SPECIES GROUP VULNERABILITY ASSESSMENT WORKSHEETS

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Prioritize the gray boxes in each section. If there is not enough time to complete the white boxes, the project team may populate these after the workshop and ask participants to review answers later.

Species Group: _____

1. Sensitivities to Climate and Climate-Driven Factors

Sensitivity involves factors that currently shape the species group; exposure involves future climate changes that could affect the species group, and is covered in another section below.

Species group sensitivity to climate and climate-driven factors may be direct (e.g., physiological, phenological) or indirect (e.g., ecological relationships).

(1) Physiological sensitivity refers to the physiological ability to tolerate changes that are higher or lower than the range currently experienced. Species groups that are able to tolerate a wide range of climatic factors may be considered less sensitive.

(2) Phenological sensitivity refers to the ability to phenologically track climate (e.g., temperature). Species groups that cannot phenologically track environmental changes may be considered more sensitive.

(3) Ecological relationships may also be affected by climate or climate-driven factors. Ecological relationships could include: predator/prey, foraging, competition, habitat, pollination, dispersal, symbiont/mutualist/parasite, and others. For example, climate-driven changes in pollinator distribution or behavior could have a significant impact on a species group, particularly if the group is dependent on that pollinator for reproduction. Ecological relationships significantly affected by small changes in climate and climate-driven factors likely have higher sensitivity.

Instructions

Step 1: Using the list provided below, identify the factors that the species group is sensitive to. Consider physiological, phenological, and ecological relationship sensitivity to climate and climate-driven factors.

Step 2: For those factors that the species group is sensitive to, estimate the degree of sensitivity, and your level of confidence in your estimate of sensitivity.

Step 3: If you have time, indicate any references that you feel are particularly relevant to your answers.

Air temperature	Timing of snowmelt & runoff	Water temperature
Precipitation (amount)	Soil moisture	Extreme events: heat waves
Precipitation (timing)	Altered stream flow regimes	Extreme events: drought
Snowpack amount	Extreme events: storms	Other (please specify)

FACTOR	DEGREE OF SENSITIVITY 1 (low) – 5 (high)	CONFIDENCE 1 (low) – 3 (high)	RELEVANT REFERENCES

FACTOR	DEGREE OF SENSITIVITY 1 (low) – 5 (high)	CONFIDENCE 1 (low) – 3 (high)	RELEVANT REFERENCES

Do any of the climate or climate-driven factors listed above BENEFIT the species group? If so, list the factor and describe how the species group benefits. *Include any relevant citations.*

Comments: *Provide any comments to support or clarify your conclusions above.*

2. Sensitivities to Disturbance Regimes

Natural disturbance regime is a concept that describes the pattern of disturbances that shape an ecosystem over a long time scale; it is distinguished from a single disturbance event because it describes a spatial disturbance pattern, a frequency and intensity of disturbances, and a resulting ecological pattern over space and time.

Species groups may be at greater risk of decline or elimination even in response to small changes in disturbance regimes. For example, altered flood regimes in aquatic habitats may decrease spawning success or juvenile survival for salmonids. Changes in disturbance regimes may be either good or bad for the species group.

Circle all disturbance regimes to which the species group is sensitive (consider both magnitude and frequency): *If none apply, do not circle any.*

Wildfire	Flooding	Insects	Other (please describe)
Disease	Wind	Grazing	

Overall, how sensitive is the species group to the circled disturbance regimes? *1 – 5 (1=low sensitivity; 5=high sensitivity)*	**Confidence in the sensitivity to disturbance regimes:** *1 – 3 (1=low confidence; 3=high confidence)*
_____	_____

Comments and Citations: *Briefly describe your selection of disturbance regimes above, detailing how the specified disturbance regime affects the species group.*

3. Future Climate Exposure

Climate exposure involves projected future climate changes that could affect the species group and the likely degree of exposure to those changes.

Instructions

Step 1: Using the list provided below, identify the future climate and climate-driven changes most relevant to consider for this species group.

Step 2: For those future climate changes that the species group is likely to be affected by, estimate the degree of exposure and your level of confidence in your estimate of exposure. Use the information provided on projected future climate changes for the Central Valley to inform your estimate of degree of exposure.

Step 3: If you have time, indicate any potential areas of refugia from each climate or climate-driven change.

