Climate Change Vulnerability Index Report

Leptosiphon bolanderi (Bolander's linanthus)

Date: 5 October 2021 Synonym: *Linanthus bakeri, Linanthus bolanderi*

Assessor: Walter Fertig, WA Natural Heritage Program

Geographic Area: Washington Heritage Rank: G4G5/S2

Index Result: Less Vulnerable Confidence: Low

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	100
	<3.9° F (2.2°C) warmer	0
2. Hamon AET:PET moisture	< -0.119	0
	-0.097 to -0.119	0
	-0.074 to -0.096	0
	-0.051 to -0.073	88.9
	-0.028 to -0.050	11.1
	>-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		Neutral/Somewhat Increase
2ai Change in historical thermal niche		Neutral
2aii. Change in physiological thermal niche		Neutral/Somewhat Increase
2bi. Changes in historical hydrological niche		Neutral
2bii. Changes in physiological hydrological niche		Neutral
2c. Dependence on specific disturbance regime		Neutral
2d. Dependence on ice or snow-covered habitats		Neutral/Somewhat Increase
3. Restricted to uncommon landscape/geological features		Neutral
4a. Dependence on others species to generate required habitat		Neutral
4b. Dietary versatility		Not Applicable
4c. Pollinator versatility		Neutral
4d. Dependence on other species for propagule dispersal		Neutral
4e. Sensitivity to pathogens or natural enemies		Neutral
4f. Sensitivity to competition from native or non-native species		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	Somewhat Increase
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: All 9 of the extant and historical occurrences of *Leptosiphon bolanderi* in Washington (100%) occur in areas with a projected temperature increase of 3.9-4.4˚ F (Figure 1).

