PROFESSIONAL PAPER SJ2003-PP3

MODIFICATION OF MODELING CRITERIA FOR APPLICATION IN THE 2025 ASSESSMENT OF LIKELIHOOD OF HARM TO NATIVE VEGETATION

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MODIFICATION OF MODELING CRITERIA FOR APPLICATION IN THE 2025 ASSESSMENT OF LIKELIHOOD OF HARM TO NATIVE VEGETATION

by

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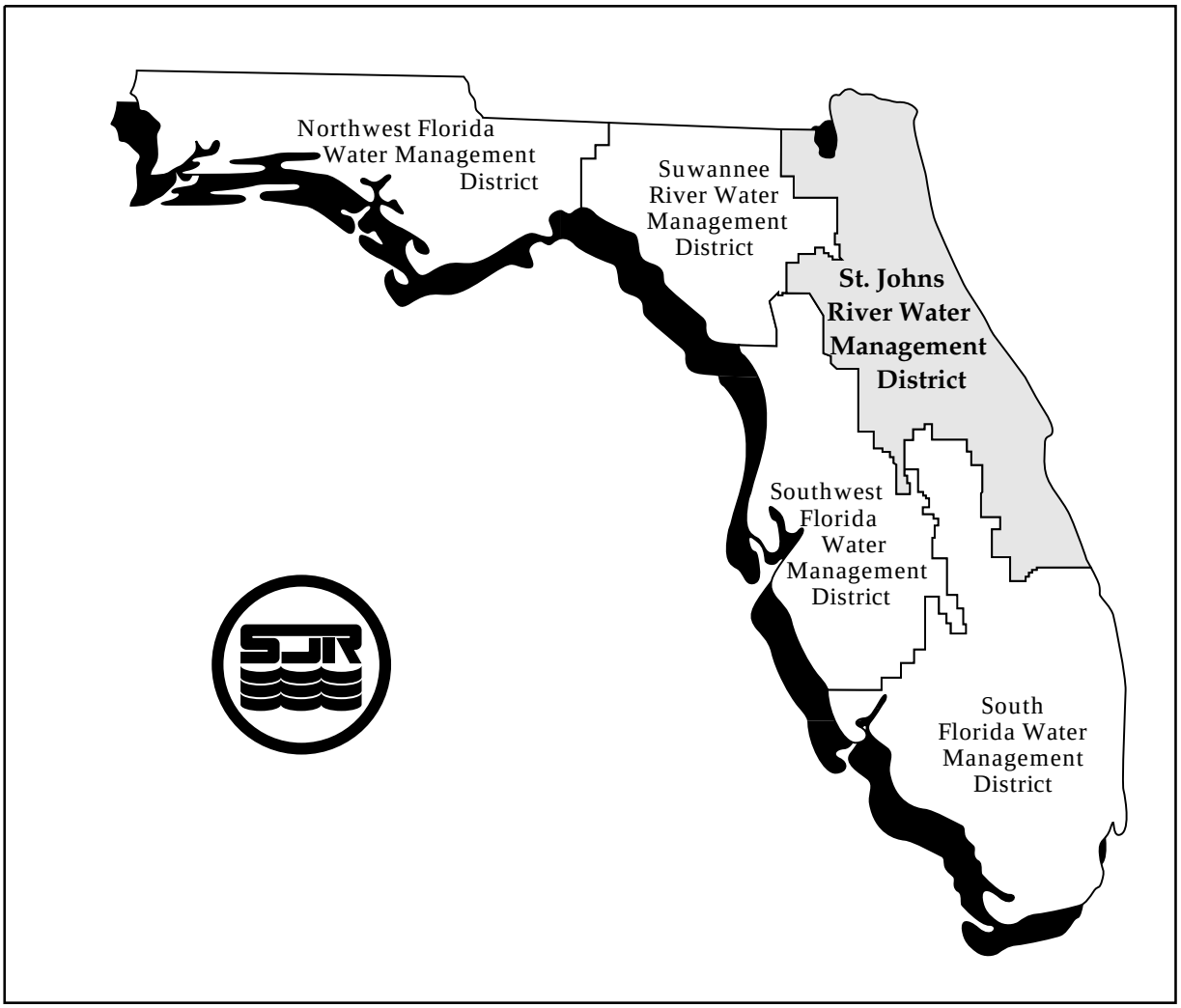
St. Johns River Water Management District
Palatka, Florida

2003



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ABSTRACT

Since 1995, a geographic information system model has been used to define areas of the St. Johns River Water Management District where wetlands vegetation is likely to be harmed from future groundwater withdrawals for agriculture, industry, and public water supply. An earlier version of this model (2010 projection) rated water table drawdown on a scale of relatively low (<0.99 feet [ft]), moderate (≥1.0 to ≤2.5 ft), and relatively high (>2.5 ft), based on the response of vegetation to dewatering.

For the 2025 likelihood of harm assessment, a need was seen to incorporate and reconcile updated vegetation constraints. To accomplish this, a set of detailed constraints was generalized to create a new drawdown scale in which water table drawdowns were rated as low (<0.35 ft), moderate (≥0.35 to ≤1.2 ft), and high (>1.2 ft). This revised scale, in conjunction with drawdown estimations for 2025, was tested in the likelihood of harm model for the east-central Florida area. The resulting acreage of wetlands predicted to have low risk of harm from groundwater withdrawal decreased slightly, but those predicted to have moderate or high risk increased 83% and 163%, respectively, in comparison with estimations using the original drawdown scale.

INTRODUCTION

In the mid-1990s, an assessment of the likelihood of harm to native vegetation from groundwater withdrawals was published by the St. Johns River Water Management District (SJRWMD) (Kinser and Minno 1995). The final map, which showed areas of wetlands and other sensitive vegetation that were likely to be harmed from groundwater use, was one of the primary elements used to delineate the boundaries of priority water resource caution areas described in the *District Water Supply Plan* (Vergara 2000).

The assessment of harm to native vegetation used a geographic information system (GIS) model incorporating soil permeability, vegetation sensitivity, and decline in the surficial aquifer data layers to highlight those areas of SJRWMD having the highest likelihood of harm to native vegetation from proposed groundwater withdrawals projected to occur by the year 2010. In this model, soil permeability, which mediates subsurface loss of water from plant communities, was used to estimate the susceptibility of land areas to dewatering. Soils were rated as high (>6.0 inches per hour [in / hr]), moderate (≥0.6 to ≤6.0 in / hr), or low (<0.6 in / hr) permeability. Areas with lower permeability were considered to be less susceptible to dewatering from groundwater withdrawal.

