Example INRMP Adaptation Planning Worksheets

The material presented here is for illustrative purposes only, and intended to help workshop participants better understand how to fill out the worksheets supporting the INRMP adaptation planning process. Specific instructions for these worksheets can be found in Appendix C of *Climate Adaptation for DoD Natural Resource Managers* (Stein et al. 2019).

Disclaimer: These worksheets are based on work carried out at Naval Weapons Station Seal Beach Detachment Fallbrook, but specific material may not represent the installation's actual situation or management priorities.

Worksheet 1.1. Installation Mission and Requirements	
Mission and Mission Support Components *What are the core mission and mission support components for the installation?*	**Critical Mission Requirements** *What are the built and natural features/conditions critical to carrying out and sustaining this installation mission component?*
Ordnance storage, maintenance, transport (Explosives Safety)	Magazines; holding yards; ordnance buildings; road network (magazine access); Explosive Safety Quantity Distance arcs; low vegetation/clear zones (for fire); restricted airspace; lightning protection.
Security and access	Patrols; road network (security, personnel access); nighttime lighting; fencing (access control); low vegetation/ clear zones (for security sightlines), electronic security systems.
Administrative and facilities	Buildings (including utilities, com lines, network, etc.), road network (personnel access).
Fire management	Road network; firebreaks; fuels (vegetation) reduction (mowed clear zones, cattle grazing infrastructure, etc.); Remote Automated Weather Station; fire hydrant/water distribution; communications.

Worksheet 1.2. Target Resources and Existing Goals		
Target Natural Resources *What are the natural resource features (species, habitats, ecosystem processes, etc.) that are the focus of this adaptation planning effort?*	**Goals/Objectives** *What are the existing INRMP goals and objectives for the target natural resources?*	**Associated Program Element(s)** *What INRMP program elements are associated with each of the target natural resources?*
Least Bell's vireo **(federally listed endangered species)**	Implement management strategies that maintain a healthy, diverse, and intact riparian community that is able to support the least Bell's vireo, where appropriate, and other Species at Risk and native sympatric species (from current INRMP)	Threatened and Endangered Species, Migratory Birds Management (Indirectly: Invasive Species Management, Agriculture Outleasing, etc.)
Riparian habitat	Maintain, monitor, and restore plant communities to support optimal species richness, biodiversity, ecosystem services, and habitat resiliency (from current INRMP)	Threatened and Endangered Species, Wetland Management, Vegetation Management, Migratory Birds Management (Indirectly: Fish and Wildlife Management, Invasive Species Management, Land Management, Agriculture Outleasing, Wildland Fire Management, Floodplains Management)

Worksheet 1.3. Planning Scope and Background Information		
Geographic Scope *What is the spatial context for addressing climate change in INRMP planning?*	**Stakeholders/Partners** *Who are the key stakeholders and participants to engage in the adaptation planning process, both within DoD and externally?*	**Available Information/Expertise** *What existing studies or resources are available for understanding regional or local climate projections and natural resource responses?*
Immediate buffer lands	Adjacent land owners (MCB Camp Pendleton, Fallbrook Public Utilities, Fallbrook Airpark, Color Spot Nursery, Community of Fallbrook); Mission Resources Conservation District; SD Co Department of Weights and Measures	California 4th Climate Change Assessment (Bedsworth et al. 2018, Statewide Summary; Kalansky et al. 2018, San Diego Region) Climate Scientists – USGS, Scripps Institute of Oceanography, etc.
Santa Margarita River and San Luis Rey River Watersheds	Internal (DoD) Stakeholders: Det FB Facilities; AG lessee (cattle grazing); Camp Pendleton; Regional NR Climate Resilience Coordinator External Stakeholders: Conjunctive Use Project (water rights) stakeholders; Santa Margarita Ecological Reserve; San Diego Weed Management Area; Climate Science Alliance (So. CA); Regulators (USFWS, NMFS, CDFW, ACOE, RWQCB)	California 4th Climate Change Assessment (Bedsworth et al. 2018, Statewide Summary; Kalansky et al. 2018, San Diego Region) Climate Scientists – USGS, Scripps Institute of Oceanography, etc.
Least Bell's Vireo breeding range in Southern California	USGS; Regulators (USFWS, CDFW)	USGS (Barbara Kus and team), USFWS

