Climate Change Vulnerability Index Report

Carex pauciflora (Few-flowered sedge)

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Assessor: Walter Fertig, WA Natural Heritage Program

Geographic Area: Washington Heritage Rank: G5/S2

Index Result: Highly Vulnerable Confidence: Very High

Climate Change Vulnerability Index Scores

Section A: Local Climate	**Severity**	**Scope (% of range)**
1. Temperature Severity	>6.0° F (3.3°C) warmer	0
	5.6-6.0° F (3.2-3.3°C) warmer	0
	5.0-5.5° F (2.8-3.1°C) warmer	0
	4.5-5.0° F (2.5-2.7°C) warmer	0
	3.9-4.4° F (2.2-2.4°C) warmer	25
	<3.9° F (2.2°C) warmer	75
2. Hamon AET:PET moisture	< -0.119	0
	-0.097 to -0.119	0
	-0.074 to -0.096	100
	-0.051 to -0.073	0
	-0.028 to -0.050	0
	>-0.028	0
Section B: Indirect Exposure to Climate Change		**Effect on Vulnerability**
1. Sea level rise		Neutral
2a. Distribution relative to natural barriers		Somewhat Increase
2b. Distribution relative to anthropogenic barriers		Neutral
3. Impacts from climate change mitigation		Neutral
Section C: Sensitivity and Adaptive Capacity		
1. Dispersal and movements		Somewhat Increase/Increase
2ai Change in historical thermal niche		Increase
2aii. Change in physiological thermal niche		Somewhat Increase
2bi. Changes in historical hydrological niche		Neutral
2bii. Changes in physiological hydrological niche		Increase
2c. Dependence on specific disturbance regime		Neutral
2d. Dependence on ice or snow-covered habitats		Somewhat Increase
3. Restricted to uncommon landscape/geological features		Neutral
4a. Dependence on others species to generate required habitat		Neutral/Somewhat Increase
4b. Dietary versatility		Not Applicable
4c. Pollinator versatility		Neutral
4d. Dependence on other species for propagule dispersal		Neutral/Somewhat Increase
4e. Sensitivity to pathogens or natural enemies		Neutral
4f. Sensitivity to competition from native or non-native species		Neutral/Somewhat Increase
4g. Forms part of an interspecific interaction not covered above		Neutral

5a. Measured genetic diversity	Unknown
5b. Genetic bottlenecks	Unknown
5c. Reproductive system	Neutral
6. Phenological response to changing seasonal and precipitation dynamics	Neutral
Section D: Documented or Modeled Response	
D1. Documented response to recent climate change	Neutral
D2. Modeled future (2050) change in population or range size	Unknown
D3. Overlap of modeled future (2050) range with current range	Unknown
D4. Occurrence of protected areas in modeled future (2050) distribution	Unknown

Section A: Exposure to Local Climate Change

A1. Temperature: Fifteen of the 20 extant and historical occurrences of *Carex pauciflora* in Washington (75%) occur in areas with a projected temperature increase of <3.9˚ F (Figure 1).