The sensitivity of each vegetation community to dewatering was rated as high (wetlands), moderate (flatwoods and mesic hardwood hammocks), or low (xeric uplands), based on the abilities of the plant species with the communities to persist, grow, and reproduce under conditions of reduced soil moisture and lowered water tables.

The combination of soil permeability and vegetation sensitivity created a data layer describing the potential for harm to native vegetation. In this layer, sensitive plant communities occurring on permeable soils were considered to have a high potential for harm from any groundwater decline that might occur.

The final layer of the model was the estimated change in the surficial aquifer system projected to occur between 1988 and 2010. Drawdowns were rated on a scale of relatively low (<1.0 ft), medium (≥1.0 to ≤2.5 ft), and relatively high(>2.5 ft), based on the response of vegetation. When combined with the potential for harm layer, the resulting map showed the likelihood of harm to native vegetation. The various combinations of soil, vegetation, and drawdown ratings are shown in Tables 1 and 2.

Table 1. Potential for harm ratings (shaded)

		Vegetation Sensitivity		
		High	Med	Low
Soil Permeability	High	High	Med	Low
	Med	Med	Med	Low
	Low	Low	Low	Low

Source: Kinser and Minno 1995

Table 2. Likelihood of harm ratings (shaded)

		Water Table Drawdown		
		High	Med	Low
Potential for Harm	High	High	High	Low
	Med	High	Med	Low
	Low	Low	Low	Low

Source: Kinser and Minno 1995

WATER 2020 WETLANDS CONSTRAINTS

In 1998, SJRWMD and CH2M HILL, a lead contractor for water supply planning projects, completed the *Water 2020 Constraints Handbook*, a document proposing specific constraints for minimum flows and levels, native wetland vegetation, groundwater quality, and interference with existing legal uses. The native wetland vegetation constraints "establishes maximum drawdown values for specific wetland community types, which, if exceeded, are likely to result in the replacement of dominant vegetative species by those characteristic of drier community types." The drawdown constraints were developed from scientific literature and unpublished data (CH2M HILL 1996) and represent values beyond which changes in dominant species resulting in different wetland types indicative of drier conditions are likely to occur. These values ranged from 0.35 to 1.2 feet of drawdown for the various kinds of wetlands (Table 3).

Table 3. Drawdown constraints

Wetland Type	Drawdown (in feet)
Bay swamp	0.35
River/lake swamp	0.35
Cypress swamp	0.55
Mixed forest	0.35
Freshwater marsh	0.55
Saltwater marsh	Not used
Wet prairie	0.35
Emergent aquatic vegetation	0.85
Submergent aquatic vegetation	1.20
Mixed scrub-shrub	0.75
Non-vegetated wetland	1.20

Source: CH2M HILL 1998

MODEL REVISION

The original 1995 model relied on rather coarse-scale soil permeability maps created from the soils database STATSGO, a regional planning-level database developed by the Natural Resources Conservation Service (NRCS). In order to give finer resolution to the model, the more current and detailed NRCS SURGO soils database, which is based on the county-level soil surveys, was used.

In the county-level soil surveys of SJRWMD published by NRCS, soil permeability is usually presented as a range in inches per hour (in/hr). For each county bordering or within SJRWMD, a table was constructed listing the minimum permeability of the least permeable horizon of each soil series. These values were then categorized as high, medium, or low, based on the same cutoff values presented in Kinser and Minno (1995). Permeability of less than 0.2 in/hr was rated as relatively low, between 0.2 and 6.0 in/hr as moderate, and greater than 6 in/hr as relatively high.

These simplified ratings were linked, using ArcInfo software, to the soil series codes in the SURGO database to produce permeability maps by county. The maps were then joined to produce a districtwide soil permeability layer. Some edge-matching was necessary where adjoining county soil surveys listed different permeability values for the same soil series, especially at the Indian River-Brevard county and Baker-Clay county boundaries. These soils were given the permeability values presented in Brevard and Clay counties, respectively. In addition, permeability maps from the less detailed STATSGO database had to be used for the Deseret Ranch area of Brevard and Osceola counties, which had not been mapped by NRCS at the county scale.

A map of vegetation sensitivity to dewatering was created from the 1995 Land Cover data layer in SJRWMD GIS library by rating the various natural communities according to their susceptibility to reduction in the water table from groundwater withdrawal. Florida's plant communities vary in their tolerance to dewatering. For instance, scrubs and sandhills were considered to have relatively low sensitivity to dewatering since these xeric communities are well adapted to dry soil conditions. Urban areas and water bodies were listed as having low sensitivity, as well. Wetlands, on the other hand, were considered to be sensitive to dewatering.

For the 2025 likelihood of harm assessment, a reconciling is proposed of Water 2020 wetlands constraints with the methods used in the initial harm assessment. In the earlier model, all wetlands were considered equally sensitive and were rated on a likelihood of harm scale of low (<0.99 ft), moderate (≥1.0 to ≤2.5 ft), and high (>2.5 ft). Beginning with the 2025 assessment, it is proposed that a new scale—low (<0.35 ft), moderate (≥0.35 to ≤1.2 ft), and high (>1.2 ft), reflecting the criteria stated in the *Water 2020 Constraints Handbook*—be used (Table 4). This is a simplification of an

approach using individual criteria for each of the types. An additional change used in the 2025 assessment was a downgrading of the sensitivity rating of flatwoods and mesic hardwood hammocks from moderate to low (Table 5). This was done because these community types were not covered in the constraints handbook, and thus no specific numerical criteria were available.

Table 4. Comparison of 1995 and 2025 constraints

Likelihood of Harm	Low	Moderate	High
1995 criteria	<0.99	≥1.0 to ≤2.5	>2.5
New criteria	<0.35	≥0.35 to ≤1.2	>1.2

Table 5. Changes (shown in bold) in the revised potential for harm ratings (shaded)

		Vegetation Sensitivity		
		High	Med	Low
Soil Permeability	High	High	**Low**	Low
	Med	Med	**Low**	Low
	Low	Low	Low	Low

To evaluate the effects of the proposed changes, the east-central Florida area was chosen as a pilot area for application of the likelihood of harm model. A calibrated numerical groundwater flow model has been developed for this region (McGurk and Fischl-Presley 2002). The likelihood of harm model was applied to the east-central Florida area. Drawdown in the surficial aquifer estimated to occur by the year 2025 was rated according to both the original 1995 criteria and the proposed new criteria listed in the *Water 2020 Constraints Handbook*. The final likelihood of harm maps were refined by re-rating low-lying areas (10-ft elevation or less), near the St. Johns River as "low."

