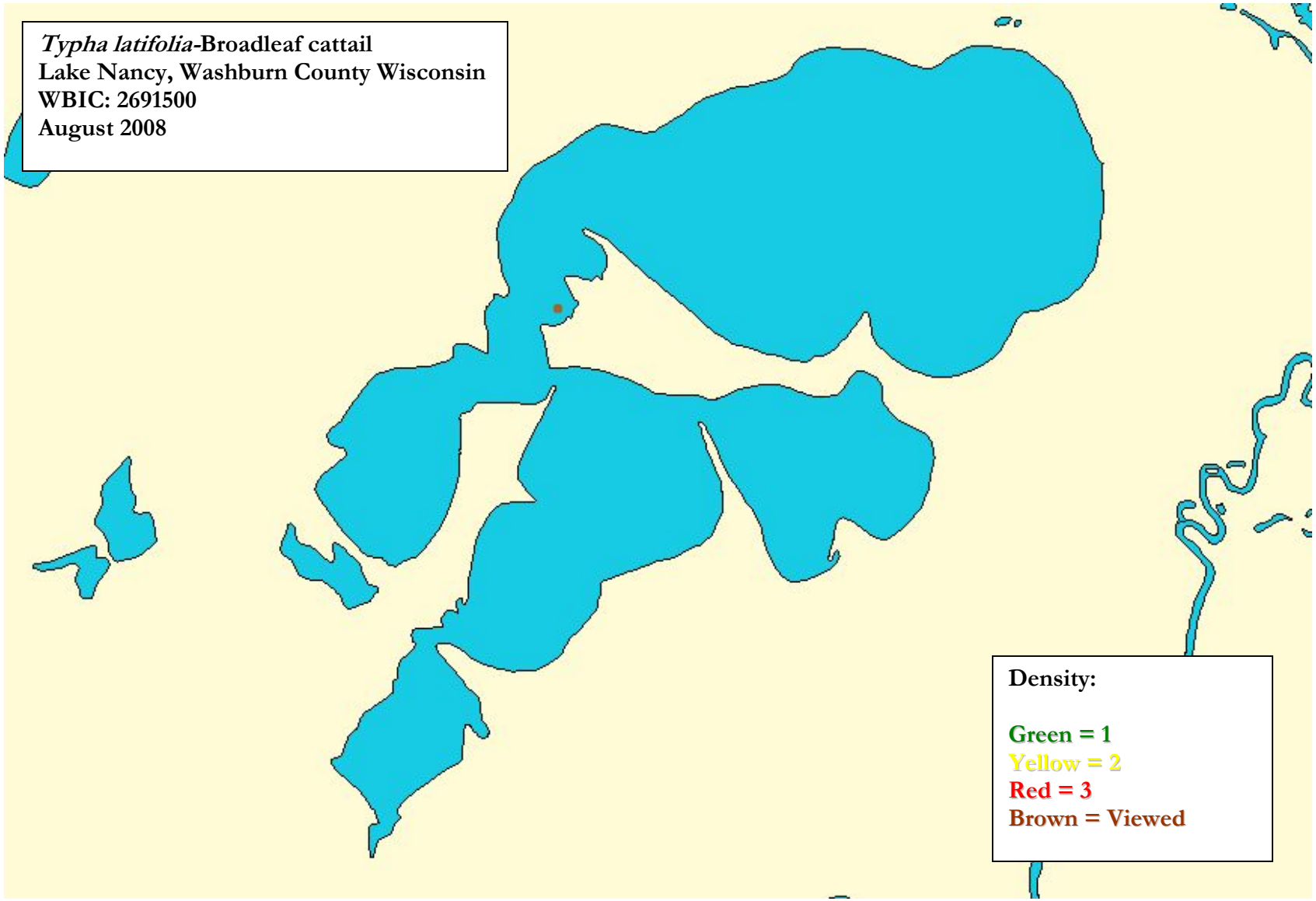

Sagittaria latifolia-Common arrowhead
Lake Nancy, Washburn County Wisconsin
WBIC: 2691500
August 2008
Density:
Green = 1
Yellow = 2
Red = 3
Brown = Viewed