Increased air temperature	Earlier snowmelt & runoff	Increased wildfire
Changes in precipitation (amount)	Increased water temperatures	Extreme events: more heat waves
Changes in precipitation (timing)	Lower stream flows	Extreme events: more drought
Decreased snowpack	Increased flooding	Other (please specify)

CLIMATE OR CLIMATE-DRIVEN CHANGE	DEGREE OF EXPOSURE 1 (low) – 5 (high)	CONFIDENCE 1 (low) – 3 (high)	Potential Areas of Refugia from Change?

Overall confidence in your assessment of exposure: *1 – 3 (1=low confidence; 3=high confidence)* _____

4. Dependencies

Species groups that use multiple habitats or utilize multiple prey or forage species are likely less sensitive to climate change (e.g., generalists). Conversely, species groups with very narrow habitat needs or habitat specialization, single prey or forage species, or dependence on another sensitive species may have a higher likelihood of decline if climate change significantly affects the habitat or species they are dependent upon (e.g., specialists). For example, a species group dependent on ephemeral wetlands or deep snowpack is likely to be susceptible to climate impacts such as increased temperatures or changes in precipitation regimes.

Overall, how much does the species group depend on one or more sensitive habitat types? (e.g. wetlands) *1 – 5 (1=low dependency; 5=high dependency)* _____	**Confidence in habitat dependency:** *1 – 3 (1=low confidence; 3=high confidence)* _____
List any sensitive habitats upon which this species group depends. *Sensitive habitats could include wetlands/vernal pools, grasslands, seeps/springs, deep, cool ponds, and balds, among others)*	
How much does the species group depend on a specific prey or forage species? *1 – 5 (1=low dependency; 5=high dependency)* _____	**Confidence in prey/forage dependency:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Are there other critical dependencies that have not been addressed that influence the group's sensitivity to climate change (e.g., pollinator dependency)? If so, list below and rank degree of dependency. *1 – 5 (1=low dependency; 5=high dependency)* _____	**Confidence in other dependency:** *1 – 3 (1=low confidence; 3=high confidence)* _____
List any other dependencies. If none, write *N/A*. *Other critical dependencies could include host plant species, pollinators, seed dispersal, specific disturbance regimes, etc.*	

5. Sensitivity and Current Exposure to Non-Climate Stressors

Sensitivity of the species group to climate change impacts may be highly influenced by the existence, extent of, and current exposure to non-climate stressors. Although a species group may be sensitive to a non-climate stressor, if it is not currently exposed to it/affected by it, the overall sensitivity of the group will be lower.

Instructions

Step 1: Using the list provided below, identify the non-climate stressors most likely to increase sensitivity of the species group.

Step 2: For those non-climate stressors that the species group is likely to be affected by, estimate the degree of current exposure, and your level of confidence in your estimate of current exposure.

Step 3: Indicate whether current exposure to a non-climate stressor occurs across the study area or is highly localized. If the current exposure occurs in a very particular location, indicate that specific location.

Urban/Suburban development	Groundwater overdraft	Roads, highways, trails	Pollution & poisons
Impervious surfaces	Invasive & other problematic species	Land use change	Nutrient loading
Dams, levees, & water diversions	Agriculture & rangeland practices	Other (please specify)	

NON-CLIMATE STRESSOR (add specific details about stressor – e.g., what kind of agricultural practices or land use change?)	**DEGREE STRESSOR AFFECTS SENSITIVITY 1 (low) – 5 (high)**	**CONFIDENCE 1 (low) – 3 (high)**	**IS EXPOSURE CONSISTENT ACROSS STUDY AREA OR HIGHLY LOCALIZED?** (if localized, identify locations)	**CONFIDENCE 1 (low) – 3 (high)**

NON-CLIMATE STRESSOR (add specific details about stressor – e.g., what kind of agriculture or land use change?)	**DEGREE STRESSOR AFFECTS SENSITIVITY 1 (low) – 5 (high)**	**CONFIDENCE 1 (low) – 3 (high)**	**IS EXPOSURE CONSISTENT ACROSS STUDY AREA OR HIGHLY LOCALIZED?** (if localized, identify locations)	**CONFIDENCE 1 (low) – 3 (high)**

Comments and Citations: *Briefly describe how each of the stressors selected above are likely to make the species group more sensitive to climate change.*

6. Other Sensitivities

Are there other critical factors that have not been addressed that influence the sensitivity of the species group? *List below any other factor that you may consider critical to understanding the potential response of this species group to climate change that was not represented with the previous questions. If no other factors apply, write N/A and specify your confidence associated with this question.*	**Collectively, to what degree do these factors influence group's sensitivity?** *1 – 5 (1=low degree; 5=high degree)* _____

Confidence in the degree to which these factors influence group sensitivity: *1 – 3 (1=low confidence; 3=high confidence)*

_____

Comments and Citations: *Describe any "other sensitivities" and how they affect the species group.*

Prioritize the gray boxes in each section. If there is not enough time to complete the white boxes, the project team may populate these after the workshop and ask participants to review answers later.