RESULTS

The results of this comparison are shown in Figures 1 through 8. The sensitivity of plant associations to dewatering and the susceptibility of soils to dewatering data layers remained the same for each approach (Figures 1 and 2). However, the potential for harm layer changed, because the downgrading of flatwoods and mesic hardwoods removed a significant amount of land previously shown as having moderate potential for harm on the map (Figures 3 and 6). The two drawdown maps (Figures 4 and 7) had the same general outline, but areas rated as medium or high expanded to cover a significantly greater area in the updated approach. This resulted in an increase in areas showing high (up by 163%) and moderate (up by 83%) likelihood of harm (Figures 5 and 8 and Table 6). Using the revised criteria, areas with high to moderate likelihood of harm extended further north in Lake County and even reached into Marion County and also grew in extent and density in the remaining counties of the pilot area.

Table 6. Comparison of original criteria and revised criteria

Ranking of Harm	Area for Old Criteria (acres)	Area for Revised Criteria (acres)	Area of Difference (acres; revised minus old)	Percent Difference
Low	1,405,546	1,330,289	–75,257	–5
Moderate	15,612	28,597	12,984	83
High	38,236	100,509	62,273	163

DISCUSSION

The new, more-sensitive drawdown criteria used in the model resulted in potential impacts to wetlands of greater extent and magnitude than those obtained using the original drawdown criteria. Although the new criteria may be more accurate in evaluating future harm to wetlands using the GIS model, they are not intended to be used for regulatory purposes. This improved likelihood of harm model appears to have useful applications for water supply planning.

The revised likelihood of harm to native vegetation model is based on the most current and accurate data available. However, both the soils data and the vegetation data are generalized. The vegetation was originally mapped from aerial photos at a scale of 1:24,000. Soils were mapped by NRCS, usually at a scale of 1:20,000 or 1:24,000, by county or sometimes parts of counties. The NRCS soil maps were rescaled to 1:24,000 and edge-matched to form a seamless data layer in the SJRWMD GIS. Both data layers are subject to the limitations in accuracy generally associated with resource mapping efforts but are well-suited for regional-scale assessments.

The east-central Florida groundwater flow model used to predict drawdown also has limitations. This model used a rather coarse grid cell size of nearly one-half square mile (2,500 ft or 762 square meters). The groundwater flow model did not directly account for the effects of runoff or stream flow on wetland water levels and did not accurately represent surface elevations of large lakes. Due to the scale of the data layers used in the model, the resulting maps may be affected by local anomalies and are best considered from a regional perspective.

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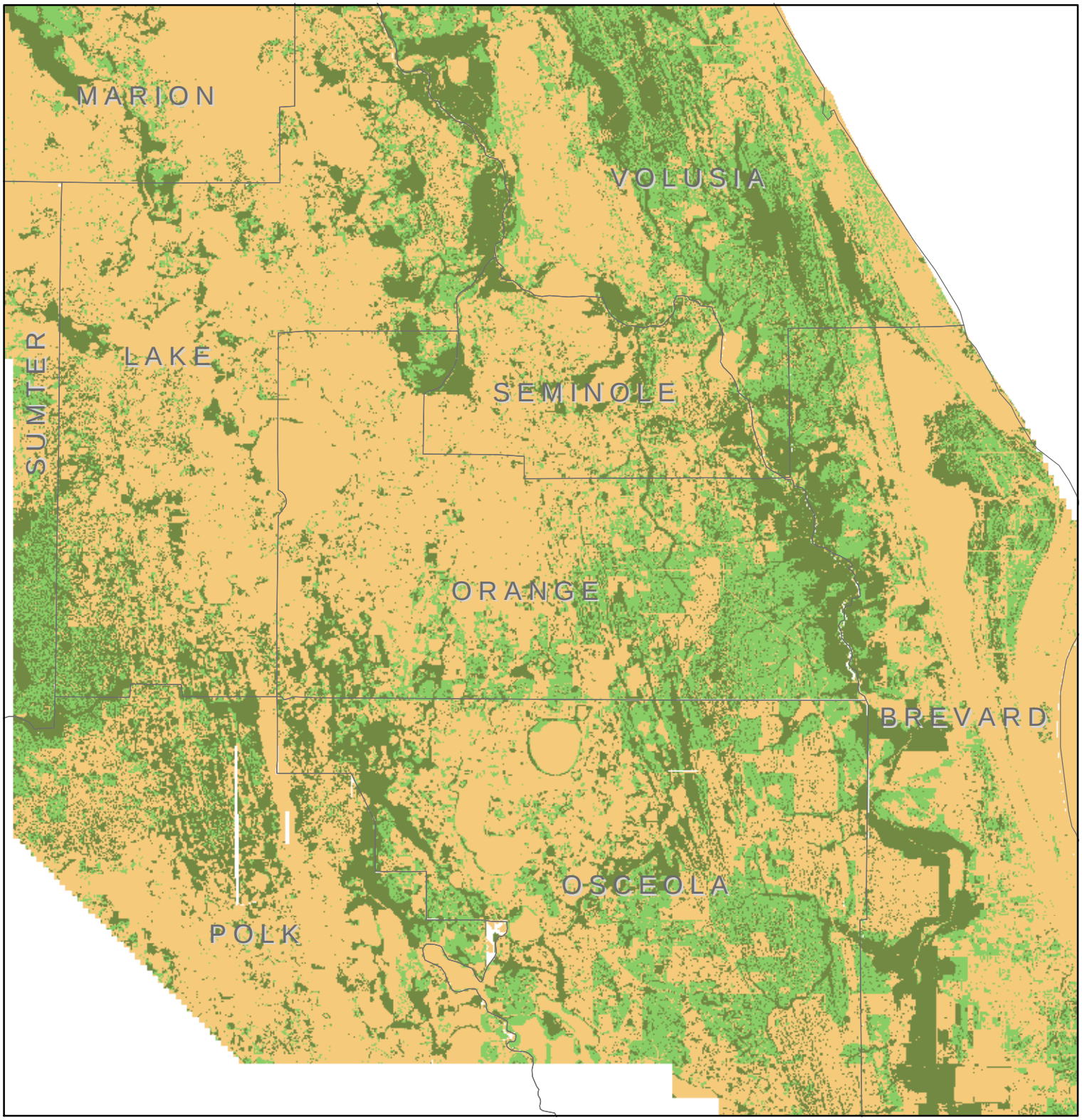
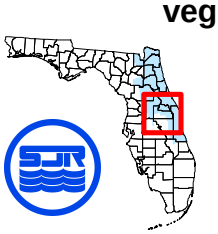