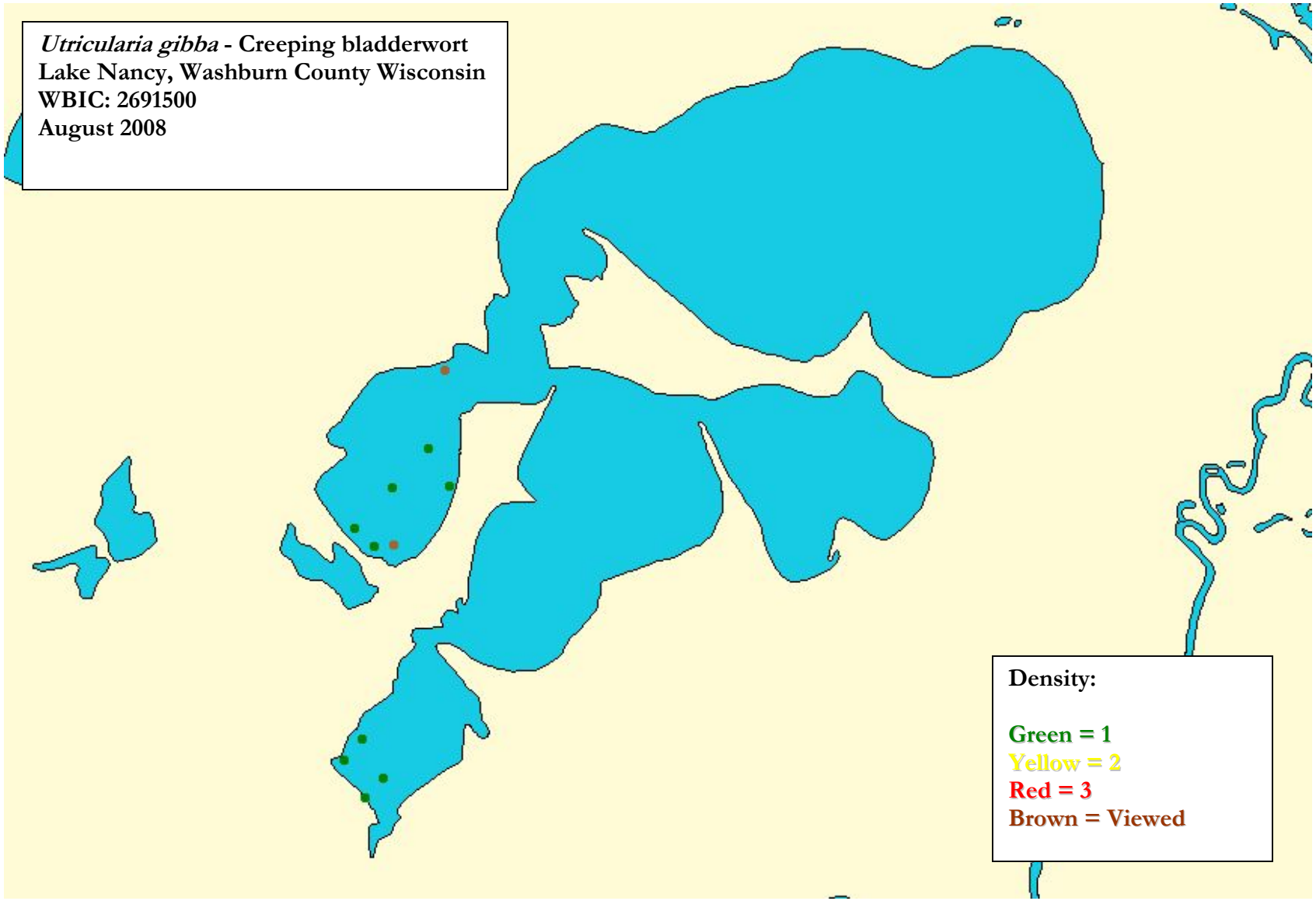

Sagittaria sp-Arrowhead rosette
Lake Nancy, Washburn County Wisconsin
WBIC: 2691500
August 2008
Density:
Green = 1
Yellow = 2
Red = 3
Brown = Viewed