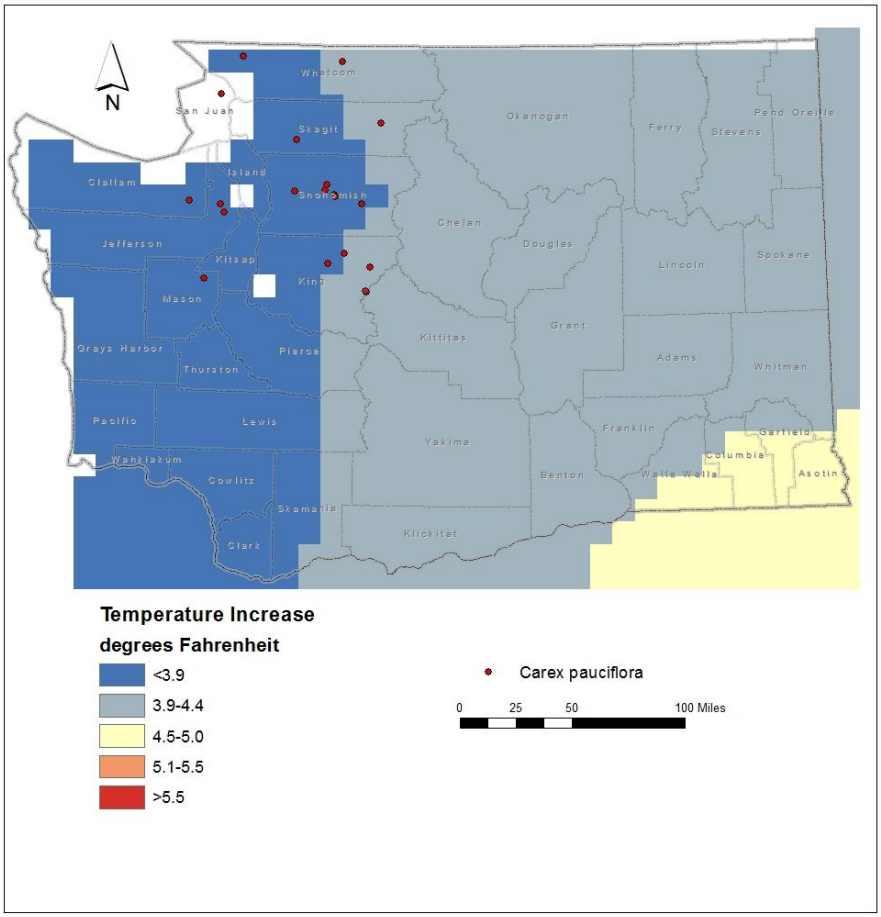

Figure 1. Exposure of *Carex pauciflora* occurrences in Washington to projected local temperature change. Base map layers from www.natureserve.org/ccvi

Five other populations (25%) are from areas with projected temperature increases of 3.9-4.4˚ F.

A2. Hamon AET:PET Moisture Metric: All 20 of the occurrences of *Carex pauciflora* in Washington (100%) are found in areas with a projected decrease in available moisture (as measured by the ratio of actual to potential evapotranspiration) in the range of -0.074 to -0.096 (Figure 2).