FIGURE 1. Sensitivity of plant associations to dewatering layer for likelihood of harm to native vegetation analysis



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Legend

Sensitivity of plant associations to dewatering

- Low (xeric uplands)
- Moderate (flatwoods, mesic hardwood hamocks)
- High (wetlands)

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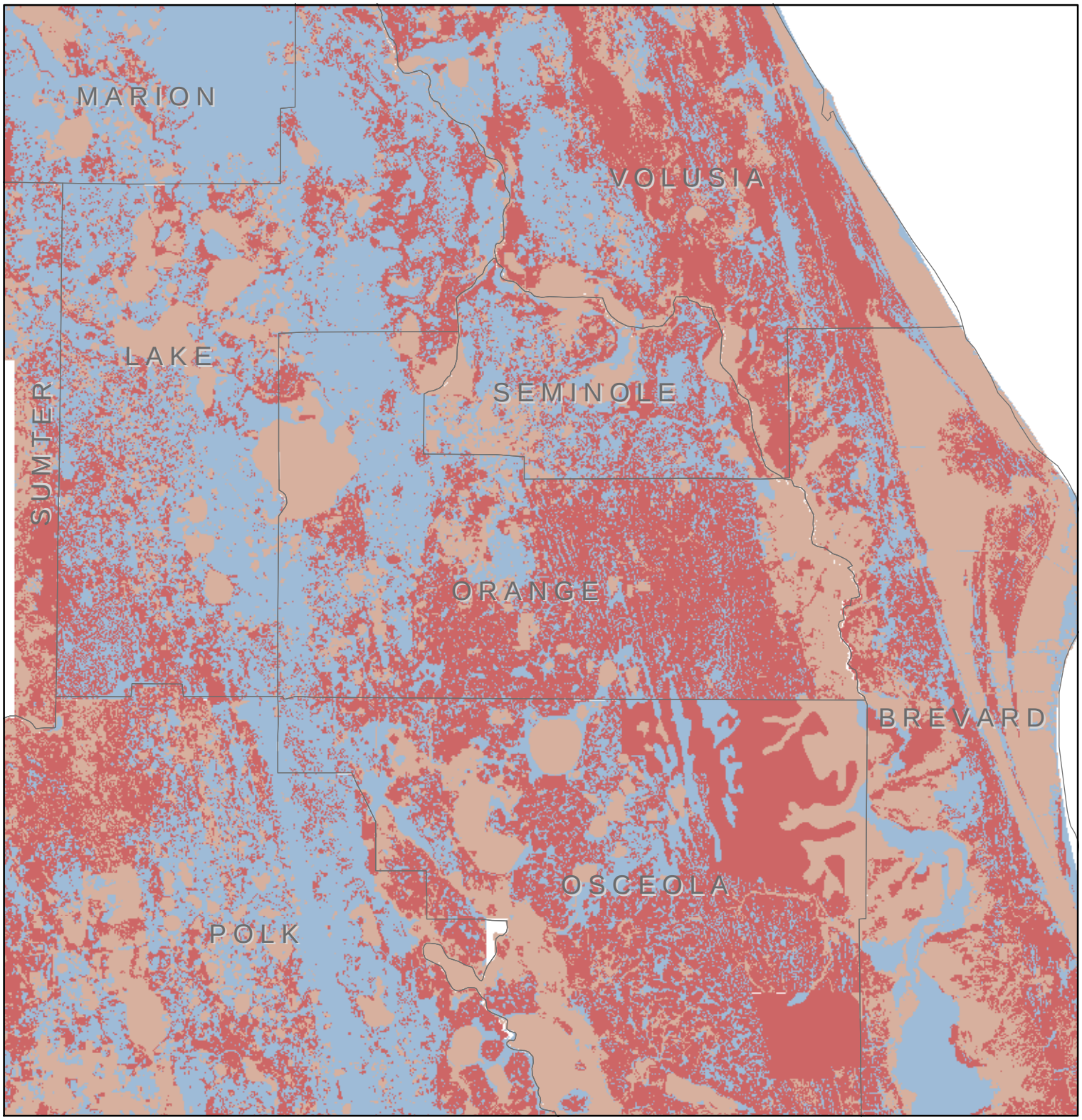
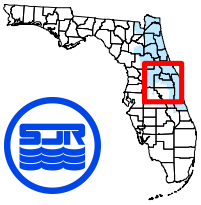
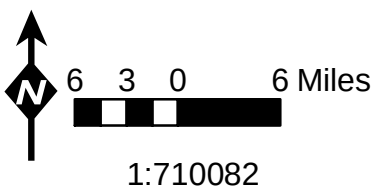


FIGURE 2. Susceptibility of soils to dewatering layer for likelihood of harm to native vegetation





Legend

Soil permeability ranking

- Low (<0.6 in/hr)
- Moderate (0.6 - 6 in/hr)
- High (>6 in/hr)