Worksheet 2.1. Climate Concerns and Projections

Key Climate Concerns *What are the key climate change-related impacts or threats to the installation, and more specifically for the target natural resources?*	**Climatic Factors** *What are the climatic factors or variables related to those concerns, and which are ecologically relevant for your installation and the resources you are managing?*	**Historical/Current Conditions** *What are the historical/current values for this climate factor?*	**Trend** *What is the trend or directionality for this factor, if known?*	**Projections** *What are available projections for this variable?*	**Confidence/ Uncertainty** *What is the level of confidence or certainty in the trend or magnitude of change for this variable (i.e., High, Medium, or Low)?*
Drought	Temperature (average, max) Precipitation (extremes)	Historical conditions (e.g. prior to 2006) are 1-1.5ºC lower than present. (1)	Increasing temperature. Lengthening of summer drought, and more frequent/ intense multi-year drought. Shading and fog water input may mitigate drought during summer fog (2)	Increase ~ 1-2oC by 2040-2069 and 2-4ºC by 2070-2100. Heat wave days will increase 3-fold by 2050 and more by 2100. (1) By 2050 spring projected to have 20% less moisture and fall will have 15% less; by 2100 spring projected to have 25% less and fall 20% less. High temperatures projected to exacerbate drought. (3)	Very high confidence for precipitation. Future predictions for fog have low certainty. (2)
Flooding	Precipitation (extremes)		Average precipitation not projected to change much (4). More extreme precipitation events likely to lead to more frequent and more intense floods (3)	Ave. precipitation may range from -1cm to +2.5cm. (4) Extreme rainfall events projected to increase (5)	Medium confidence. (5)
Wildland Fire	Precipitation Temperature Evapotranspiration		Fire "season" will continue to lengthen, esp. with increasing overlap of drought and Santa Ana winds. (6,7). Wildfire size and intensity will increase regionally.	Quantitative projections for wildfire risk not available, but wildfire risks are projected to increase. Coastal fog in southern CA may mitigate some fire risks. (2)	Medium confidence. (8) Trade-offs between fuel loading & moisture gradients make local changes difficult to predict.
Information Sources *List sources of information used to populate this table*	(1) Jennings et al. in Jennings et al. 2018; (2) Lawson et al. in Jennings et al. 2019; (3) Kalansky et al. in Jennings et al. 2018; (4) Cayan et al. 2008; (5) Jennings et al. 2018b; (6) Syphard et al. in Jennings et al. 2018; (7) Guzman-Morales and Gershunov 2019; (8) Batllori et al. 2013.				

Worksheet 2.2. Climate Vulnerabilities of Target Natural Resources

Target Natural Resource(s) *What are the target natural resources to be evaluated (from Worksheet 1.2)?*	**Climate-Related Threats**			**Other Threats** *What existing or "non-climate" threats to the resource may be exacerbated by or amplified due to projected changes in climatic factors?*	**Degree/Reason for Vulnerability** *Rate the relative vulnerability (e.g., Very High, High, Medium, Low) and the reason for that rating.*
	Sensitivity *How and to what degree might this resource respond (negatively or positively) to expected climate-related changes?*	**Exposure** *To what degree is the resource likely to overlap with and be exposed to conditions to which it is sensitive?*	**Adaptive Capacity** *Does the target resource have the ability to accommodate, cope with, or adjust to projected changes in climate conditions? If so, how?*		
Least Bell's Vireo (LBVI)	• Requires structurally diverse native riparian scrub and mature forest communities. Sensitive to loss/degradation (e.g., from invasive plants) of suitable riparian habitat • Insectivorous, but prey on wide variety of insect types • Factors believed most responsible for LBVI decline are habitat fragmentation and brood parasitism (both exacerbated directly or indirectly by climate-related changes)	• Habitat loss or degradation from extended drought (e.g., drought stressed vegetation more susceptible to fire, bark beetles) • Temporary habitat loss from climate-accentuated fire	• LBVI observed to return within a short period (<3 years) to burned habitat if mulefat/willows return • Varied prey base may allow LBVI to adjust to declining or varying insect populations • LBVI commonly abandon parasitized nests; however, high parasitism pressure affects productivity	• Habitat degradation from increased pressure from cattle seeking shade during heat waves • Climate-related expansion of invasive species (Arundo, tamarisk, other weeds; shothole borer bark beetles) • Brown-headed cowbird (brood parasitism)	**Medium** LBVI has a moderate degree of sensitivity due to its reliance on riparian areas (which themselves are vulnerable to increased fire and floods – see below). While the species has some degree of adaptive capacity, exposure to both increased fire and floods is high). This rating is consistent with rangewide LBVI vulnerability assessments.
Riparian Habitat	• Drought and lowered groundwater (e.g. from extended drought) can lead to plant mortality, slow recovery after fire, etc. • More extreme precipitation events may exacerbate streambank erosion; elevated flow rates with narrow, channelized banks and steep gradients inhibit groundwater recharge • Increases in temp elevate evapotranspiration (loss of water from system)	• High: Greatly incised streams at Det Fallbrook are incapable of supporting wide riparian corridors; very little floodplain • Medium: Invasive Arundo and tamarisk have been greatly reduced on Det Fallbrook, but control needs to be maintained and other species may become more problematic	• Adapted to ephemeral hydrology (annual drought), but vulnerable to successive years of drought and lowered groundwater. • Riparian vegetation has a high potential for recovery from fire, so long as environmental conditions (e.g., water availability) are favorable and fire	• Anthropogenic disturbances region-wide (habitat loss, fragmentation, or degradation from urbanization; reduction in surface water and groundwater availability from diversions, drawdowns) • Invasive species (competitive plants, bark beetles, etc.) • Livestock grazing	**Medium - High** Riparian habitat has a *high degree of sensitivity* to a number of climatic variables, including increased drought, extreme precipitation/flooding, increased fire risks, and other threats (e.g., invasive species, livestock grazing) that may be exacerbated by climate change. Climate projections suggest a *moderate degree of exposure* to those risks, but they are *moderated* to some degree by *natural adaptive capacity*.