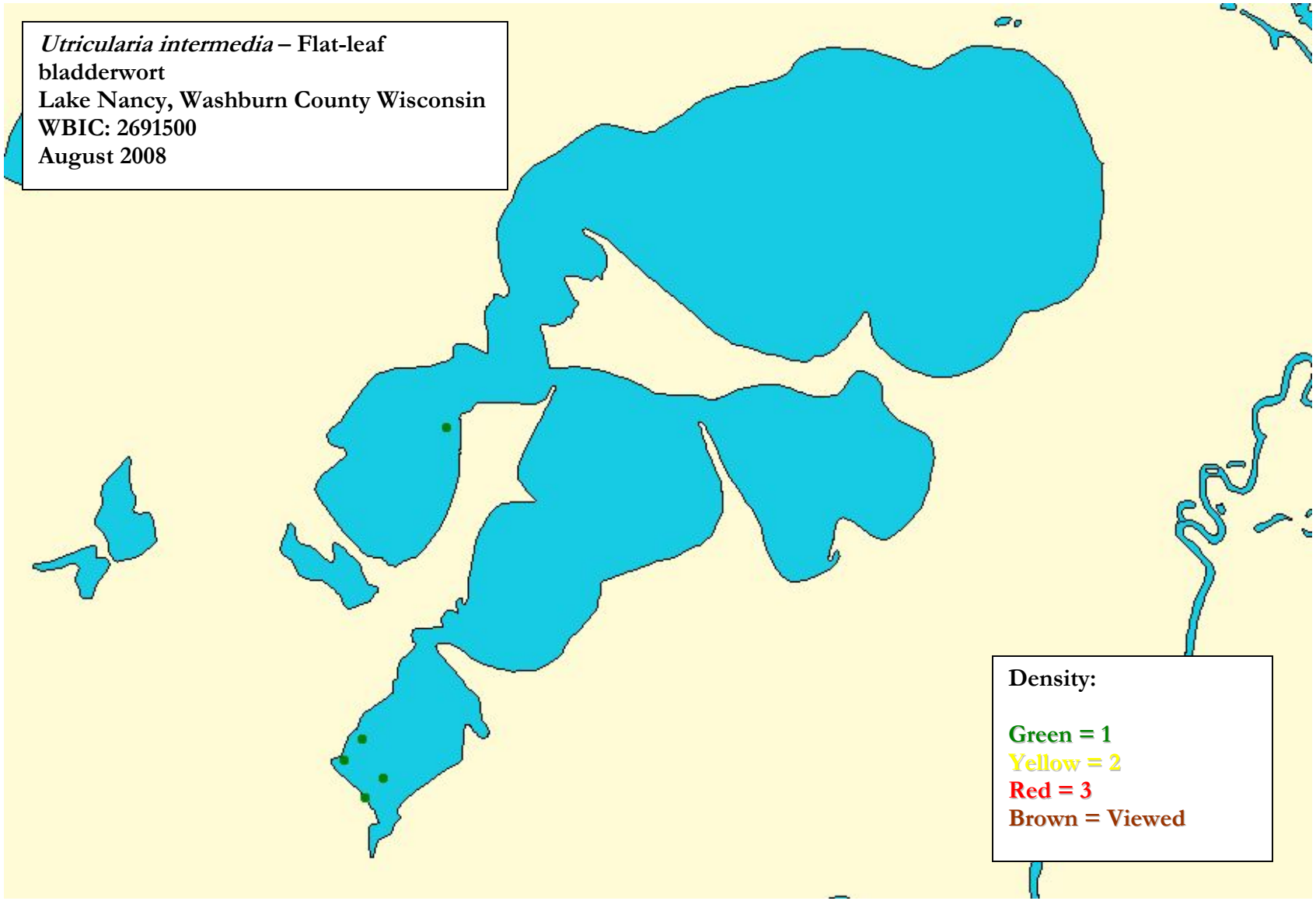

Schoenoplectus acutus-Hardstem bulrush
Lake Nancy, Washburn County Wisconsin
WBIC: 2691500
August 2008
Density:
Green = 1
Yellow = 2
Red = 3
Brown = Viewed


Schoenoplectus tabernaemontani -
Softstem bulrush
Lake Nancy, Washburn County Wisconsin
WBIC: 2691500
August 2008
Density:
Green = 1
Yellow = 2
Red = 3
Brown = Viewed