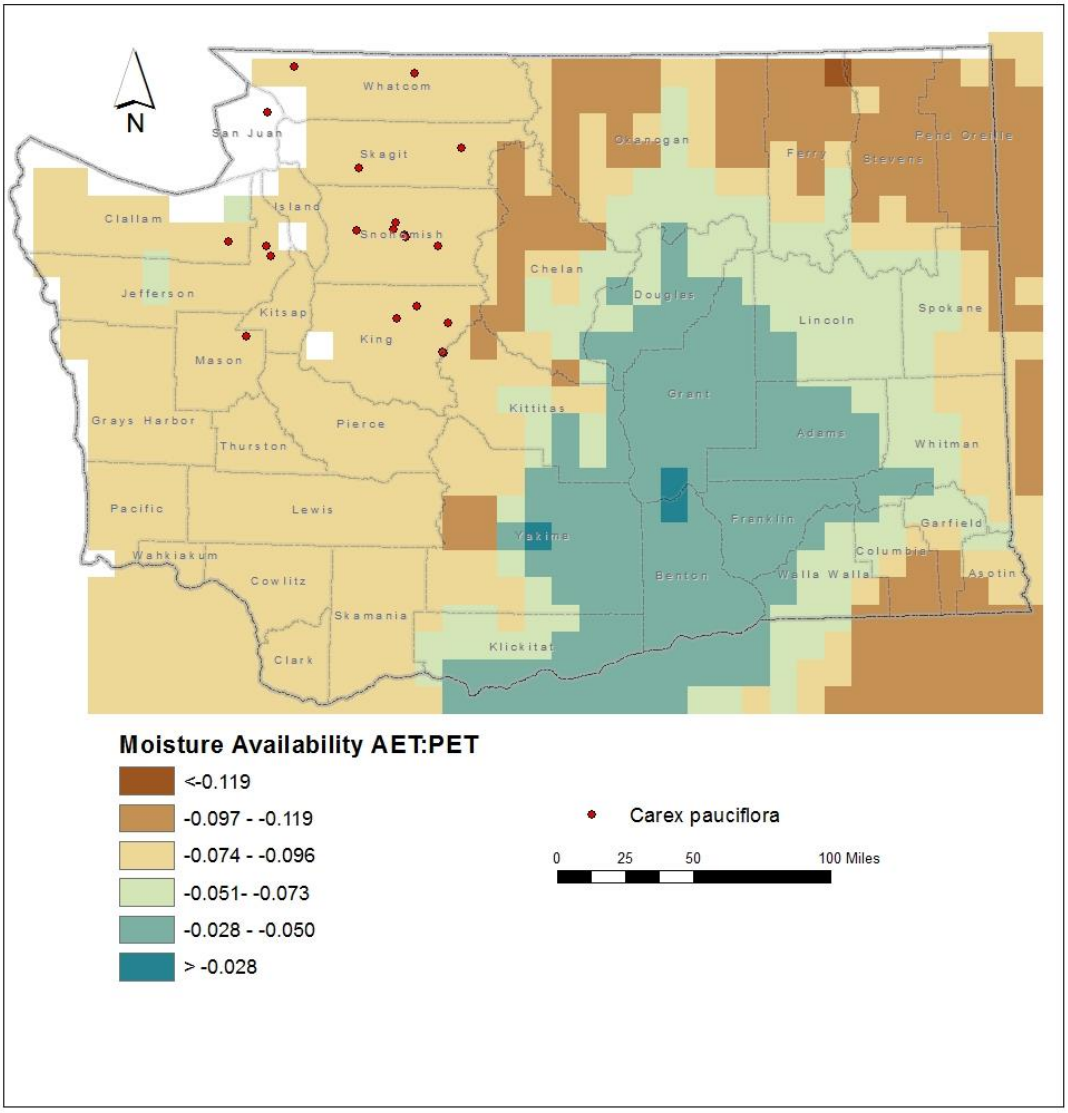

Figure 2. Exposure of *Carex pauciflora* occurrences in Washington to projected moisture availability (based on ratio of actual to predicted evapotranspiration). Base map layers from www.natureserve.org/ccvi

Section B. Indirect Exposure to Climate Change

B1. Exposure to sea level rise: Neutral.
Washington occurrences of *Carex pauciflora* are found at 250-4550 feet (75-1390 m) and would not be inundated by projected sea level rise.

B2a. Natural barriers: Somewhat Increase.
Carex pauciflora occurs primarily on moss mats in sphagnum bogs and peatlands on islands, lakeshores, and benches embedded within western hemlock (*Tsuga heterophylla*), lodgepole pine (*Pinus contorta*), alpine laurel (*Kalmia microphylla*) and bog Labrador tea (*Rhododendron groenlandicum*) communities (Camp and Gamon 2011; Wilson et al. 2018). This habitat is part of the North Pacific Bog and Fen ecological system (Rocchio and Crawford 2015). Populations are separated from each other by 0.5-44 miles (1.2-69 km). These peatland habitats are naturally small and isolated within a matrix of unsuitable forest, agricultural, and urban/rural lands that create a barrier to migration and dispersal.

B2b. Anthropogenic barriers: Neutral.
Populations of *Carex pauciflora* in Washington are primarily found in high elevation areas of the Olympic and northern Cascade mountains (at least 7 populations are in designated protected areas). Some populations may be near roads or timber harvesting areas, but otherwise are less impacted by human infrastructure than most lowland plant species. The patchy and specific hydrologic requirements of its natural habitat is a more significant barrier to dispersal or migration than human impacts.

B3. Predicted impacts of land use changes from climate change mitigation: Neutral.

Section C: Sensitive and Adaptive Capacity

C1. Dispersal and movements: Somewhat Increase/Increase.
Carex pauciflora produces 2-6 one-seeded dry fruits per inflorescence. At maturity, the dagger-shaped perigynia (a bladdery sac enclosing the achene fruit) are deflexed downward due to overgrowth of spongy cells at the base of each perigynium and the sterile scale that normally subtends the perigynium is shed. A passing animal that brushes the fruiting spike causes the perigynium to spring upwards, compressing the spongy tissue and forcibly discharging the perigynium 1-2 feet (Hutton 1976; Wilson et al. 2018). Once dehisced, the perigynium and achene may be secondarily transported by wind, water, or animals, although the total distance dispersed is probably less than 100m.