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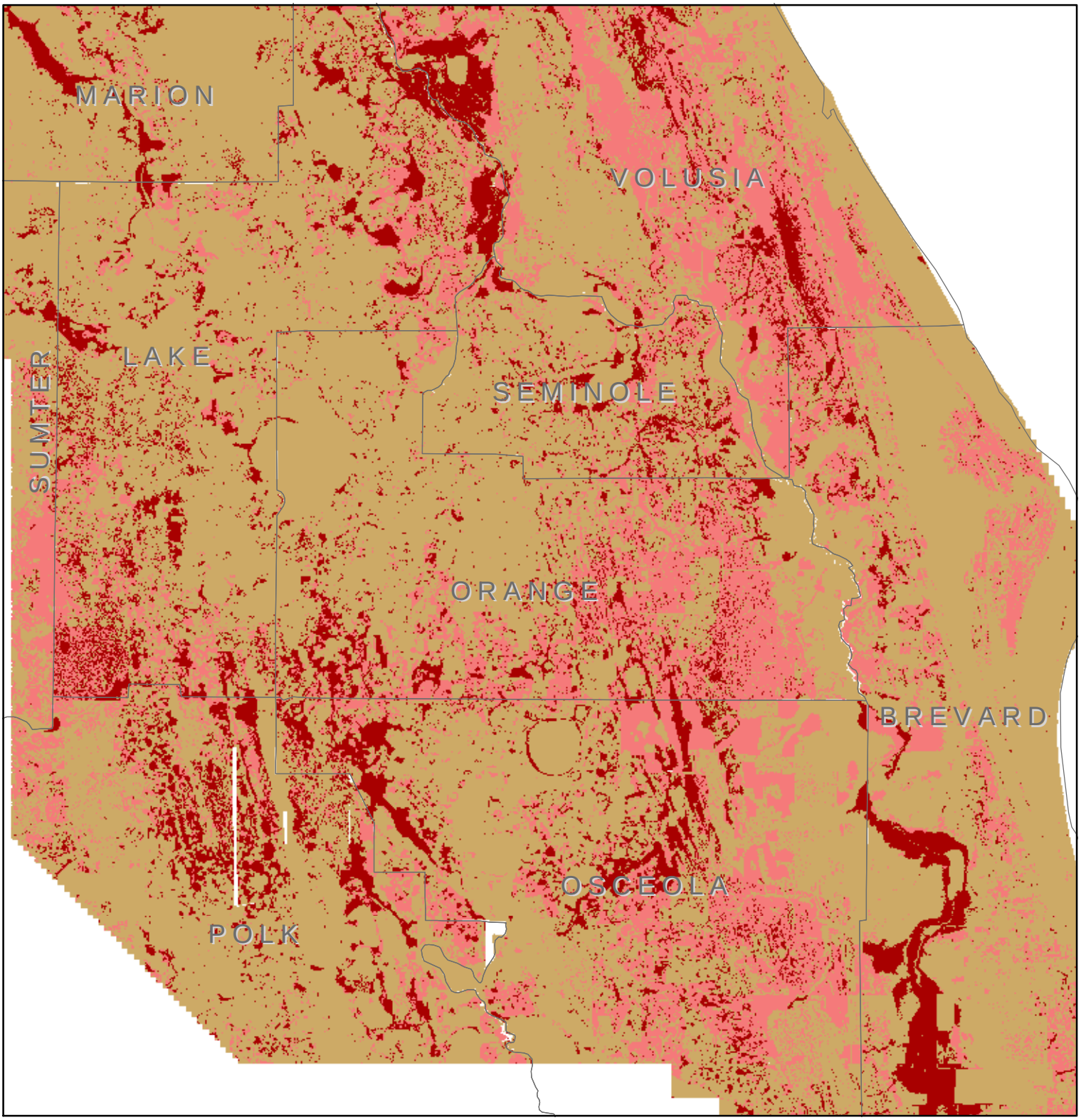
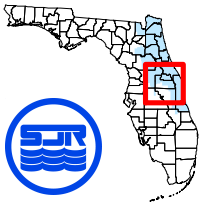


FIGURE 3. Potential for harm layer for likelihood of harm to native vegetation analysis (original criteria)



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Legend

Potential for harm

- Low (plants drought-tolerant and soils not susceptible to dewatering)
- Moderate (plants and soils moderately sensitive to drought and dewatering)
- High (plants not drought-tolerant and soils susceptible to dewatering)

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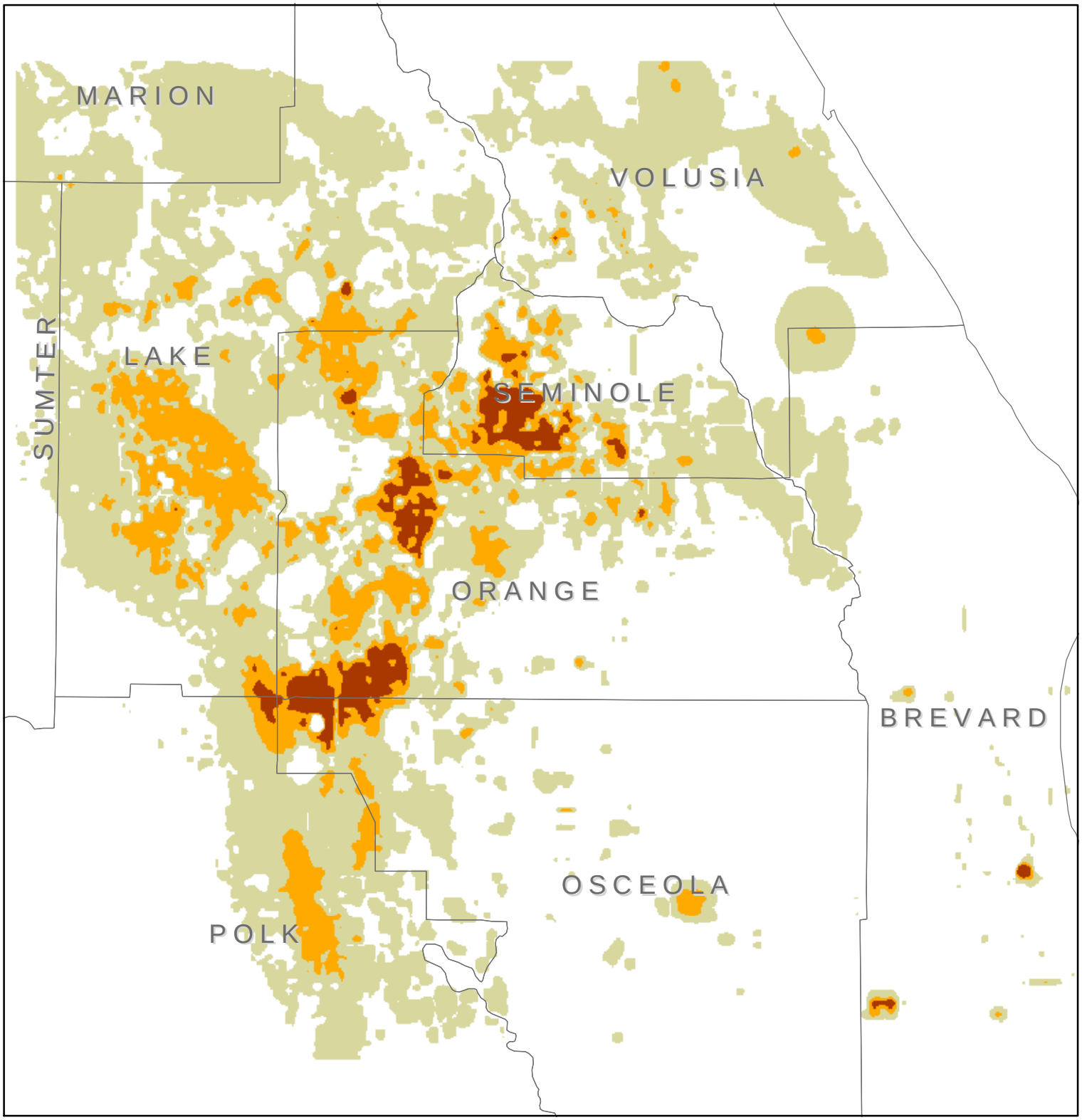
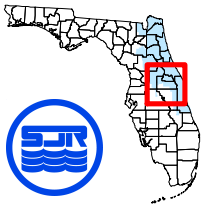