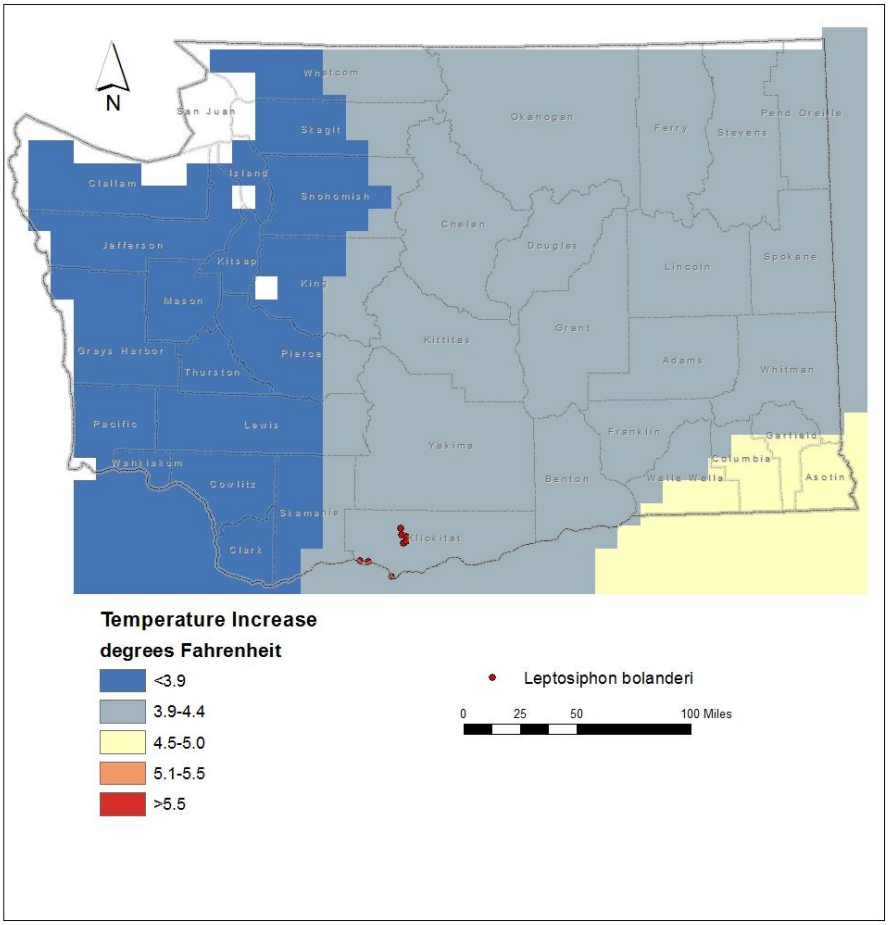

Figure 1. Exposure of *Leptosiphon bolanderi* occurrences in Washington to projected local temperature change. Base map layers from www.natureserve.org/ccvi

A2. Hamon AET:PET Moisture Metric: Eight of the 9 occurrences (88.9%) of *Leptosiphon bolanderi* in Washington 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 -0.051 to -0.073 (Figure 2). One other population (11.1%) is from an area with a projected decrease of -0.028 to -0.050.