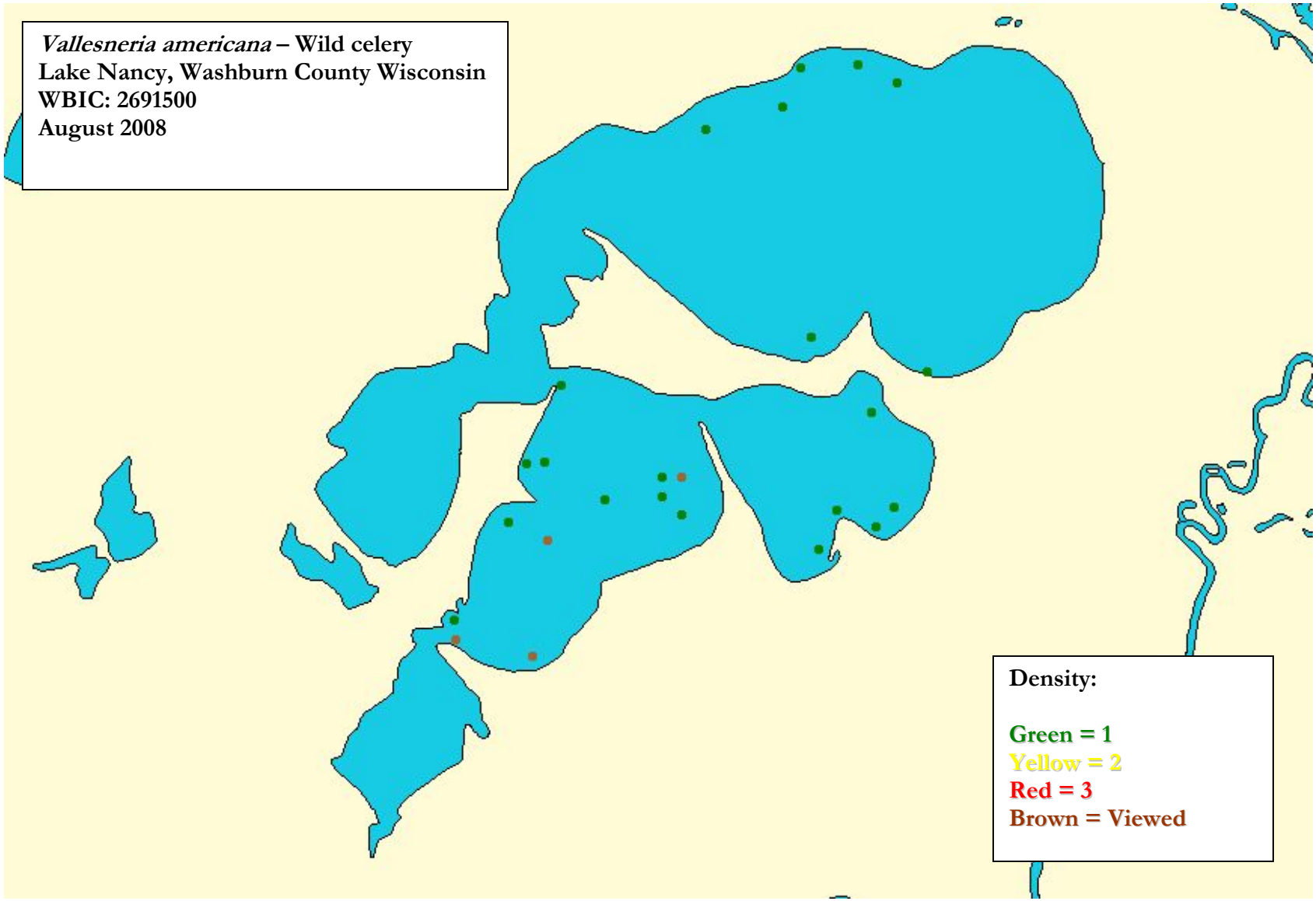

Sparganium natans– Small bur-reed
Lake Nancy, Washburn County Wisconsin
WBIC: 2691500
August 2008
Density:
Green = 1
Yellow = 2
Red = 3
Brown = Viewed


Typha latifolia-Broadleaf cattail
Lake Nancy, Washburn County Wisconsin
WBIC: 2691500
August 2008
Density:
Green = 1
Yellow = 2
Red = 3
Brown = Viewed


Utricularia gibba - Creeping bladderwort
Lake Nancy, Washburn County Wisconsin
WBIC: 2691500
August 2008
Density:
Green = 1
Yellow = 2
Red = 3
Brown = Viewed