C2ai. Historical thermal niche: Increase.
Figure 3 depicts the distribution of *Carex pauciflora* in Washington relative to mean seasonal temperature variation for the period from 1951-2006 ("historical thermal niche"). Fifteen of the 20 known occurrences in the state (75%) are found in areas that have experienced small temperature variation (37-47˚F/20.8-26.3˚C) during the past 50 years and are considered at increased vulnerability to climate change (Young et al. 2016). The other five occurrences (25%) have experienced slightly lower than average (47.1-57˚F/26.3-31.8˚C) temperature variation over the same period and are at somewhat increased vulnerability to climate change.

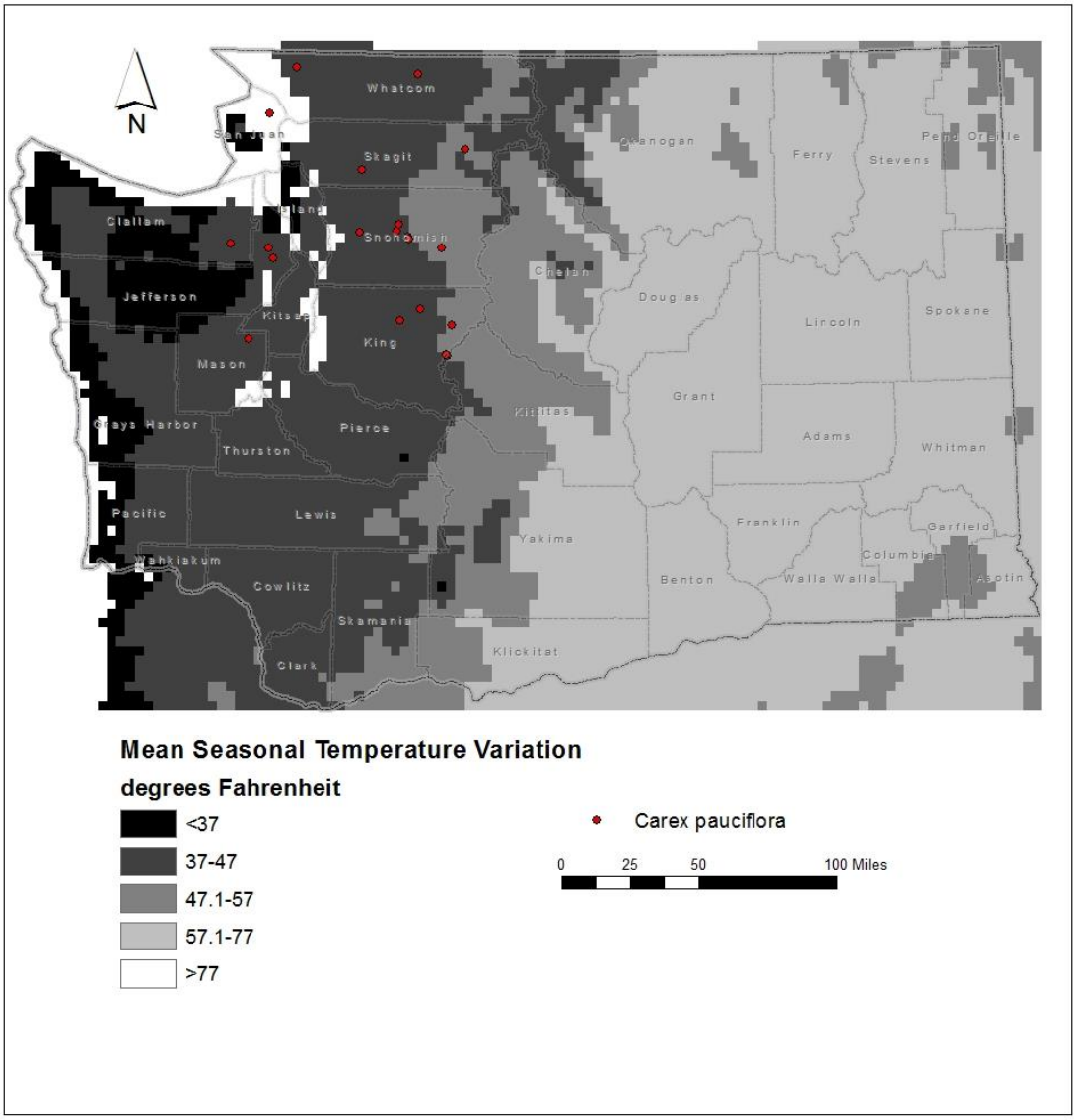

Figure 3. Historical thermal niche (exposure to past temperature variations) of *Carex pauciflora* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2aii. Physiological thermal niche: Somewhat Increase.
The bog and peatland habitat of *Carex pauciflora* is often associated with cold air drainage sites in montane settings and are cooler than the surrounding matrix vegetation.