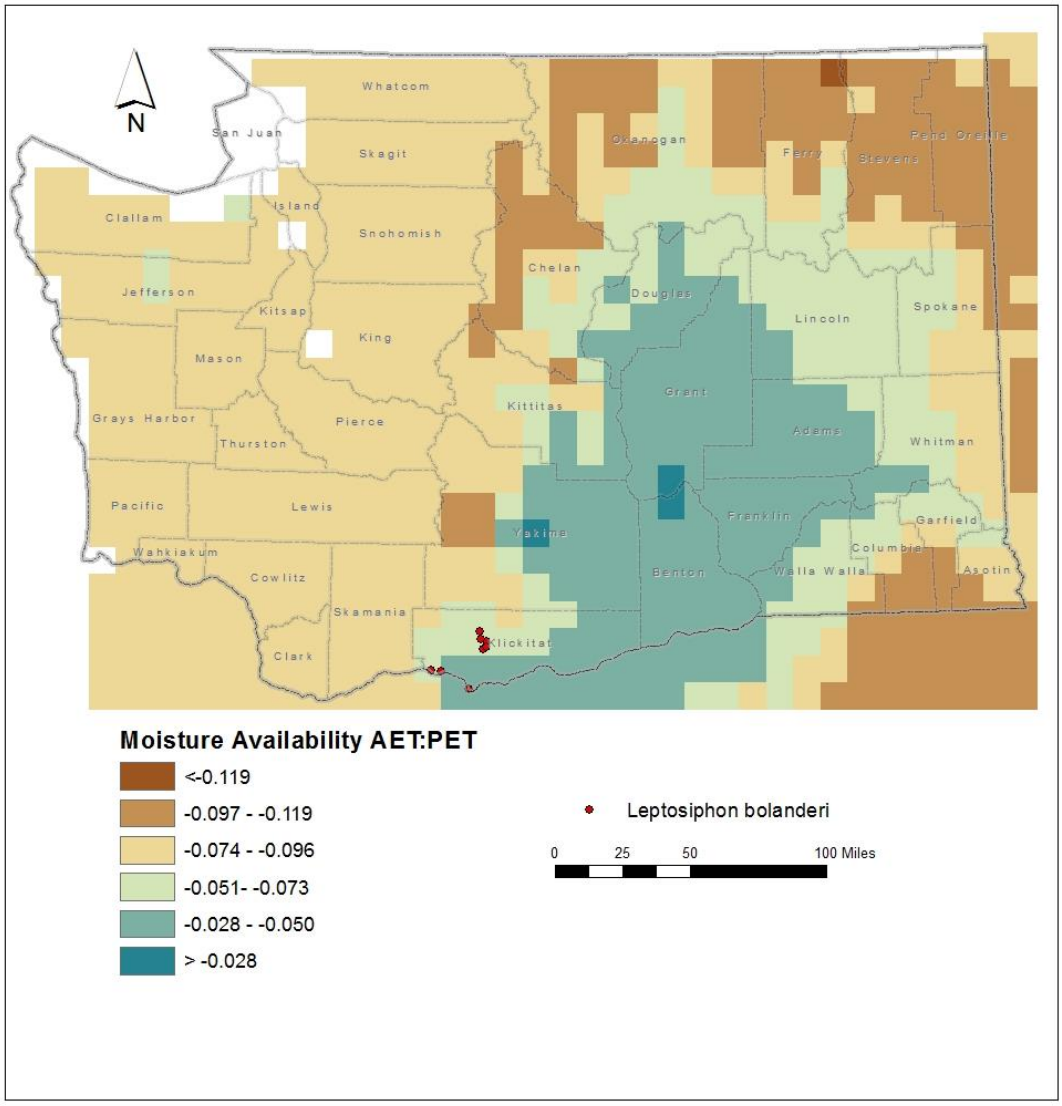

Figure 2. Exposure of *Leptosiphon bolanderi* occurrences in Washington to projected moisture availability (based on ratio of actual to predicted evapotranspiration). Base map layers from www.natureserve.org/ccvi

Section B. Indirect Exposure to Climate Change

B1. Exposure to sea level rise: Neutral.
Washington occurrences of *Leptosiphon bolanderi* are found at 850-1800 feet (260-550 m) and would not be inundated by projected sea level rise.

B2a. Natural barriers: Somewhat Increase.
Leptosiphon bolanderi occurs primarily on dry, partially vegetated rocky areas with bare mineral soil in openings in Oregon white oak (*Quercus garryana*) and bluebunch wheatgrass (*Pseudoroegneria spicata*) communities (Camp and Gamon 2011; Washington Natural Heritage Program 2021). This habitat is part of the East Cascades Oak-Ponderosa Pine Forest & Woodland ecological system (Rocchio and Crawford 2015). Populations are separated from each other by 1.5-17.5 miles (2.5-28 km). There are natural, topographic barriers between the main concentrations of populations along the upper Klickitat River Canyon and the Columbia River that may limit overland dispersal.

B2b. Anthropogenic barriers: Neutral.
This species is adapted to sparsely vegetated, bare soil areas within Oregon white oak/ponderosa pine habitat. Human activities over the past 150 years have increased the amount of disturbed habitat in Klickitat County and created potential new conduits for dispersal along roads or across deforested areas, but has not seemed to increase the spread of *Leptosiphon bolnderi*.

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

Section C: Sensitive and Adaptive Capacity

C1. Dispersal and movements: Neutral/Somewhat Increase.
Leptosiphon bolanderi produces numerous, small seeds within dry capsule fruits that split open to release the seeds passively at maturity. Dispersal distances may vary from short (less than 100 m) to 1000 m or more, depending on whether the seed becomes wet and mucilaginous (sticky-gooey), allowing them to become fastened to animals (Moran 1977).

C2ai. Historical thermal niche: Neutral.
Figure 3 depicts the distribution of *Leptosiphon bolanderi* in Washington relative to mean seasonal temperature variation for the period from 1951-2006 ("historical thermal niche"). Seven of the 9 known occurrences in the state (77.8%) are found in areas that have experienced average (57.1-77˚F/31.8-43.0˚C) temperature variation during the past 50 years and are considered at neutral vulnerability to climate change (Young et al. 2016). Two of nine populations (22.2%) have had slightly lower than average (47.1-57˚F/26.3-31.8˚C) temperature variation during the same period and are considered at somewhat increased vulnerability to climate change (Young et al. 2016).