	• Climate-related stressors can make riparian vegetation more susceptible to competitive exclusion from invasive plant species (e.g., Arundo, tamarisk). • Climate related stressors can make riparian vegetation more susceptible to invasive pests (e.g., shothole borer bark beetles). • Fire causes temporary loss of habitat and high fire return intervals can degrade habitat quality over time.	• Medium: shothole borer beetles are spreading in region, although the extent of damage they cause seems to vary • Medium-High: Some areas of Det Fallbrook have greater exposure to fire risk than other areas (e.g., ignition sources on Pendleton)	return intervals aren't too short.	• Non-climate-related fire.	

Worksheet 2.3. Military Mission Risks from Natural Resource Vulnerabilities		
Vulnerabilities of Target Natural Resources *List the most consequential natural resource vulnerabilities identified in the last column of Worksheet 2.2.*	**Risks to Installation Mission Requirements** *How might this natural resource vulnerability affect the ability of the installation to deliver its military mission (e.g., training, testing, etc.) and long-term sustainment?*	**Degree of Risk** *Rate the relative risk this vulnerability poses to the installation's ability to meet its military mission requirements (e.g., Very High, High, Medium, Low).*
Loss/degradation of riparian habitat (which serves as Least Bell's Vireo habitat)	• Regulatory pressure: Reduced LBVI population numbers could put species in jeopardy and indirectly affect mission with increased regulatory pressure on remaining occupied refugia or potentially suitable habitat (e.g., potential effects from mission projects such as security lighting would have a relatively greater effect on LBVI population as a whole). • Fire risk: Conservation grazing strategies to reduce fire hazard may need to be curtailed if riparian habitat degradation is exacerbated. Habitat degradation (e.g., dead fuel, low fuel moisture, invasive plants) elevate risks for wildland fire that come with increased explosive safety risks and damage to mission assets and infrastructure. Fire suppression may be more restricted due to reduced surface water availability. • Flooding/erosion risk: Entrenched, channelized streams with minimal floodplains are limited in ability to attenuate storm pulses, potentially leading to flooding/erosion that causes road washouts, access barriers, impacts to utilities/assets.	• Regulatory pressure: Medium • Fire risk: High • Flooding/erosion risk: Medium

Worksheet 3. Climate Implications for INRMP Goals and Objectives		
INRMP Goals to Evaluate *What are the existing goals for the target natural resources under consideration (from Worksheet 1.2)?*	**Climate Implications for Existing Goals/Objective** *Based on climate concerns (Worksheet 2.1), vulnerabilities (Worksheet 2.2), and mission risks (Worksheet 2.3), how might your ability to achieve existing goals be compromised?*	**Climate-Informed Goals/Objectives** *Are there any refinements or updates that may be needed to craft a more climate-informed version of the goal or objective*
"Implement management strategies that maintain a healthy, diverse, and intact riparian community that is able to support the Least Bell's Vireo, where appropriate, and other Species at Risk and native sympatric species."	• It may be difficult to "maintain" status quo species diversity and LBVI populations with continuation of existing management. Existing management may not be enough in the face of increased drought, fire, flooding	• Consider building into goal increased native habitat resiliency (e.g., improve groundwater recharge, flood attenuation capacity; seek to reverse streambank erosion and widen riparian corridors) for the benefit of LBVI habitat composition and structure
"Maintain, monitor, and restore plant communities to support optimal species richness, biodiversity, ecosystem services, and habitat resiliency."	• Restoration to support habitat resiliency and ecosystem services still seems feasible considering climate implications (although will likely require more than status quo management to achieve). • "Optimal" was not explicitly defined and can be considered in context of what is feasible under projected conditions	• Goal remains feasible; however, objectives and management projects and actions to meet goal are expected to need adjustment