Species Group: _____

1. Extent, Integrity, and Dispersal Ability

Species groups that are currently widespread in their geographic extent, with good overall health/functional integrity, connectivity, and a high ability to disperse likely have higher adaptive capacity. These species groups may be more likely to withstand and persist into the future despite climatic and non-climatic stressors.

Species groups that are endemic, degraded, isolated or fragmented, and/or exhibit limited ability to disperse likely have lower adaptive capacity.

What is the geographic extent of the species group? *1 – 5 (1=endemic to my particular area; 5=transboundary)* _____	**Confidence in extent:** *1 – 3 (1=low confidence; 3=high confidence)* _____
What is the overall health or functional integrity of the species group? *1 – 5 (1=degraded; 5=robust)* _____	**Confidence in integrity:** *1 – 3 (1=low confidence; 3=high confidence)* _____
What is the degree of connectivity between populations of the species group? *1 – 5 (1=isolated/quite fragmented; 5=continuous)* _____	**Confidence in connectivity:** *1 – 3 (1=low confidence; 3=high confidence)* _____
What is the ability of the species group to disperse? *1 – 5 (1=low ability; 5=high ability)* _____	**Confidence in dispersal ability:** *1 – 3 (1=low confidence; 3=high confidence)* _____

Comments and Citations: *Provide any comments or citations to support or clarify your conclusions above.*

2. Barriers to Dispersal

More permeable landscapes with fewer barriers to dispersal and/or seasonal migration help to increase adaptive capacity of species groups. Multiple or significant barriers to dispersal lowers adaptive capacity, even for those species with high innate dispersal ability.

Instructions

Step 1: Using the list provided below, identify the most relevant barriers to dispersal for this species group.

Step 2: For each barrier to dispersal, specify the type of barrier, estimate the degree of to which the barrier affects group dispersal, and estimate your level of confidence in your assessment of the impact of the barrier.

Step 3: If you have time, indicate any references that you feel are particularly relevant to your answers.

Urban/Suburban development	Agricultural & rangeland practices	Land use change
Energy production & mining	Invasive/Non-native species	Riprap
Roads, highways, trails	Dams, water diversions, & levees	Geologic features
Other (please specify)		

BARRIER TO DISPERSAL (specify type of barrier – e.g., conversion to vineyard)	**DEGREE BARRIER AFFECTS DISPERSAL 1 (low) – 5 (high)**	**CONFIDENCE 1 (low) – 3 (high)**	**RELEVANT REFERENCES AND COMMENTS**

Comments and Citations: *Provide any comments or citations to support or clarify your conclusions above.*

3. Intraspecific/Life History Diversity

Life history diversity: Species groups with a diversity of life history strategies (e.g., variations in age at maturity, reproductive or nursery habitat use, or resource use) may be more resilient to climate change.

Genetic diversity: Species groups with characteristics such as faster generation times, genetic diversity, heritability of traits, larger population size, or multiple populations with connectivity among them to allow for gene flow likely exhibit higher adaptive capacity.

Phenotypic and behavioral plasticity: Species groups with the capacity to express different traits (e.g., phenology, behavior, physiology) in response to environmental variation likely have higher adaptive capacity. For example, some grassland species are able to become dormant under sub-optimal conditions.

Instructions

Step 1: For each characteristic listed below estimate the degree of diversity or plasticity and your level of confidence in your estimate.

Step 2: If you have time, indicate any references that you feel are particularly relevant to your answers.