C2aii. Physiological thermal niche: Neutral/Somewhat Increase.
The sparsely vegetated openings within oak-ponderosa pine woodland habitat of *Leptosiphon bolanderi* may be on exposed ridges or in topographic depressions. The latter sites are cooler

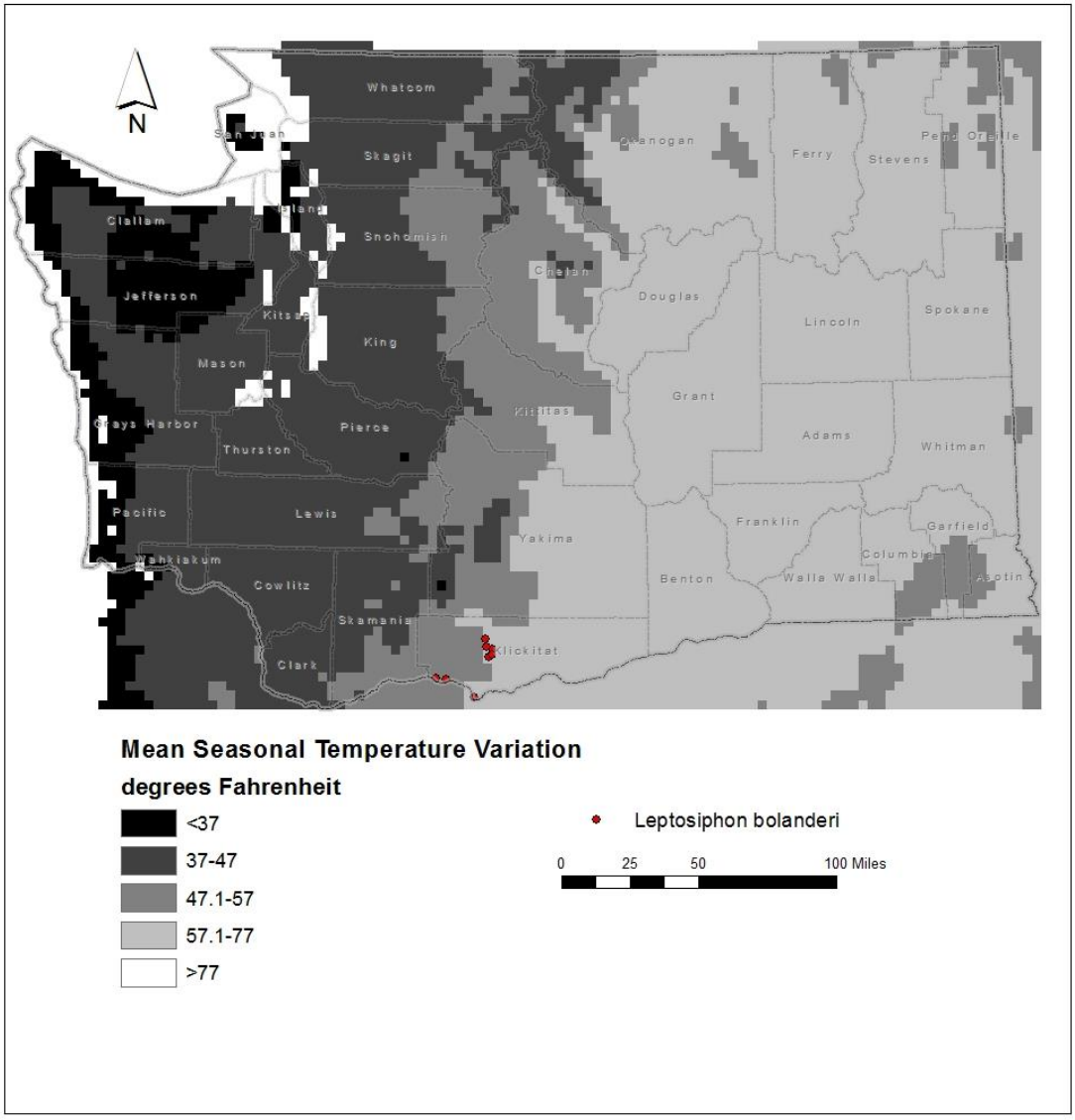

Figure 3. Historical thermal niche (exposure to past temperature variations) of *Leptosiphon bolanderi* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

microsites during the flowering season and could be impacted by increasing temperatures from climate change.