C2bi. Historical hydrological niche: Neutral.
Sixteen of the 20 populations of *Carex pauciflora* in Washington (80%) are found in areas that have experienced greater than average precipitation variation in the past 50 years (>40

inches/1016 mm) (Figure 4). The other four populations (20%) are from areas with average precipitation variation (20-40 inches/508-1016 mm). According to Young et al. (2016), all of the Washington occurrences are neutral for climate change.

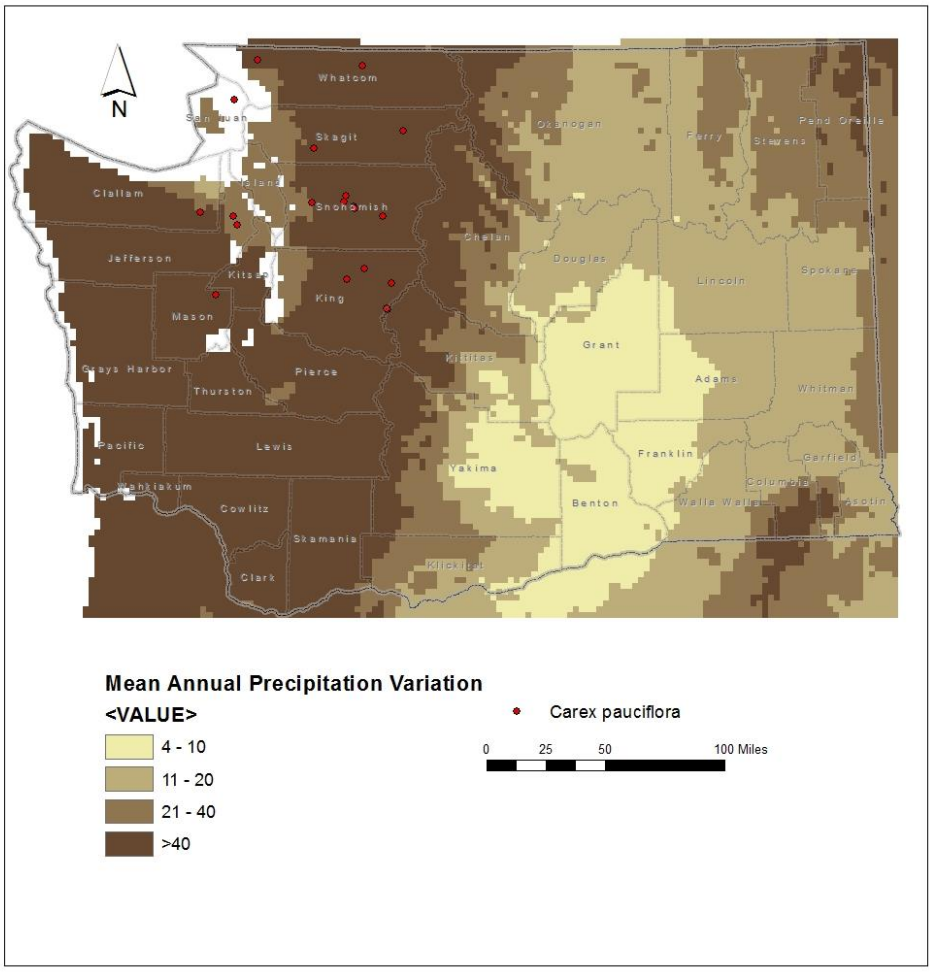

Figure 4. Historical hydrological niche (exposure to past variations in precipitation) of *Carex pauciflora* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2bii. Physiological hydrological niche: Increase.
The peatland habitat of *Carex pauciflora* is dependent on adequate year-round moisture (particularly from groundwater). Changes in the amount of precipitation, shifts from snow to rain, decreased snowpack, or changes in timing of snowmelt could result in a drop in water table depth that in turn would facilitate the transition from bog to wet meadow vegetation (Rocchio and Ramm-Granberg 2017).

