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Subject: [EXTERNAL] Responses to climate questions
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Attachments: 20200414 Draft Climate Influence Questions - Ellis response.docx

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Put this together quickly, so may not be coherent in spots - there are long chains of causation that are hard to articulate in a few words.

Species Experts Questions on Climate Influence to *S. n. nokomis*
April 14, 2020

S. Ellis response

1. Will a warm and wet climate positively or negatively affect *S. n. nokomis*?

    - Wet would be positive to maintain groundwater flows required for nokomis wet meadow habitat; extremely wet (frequent floods in occupied riparian habitats) would not be.
    - Warm probably negative because of uncertainties around violet habitat requirements, and competitive relationships with other plant species. Currently one nokomis population in Utah that occurs in a blackbrush/sagebrush/pinyon juniper community at 5,300 ft, which is probably the warmest annual climate condition for the populations being considered.

2. Will a feast or famine climate (hot/dry one year warm/wet the next, for example) negatively affect the butterfly?

    - Because of the reliability of groundwater flows in spring-fed meadows, year to year fluctuations would generally not affect the butterfly foodplant violets or adult nectar sources dependent on the same wetlands. For example, 2018 was a drought year in western Colorado, but S. nokomis, violets, and surface water flows in wetlands were abundant on the [redacted] properties in Unaweep Canyon.

3. Is it accurate to say that a hot and dry climate will negatively affect the butterfly by reducing the host violet as well as nectar sources?

    - The likely chain in a hot and dry climate (over several to many years) would be reduction in spring flows into wetland meadows, reducing the area of annually saturated soils, reducing violet suitable habitat and wetland nectar sources, converting wetland vegetation to drier vegetation (likely irreversible), with ultimate extinction of the butterfly. The working example for this occurrence is the former very small S. nokomis colony near Tropic, Utah where nokomis was found in 1979 – in 2020 still some wetland vegetation, but largely overgrown by shrubs, and trees, and no violets found, no butterflies.

4. How long are violet seeds viable and could violets come back after a few years of dry conditions?

    - Limited data, but likely seeds could remain dormant for a few (less than 10 years?). The problem is that other dry-adapted vegetation may become dominant, and exclude seedling violets.

5. What's the preferred temperature range for the butterfly during the adult flight season?

    - 60 to 85 degrees F.

6. What are the daily temperatures that are too cold and too hot for the butterflies to fly?

    - Below 50 degrees – too cold, but depends if there is sun to provide body warming; above 85 degrees – too hot, but butterflies take shelter and can withstand temperatures in the high 90s over short intervals in the afternoon.

7. If there's a very wet year would the increased cloud cover reduce survival due to less mating activity?

    - Unlikely, given the ability of the butterfly to respond quickly to short intervals of sun, and the very low probability of long duration cloud cover where this species occur.

8. Is there a minimum winter temperature that's too cold for the larva to survive due to freezing?

    - Unknown, but S. nokomis occurs along the margins of the San Luis Valley where winter temperatures can fall to more than 30 degrees below zero.

9. Is there a maximum average winter temperature that would reduce survival (due to rousting of the larva prematurely, for example)?

    - Unknown, but greater fluctuation in early spring temperatures may disrupt synchrony between larval behavior and foodplant availability; there may be a larval response to increasing day length, but not known.

10. Do the butterflies need snow cover for the larva to survive?

    - No, but snow cover would be beneficial under very cold conditions. Saturated soils with flowing water where larvae overwinter probably don't freeze solid – but this assumption hasn't been verified

11. If there is less snow cover or irregular snow cover over the butterflies will that reduce survival?

    - Per 10 response, don't think this is a critical survival variable.

12. As the climate warms would you expect the range to shift upwards in elevation?

    - Because of the very specific habitat factors for this species, it is highly unlikely that range could shift upwards in elevation unless there is habitat continuity between the lower and higher elevations, and the foodplant violet already occurs at higher elevations. For example, it might be possible for the [redacted] population to move upward in elevation along the [redacted] Creek drainage, where there may be riparian habitat that could become suitable as the climate warms.

13. As the climate warms would you expect lower elevation colonies to become extirpated without the range shifting upward in elevation?

    - I would expect the extirpation risk to be substantially higher for the lower elevation colonies because of the reduction in spring flows caused by higher temperatures and evapotranspiration. As noted for 12, don't think there is much opportunity to move upslope because of narrow habitat requirements.

14. Are there climate variables that would affect violet distribution, density, or nutrition?

    - Key variables are temperature and precipitation, which tie into aquifer recharge and groundwater surface discharge. There is probably an upper limit temperature for Viola nephropylla – for example, the species doesn't appear to occur in hanging gardens at low elevations in the Colorado River drainage. Violet leaves are green all growing season, so season length may not matter – e.g. saw green violet leaves in late September in Utah.

15. Are there climate variables that would affect primary nectar source distribution, density, or nutrition?

    - Same as violets, since they generally share the same habitat. A good example is joe pye weed, which co-occurs with violets in the Unaweep Seep. If surrounding upland vegetation shifts to a more drought/high temperature regime, then there may be a shift in available preferred nectar plants (such as rabbit brush).

16. What future increase or decrease in what climate variables would most likely influence butterfly population resiliency, how/why?

    - Increases in temperature (and associated evaporation and transpiration) would likely reduce resiliency because of overall reduction in groundwater recharge, and shifts in snow melt from mountains. Consequently, groundwater contributions to wetland meadow habitats would be reduced. Since it is not expected that potentially suitable habitat will become newly available as vegetation communities move upslope, there would be an overall reduction in resiliency.

- Increases in precipitation may offset some of the increase in temperature in terms of wetland soil water availability, but may cause other changes in wetland community composition, and may introduce other variables (e.g. overbank flooding, downcutting of stream channels that dewater riparian wetlands).