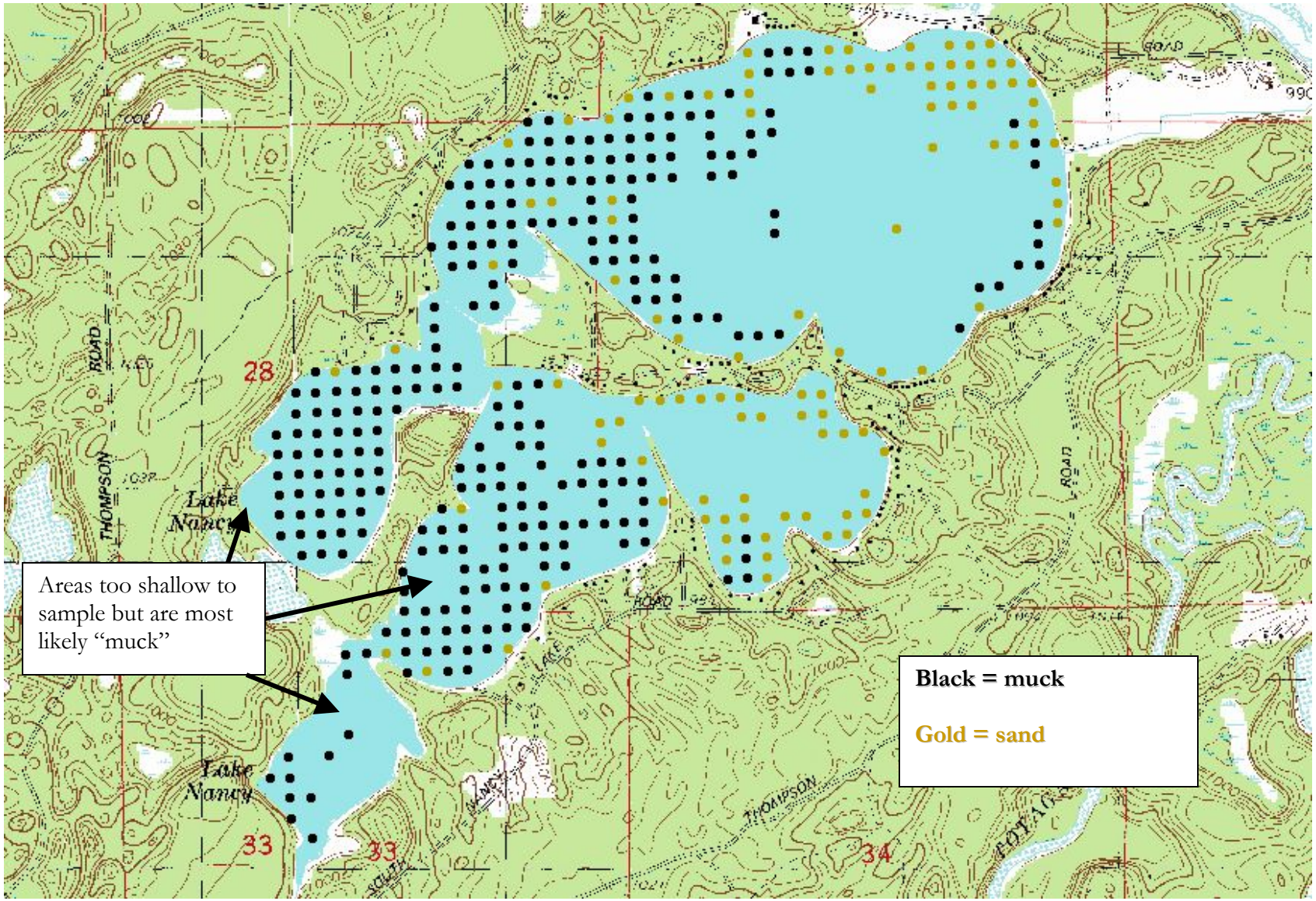

Utricularia intermedia – Flat-leaf bladderwort
Lake Nancy, Washburn County Wisconsin
WBIC: 2691500
August 2008
Density:
Green = 1
Yellow = 2
Red = 3
Brown = Viewed


Utricularia vulgaris - Common bladderwort
Lake Nancy, Washburn County Wisconsin
WBIC: 2691500
August 2008
Density:
Green = 1
Yellow = 2
Red = 3
Brown = Viewed


Vallesneria americana – Wild celery
Lake Nancy, Washburn County Wisconsin
WBIC: 2691500
August 2008
Density:
Green = 1
Yellow = 2
Red = 3
Brown = Viewed

Appendix C- Locations of each species spreadsheets.

Appendix D- Predominant sediment types at sampled points.


Areas too shallow to sample but are most likely "muck"
Black = muck
Gold = sand
Lake Nancy
Lake Nancy
28
33
33
34
THOMPSON
ROAD