FIGURE 4. Projected 2025 surficial aquifer drawdown layer for harm to native vegetation analysis (original criteria)



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Legend

ECF projected 2025 surficial drawdown (ft)

- Low (0.1 - 1)
- Medium (1 - 2.5)
- High (>2.5)

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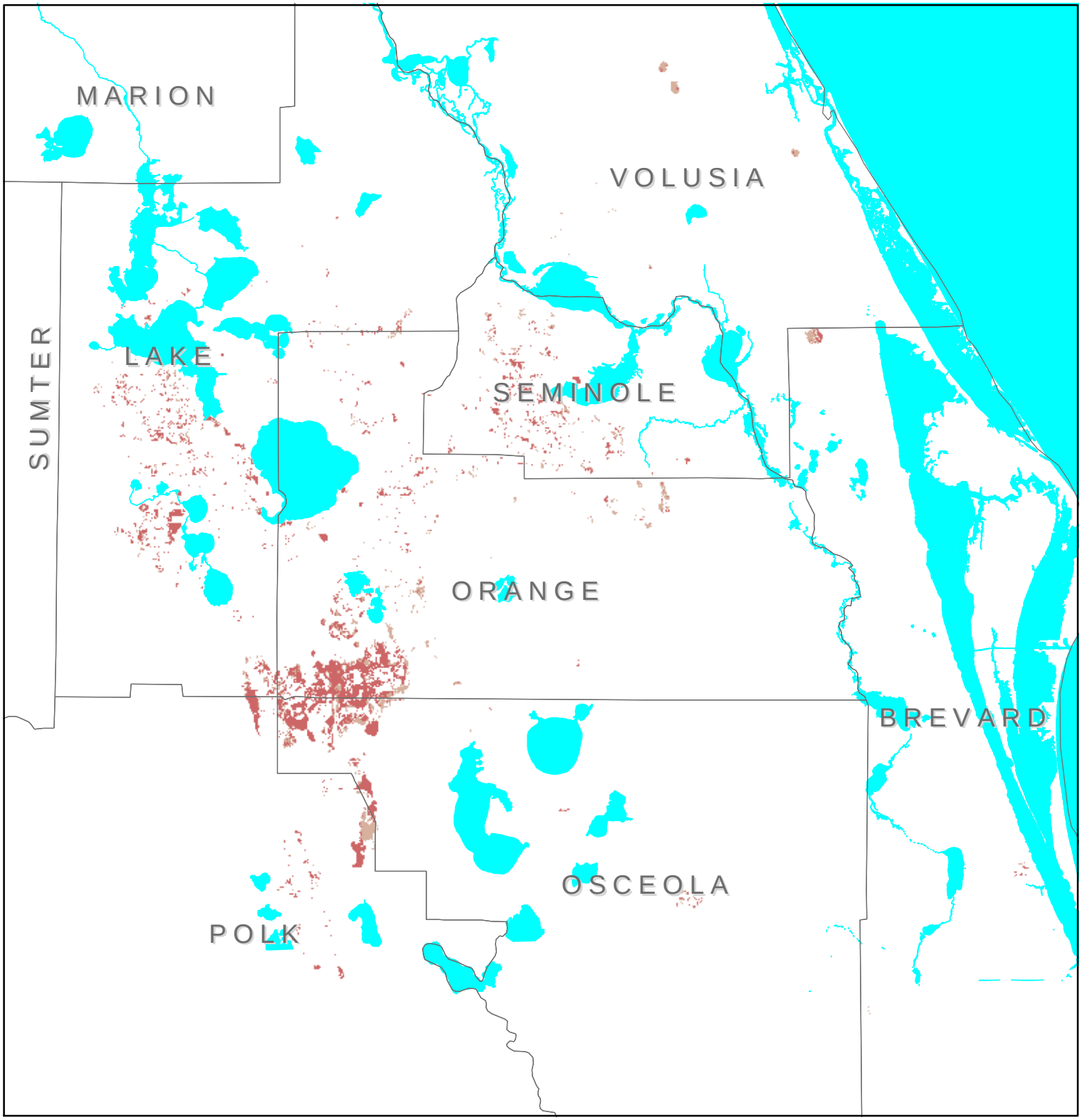
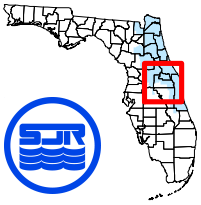
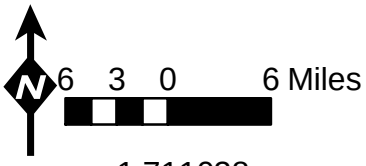


FIGURE 5. Likelihood of harm to native vegetation due to modeled groundwater withdrawals (original criteria)





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Likelihood of harm to native vegetation