C2bi. Historical hydrological niche: Neutral.
All of the known populations of *Leptosiphon bolanderi* in Washington are found in areas that have experienced average precipitation variation in the past 50 years (20-40 inches/508-1016 mm) (Figure 4). According to Young et al. (2016), these occurrences are neutral for climate change.

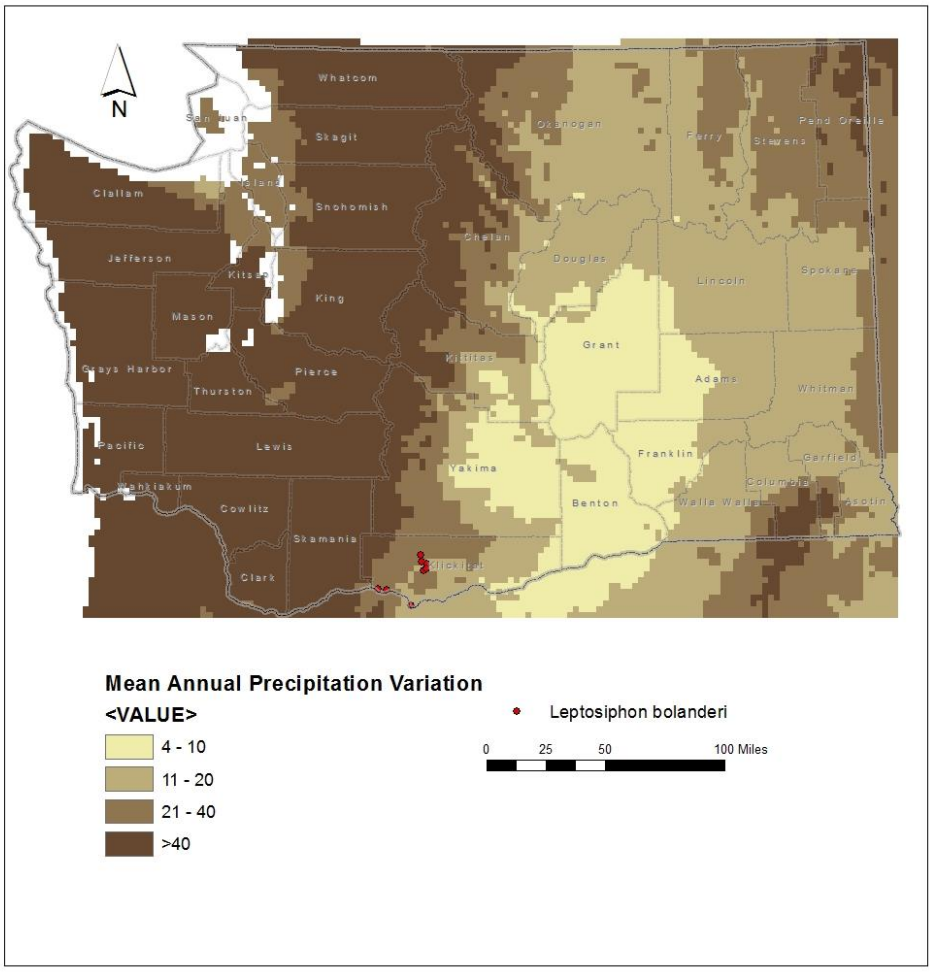

Figure 4. Historical hydrological niche (exposure to past variations in precipitation) of *Leptosiphon bolanderi* occurrences in Washington. Base map layers from www.natureserve.org/ccvi

C2bii. Physiological hydrological niche: Neutral.

This species occurs in partially barren openings associated with Oregon white oak and ponderosa pine that are not associated with perennial water sources or a high water table. Reduction in precipitation or warmer temperatures leading to more frequent or prolonged drought are likely to increase the fire frequency in this ecological system and result in a shift from mixed pine and oak to oak dominance, or more open habitat (Rocchio and Ramm-Granberg 2017). Disturbance from fire and drought may actually increase the amount of habitat available for *Leptosiphon bolanderi*, but this positive effect could be countered by increased competition with invasive, weedy annuals.