CHARACTERISTIC	DEGREE OF DIVERSITY OR PLASTICITY 1 (low) – 5 (high)	CONFIDENCE 1 (low) – 3 (high)	COMMENTS AND RELEVANT REFERENCES
Life history diversity			
Genetic diversity			
Behavioral plasticity			
Phenotypic plasticity			

Comments and Citations: *Provide any comments or citations to describe or clarify the diversity of life history strategies for the species group, characteristics that may allow the species group to adapt evolutionarily, or how the species group is able to modify its physiology or behavior.*

4. Resistance and Recovery

Some species groups may be more resistant to changes, stressors, or maladaptive human responses, or are able to recover more quickly from stressors; these groups likely exhibit higher adaptive capacity.

Resistance: Resistance refers to the stasis of a species group in the face of change. Some species groups may have higher tolerance thresholds than others in response to climate perturbations, leading to higher adaptive capacity. For example, serpentine species can resist invasion under natural climatic fluctuations (e.g., variable precipitation). Alternatively, maladaptive human interventions can reduce the resistance of a species group by accelerating rates or severity of change, leading to lower adaptive capacity.

Recovery: Some species groups with a shorter recovery period from the impacts of stressors (<20 years) may have greater intrinsic adaptive capacities than slower recovering species groups (>20 years), as slower recovering species groups may be more intrinsically vulnerable to the potential intervening effects of climate change. For example, native annual forbs can remain dormant until periods of low competition, enhancing the ability of these annual species to recover after disturbance or in response to climatic variability.

To what degree is the species group resistant to the impacts of stressors/maladaptive human responses? *1 – 5 (1=low degree; 5=high degree)* _____	**Confidence in resistance:** *1 – 3 (1=low confidence; 3=high confidence)* _____
To what degree is the species group able to recover from the impacts of stressors? *1 – 5 (1=low degree; 5=high degree)* _____	**Confidence in recovery:** *1 – 3 (1=low confidence; 3=high confidence)* _____

Comments and Citations: *Provide any comments or citations to support or clarify your conclusions above.*

5. Management Potential

Management potential reflects our ability to impact the adaptive capacity and resilience of a species group to climatic changes.

Management potential can be evaluated in two ways:
(1) Societal value: Is the species group highly valued? Species groups with a high societal value likely have higher adaptive capacity, as people may have a greater interest in protecting and/or maintaining them and the ecosystem services they provide.
(2) Managing or alleviating climate impacts: Can climate impacts on the species group be managed or alleviated? If human intervention or management has a high likelihood of alleviating climate impacts, the adaptive capacity of a species group is likely higher. The costs and benefits of management actions will vary depending on the species group; actions will be most feasible when the group and/or its services are culturally and economically valued and the costs of implementing actions are low.

How much do people value this species group? *1 – 5 (1=low value; 5=high value)* _____	**Confidence in group value:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Describe species group value.	
How much societal support (e.g., financial, regulatory, legislative) is there for managing or conserving this species group? *1 – 5 (1=low support; 5=high support)* _____	**Confidence in societal support:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Describe societal support.	
To what degree can agriculture and rangelands benefit/support/increase resilience of this species group? *1 – 5 (1=low degree; 5=high degree)* _____	**Confidence in degree:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Describe how agriculture and rangelands benefit/support/increase resilience of this species group.	

To what degree would extreme events (e.g., flooding, extended drought) influence societal support for taking action? *1 – 5 (1=low degree; 5=high degree)* _____	**Confidence in degree:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Describe the type of event that may influence societal support.	
What is the likelihood of or support for retired agriculture land being converted to maintain or enhance this species group? *1 – 5 (1=low likelihood; 5=high likelihood)* _____	**Confidence in likelihood:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Describe likelihood of or support for retired agriculture land being converted to maintain or enhance this species group.	
What is the likelihood of managing or alleviating climate impacts for this species group? *1 – 5 (1=low likelihood; 5=high likelihood)* _____	**Confidence in likelihood:** *1 – 3 (1=low confidence; 3=high confidence)* _____
Describe likelihood of managing or alleviating climate impacts.	

6. Other Adaptive Capacity Factors

Are there other critical factors that have not been addressed that may affect the group's adaptive capacity? *List below any other factor that you may consider critical to understand the potential adaptive response of the species group to climate change that has not been addressed yet. If no other factors apply, write N/A and specify your confidence associated with this question.*	**Collectively, to what degree do these factors affect the adaptive capacity of the species group?** *1 – 5 (1=low degree; 5=high degree)* _____
Confidence in the degree to which these factors affect the group's adaptive capacity: *1 – 3 (1=low confidence; 3=high confidence)* _____	
Comments and Citations: *Describe any other adaptive capacity factors for the species group.*	