- Low
- Moderate
- High

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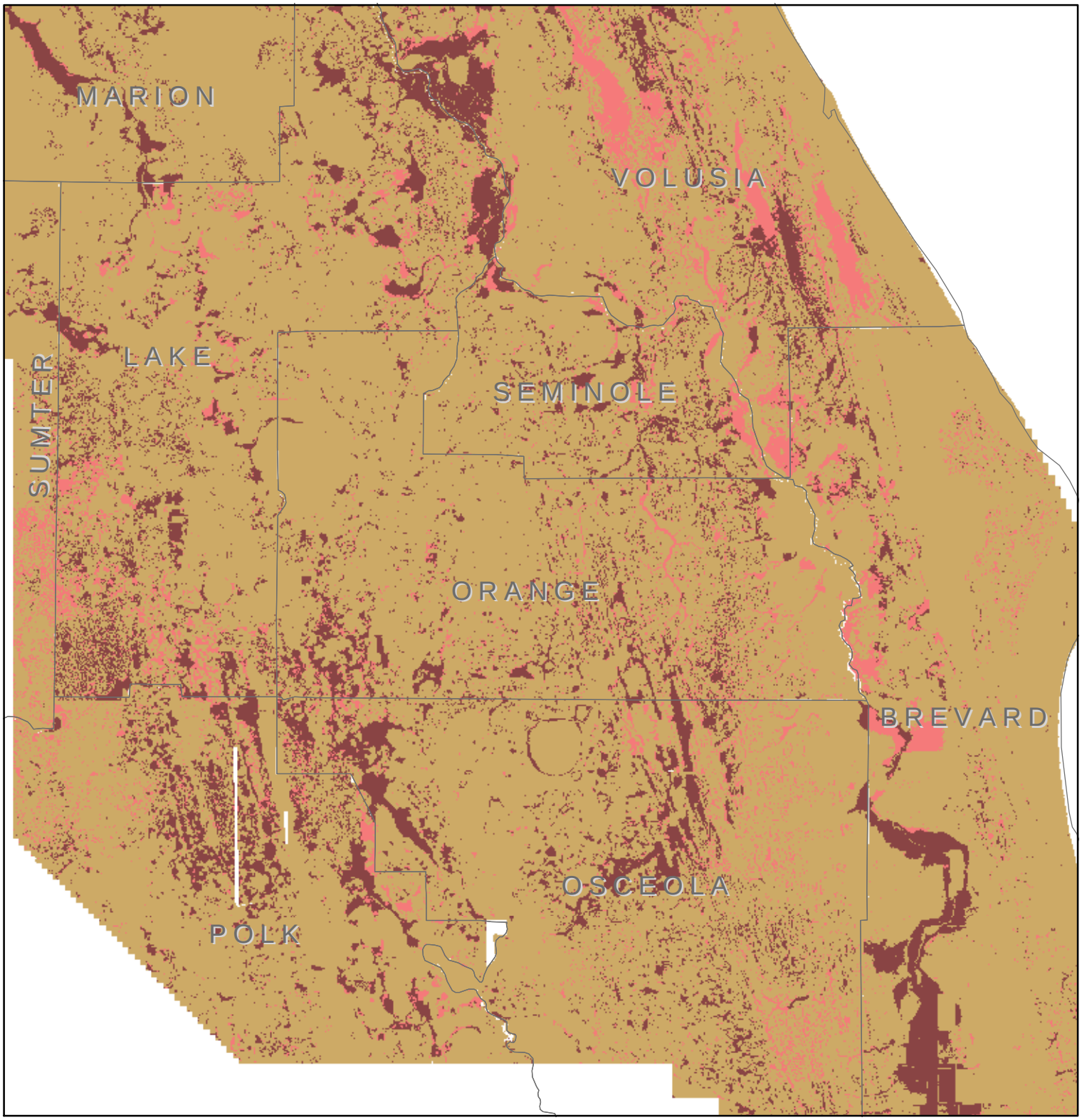
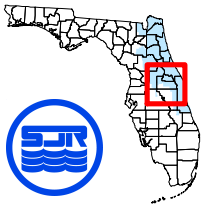
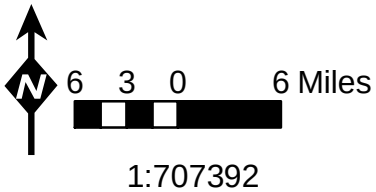


FIGURE 6. Potential for harm layer for likelihood of harm to native vegetation analysis (revised criteria)





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Potential for harm

- Low (plants drought-tolerant and soils not susceptible to dewatering)
- Moderate (plants and soils moderately sensitive to drought and dewatering)
- High (plants not drought-tolerant and soils susceptible to dewatering)

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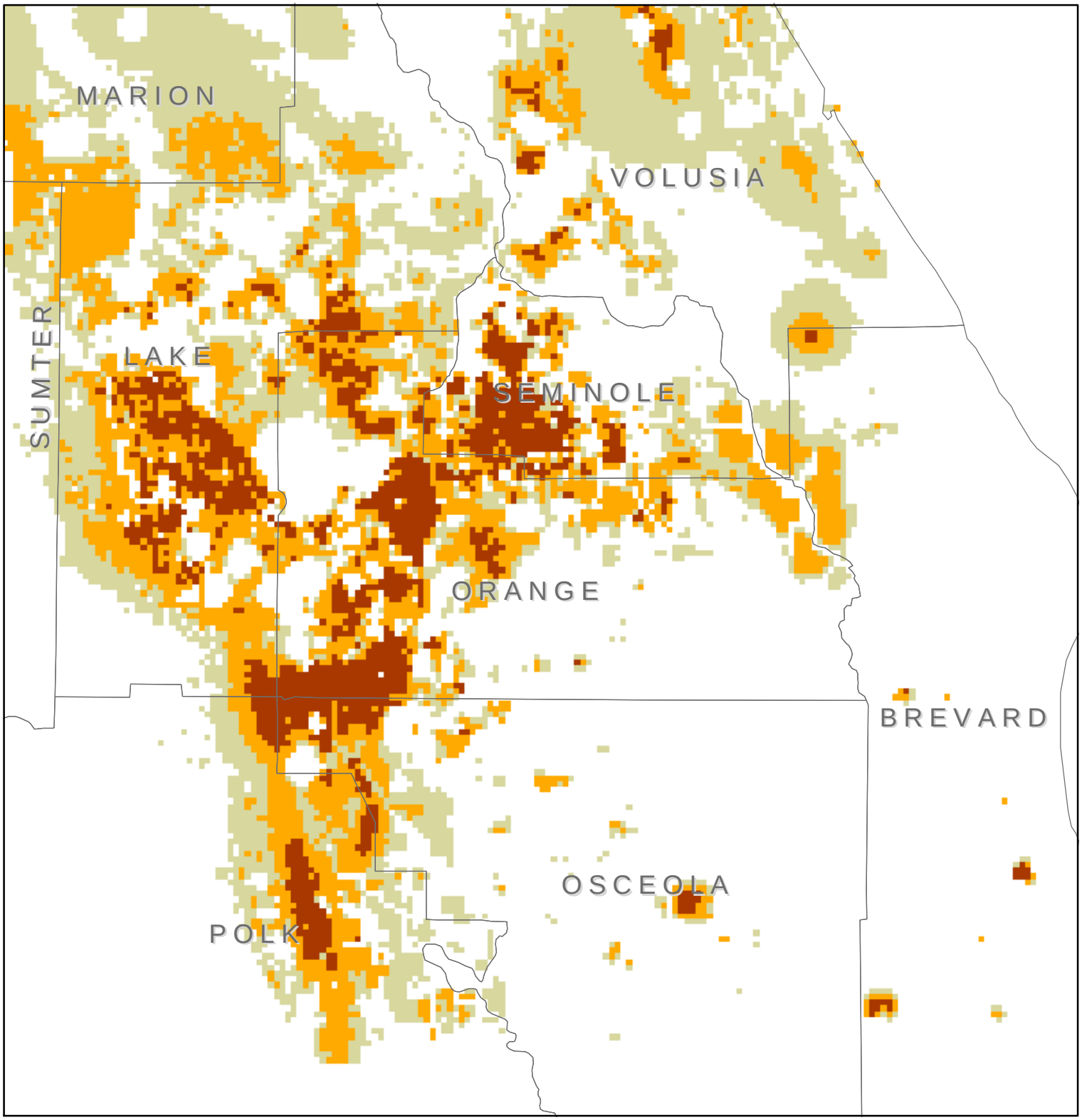
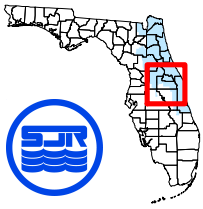