C2c. Dependence on a specific disturbance regime: Neutral.
Leptosiphon bolanderi occurs in sparsely vegetated and rocky openings in dry Oregon white oak/ponderosa pine woodlands. Natural or anthropogenic disturbances, including fire, may be neutral to beneficial in creating or maintaining these open and early seral conditions. Projected climate change is likely to make these areas drier, hotter, and more prone to wildfire and insect outbreaks that may negatively impact oaks (Rocchio and Ramm-Granberg 2017).

C2d. Dependence on ice or snow-cover habitats: Neutral/Somewhat Increase.
The populations of *Leptosiphon bolanderi* in Washington are found in low elevation foothill areas of the eastern Cascades and Columbia River that receive relatively low amounts of snow. Annuals, like *Leptosiphon bolanderi*, may have better flower or seed production, however, following wetter winters.

C3. Restricted to uncommon landscape/geological features: Neutral.
In Washington, *Leptosiphon bolanderi* is found mostly on soils derived from Wanapum or Grande Ronde basalt and Quaternary alluvium, all of which are widespread within its range (Washington Division of Geology and Earth Resources 2016). Populations from California may be associated with serpentine soils which often have specialized floras adapted to low levels of nitrogen, phosphorus, and potassium and high amounts of heavy metals, like cobalt, chromium, and nickel (Hitchcock et al. 1959). Serpentine is uncommon in Washington, being known primarily from islands in the Salish Sea and the Wenatchee Mountains, both areas where *L. bolanderi* has not been documented.

C4a. Dependence on other species to generate required habitat: Neutral
The open, rocky habitat of *Leptosiphon bolanderi* is created and maintained largely by natural abiotic conditions, such as fire or drought, but may be enhanced by grazing or soil disturbance by burrowing animals.

C4b. Dietary versatility: Not applicable for plants

C4c. Pollinator versatility: Neutral.
Leptosiphon bolanderi has small, white to pink flowers (6-8 mm long) that may be pollinated by small insects. Like other small-flowered *Leptosiphon* species, it is also likely capable of self-pollination (Goodwillie 1999).

C4d. Dependence on other species for propagule dispersal: Neutral.
The small seeds of *Leptosiphon bolanderi* may disperse passively by wind or be carried on the surface of animals (including waterfowl) after the seed coat has been wetted and become sticky. It is not dependent on a single species for transport.

C4e. Sensitivity to pathogens or natural enemies: Neutral.
Not known, but probably not a limiting factor.

C4f. Sensitivity to competition from native or non-native species: Somewhat Increase.
The open, rocky, partially barren habitat of *Leptosiphon bolanderi* is prone to invasion by annual weedy species that may compete for space or resources. Climate change is likely to make its habitat drier, hotter, and more vulnerable to wildfire and may hasten the spread of non-native competitors (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.
Studies of the genetic diversity within and between Washington populations of *Leptosiphon bolanderi* have not been done.

C5b. Genetic bottlenecks: Unknown.
Not known.

C5c. Reproductive System: Somewhat Increase.
Leptosiphon bolanderi has a mixed mating system involving both outcrossing and potential self-pollination. As a result, it may have lower genetic variability overall than might be expected, but more variability between populations.

C6. Phenological response to changing seasonal and precipitation dynamics: Neutral.
Based on herbarium records in the Consortium of Pacific Northwest Herbaria website (pnwherbaria.org), *Leptosiphon bolanderi* has not changed its typical blooming time since the 1880s.

Section D: Documented or Modeled Response to Climate Change

D1. Documented response to recent climate change: Neutral.
Two historical populations along the Columbia River have not been relocated and may be extirpated due to habitat loss from development. Impacts from climate change does not appear to have altered the distribution of this species.

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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