C2c. Dependence on a specific disturbance regime: Neutral.
Carex pauciflora is not dependent on disturbance to maintain its peatland habitat.

C2d. Dependence on ice or snow-cover habitats: Somewhat Increase.
The populations of *Carex pauciflora* in Washington are found in areas of the Olympic and northern Cascade mountains with very high snowfall. Melting snow is a significant contributor to ground water that sustains many peatlands. Warming temperatures could result in a shift from snow to more winter rainfall in western Washington. A reduction in overall snowpack could result in less water being available in summer and a lowering of the water table. In turn, drier conditions could promote increased decay of peat or shifts in the dominance of plant species to those adapted to wet meadows (Rocchio and Ramm-Granberg 2017).

C3. Restricted to uncommon landscape/geological features: Neutral.
Carex pauciflora is found primarily on peat soils over Quaternary alluvium and Pleistocene glacial drift. Some populations in the Cascade Range occur on granodiorite outcrops of the Snoqualmie batholith or Barlow Pass volcanics. Most of these geologic types are widespread in the Cascade and Olympic ranges of northwestern Washington (Washington Division of Geology and Earth Resources 2016).

C4a. Dependence on other species to generate required habitat: Neutral/Somewhat Increase.
One *Carex pauciflora* population in Skagit County appears to have been maintained in part by past beaver (*Castor canadensis*) activity (WNHP records). Whether beaver dams are maintaining high water tables at other peatland occurrences of *C. pauciflora* has not been documented.

C4b. Dietary versatility: Not applicable for plants

C4c. Pollinator versatility: Neutral.
Carex pauciflora is entirely wind pollinated and not dependent on animals for pollination.

C4d. Dependence on other species for propagule dispersal: Neutral/Somewhat Increase.
Perigynia of *Carex pauciflora* are ejected from the fruiting heads by being disturbed by passing animals and may be secondarily transported on muddy fur or feet. Otherwise, dispersal is primarily passive (gravity, wind, and flowing water).

C4e. Sensitivity to pathogens or natural enemies: Neutral.
Impacts from pathogens are not known. Grazing is not considered a significant threat to this species (Wilson et al. 2018).

C4f. Sensitivity to competition from native or non-native species: Neutral/Somewhat Increase.
Under present conditions, competition from non-native species is minor, as few introduced plants are adapted to acidic bog environments. Potential shifts in vegetation from peatland to wet meadow that could result from persistently lowered water tables from climate change would increase competition from plant species adapted to drier conditions (Rocchio and Ramm-Granberg 2017).

C4g. Forms part of an interspecific interaction not covered above: Neutral.
Does not require an interspecific interaction.

C5a. Measured genetic variation: Unknown.
No data are available on genetic variability in *Carex pauciflora* populations in Washington. Populations in the state are at the southern edge of the species' range, and so might have lower genetic diversity due to genetic drift or founder effects.

C5b. Genetic bottlenecks: Unknown.
Not known.

C5c. Reproductive System: Neutral.
Carex pauciflora is a wind-pollinated, obligate outcrosser and would be expected to have at least average genetic variability.

C6. Phenological response to changing seasonal and precipitation dynamics: Neutral.
Based on herbarium records in the Consortium of Pacific Northwest Herbaria website (pnwherbaria.org), *Carex pauciflora* has not changed its typical blooming time since the 1890s.

Section D: Documented or Modeled Response to Climate Change

D1. Documented response to recent climate change: Neutral.
No major changes have been detected in the distribution of *Carex pauciflora* in Washington in the last century. Wilson et al. (2018) state that some populations in Washington seem to be declining. Abundance data from WNHP records suggest most populations are locally abundant (often being a community dominant) and relatively stable, although two populations may be historical or extirpated. Whether these occurrences have disappeared due to habitat loss or climate change is not known.

D2. Modeled future (2050) change in population or range size: Unknown

D3. Overlap of modeled future (2050) range with current range: Unknown

D4. Occurrence of protected areas in modeled future (2050) distribution: Unknown

References

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