FIGURE 7. Projected 2025 surficial aquifer drawdown layer for harm to native vegetation analysis (revised criteria)



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ECF projected 2025 surficial drawdown (ft)

- Low (0.1 - 0.35)
- Medium (0.35 - 1.2)
- High (>1.2)

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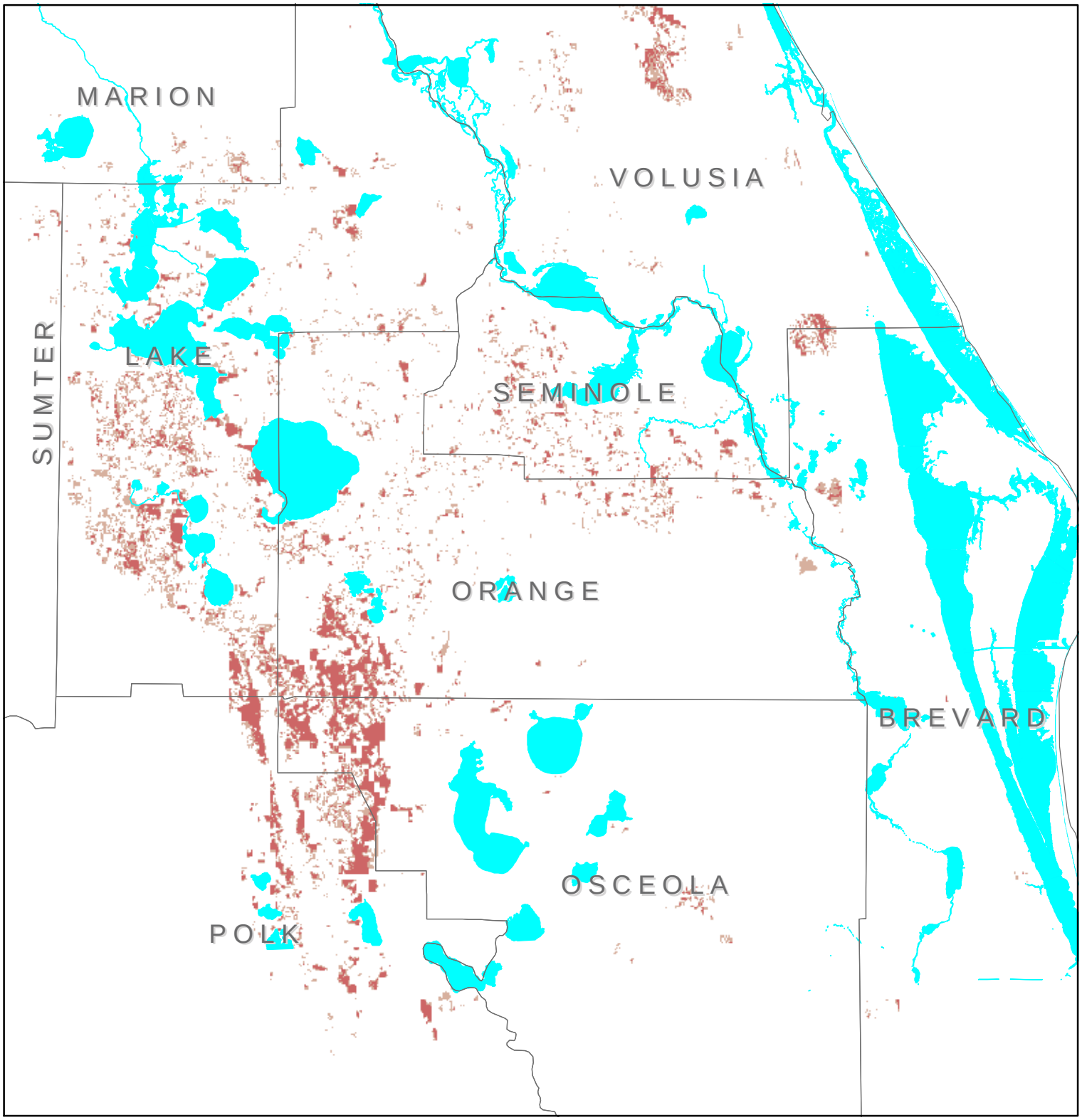
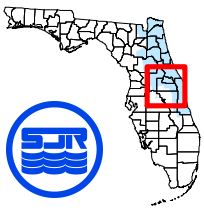
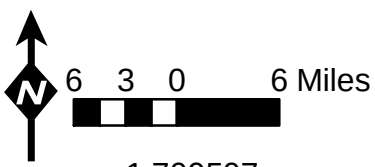


FIGURE 8. Likelihood of harm to native vegetation due to modeled groundwater withdrawals (revised criteria)





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Likelihood of harm to native vegetation

- Low
- Moderate
- High

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