Worksheet 4.1. Identification of Possible Adaptation Strategies and Actions

Vulnerability/Risk *What specific natural resource vulnerability (from Worksheet 2.2) or mission risk (from Worksheet 2.3) is being addressed?*	**Risk Reduction Strategies** *What strategies could reduce these vulnerabilities and risks?*	**Supporting Actions/Projects** *What actions or projects could be carried out to realize a given strategy?*	**Rationale and Assumptions** *How is this strategy or set of actions likely to reduce these vulnerabilities or risks?*
Fire risk from habitat degradation	Strategy 1. Improve water availability to natural vegetation	• Restore wider floodplains through grade controls and laying back streambanks of channelized reaches	• Improved floodplain structure and groundwater recharge will make vegetation be more resilient to drought, increase fuel moisture (and benefit LBVI habitat)
	Strategy 2. Reduce excessive buildup of fuel load	• Continue cattle grazing to remove excessive buildup of dead fine fuels • Consider cutting/chipping larger woody debris • Continue/increase invasive plant control to reduce fuel loads • Evaluate existing fuelbreaks and clear zones for areas of strategic improvement	• Reduced fuel reduces fire risk. Fire may still occur, but severity and associated risks may be mitigated • Invasive plants can create continuous flammable fuel beds that promote fire spread • Fuelbreaks won't necessarily prevent fires, but can reduce risks by slowing fires or reducing burn severity
	Strategy 3. Improve understanding of where and when fire risks are greatest on the installation	• Monitor fuel moisture, vegetation mortality, habitat trends, and invasive species coverage	• Better fire risk maps will help more effectively target (in space and time) fire prevention and suppression activities
	Strategy 4. Reduce ignition risks during high fire risk periods	• Maintain or increase clear zones around powerlines and other possible sources of ignition • Bury electric lines in high fire risk areas • Proactively shut down power during high-wind/high fire risk conditions • Coordinate with Camp Pendleton to reduce ignition potential during high fire-risk periods	• Reducing ignition risks is essential complement to reducing fuel loads and improving suppression capacity
Flooding/erosion risk	Strategy 1. Improve riparian system's capacity for flood protection and groundwater recharge	• Dredge existing reservoirs to increase water storage capacity and flood control • Actively restore wider floodplains through grade controls and laying back streambanks of channelized reaches	• Improving hydrology and storage capacity should help make more the system more resilient to drought and reduce scouring during flooding

Worksheet 4.2. Evaluation and Selection of Adaptation Strategies and Actions

Worksheet Focus		Action 1	Action 2	Action 3
Risk: Flooding/Erosion **Strategy**: Improve riparian system's capacity for flood protection and groundwater recharge		**Dredge existing reservoirs to increase water storage capacity and flood control**	**Actively restore wider floodplains through grade controls and laying back streambanks of channelized reaches**	**No action alternative**
Criteria for Evaluation *Identify and list below relevant criteria for evaluating/comparing proposed strategies/actions.*				
Effectiveness at meeting climate-informed natural resource goals	Expansion of riparian habitat by improving underlying hydrology	Low	High	Low
	Decrease streambank erosion risk	Medium	High	Low
Effectiveness in meeting other installation objectives	Protect mission critical infrastructure from flooding/erosion	Low - Medium	Medium - High	Low
	Maintain or increase availability of water for fire suppression activities	High	Low	Very Low
Feasibility	Complexity or challenge of permitting process (e.g., ESA, CWA); Potential for Categorical Exclusion under NEPA.	Medium - High	Medium - High	Low
	Construction and maintenance cost	Medium - High	Medium - High	Low cost in short term, could be very high in long term
RECOMMEND FOR INCLUSION IN INRMP?		Yes – for some stock ponds, reservoirs (see worksheet 5)	Yes – for select stream reaches (see worksheet 5)	No

Worksheet 5. Implementation of Adaptation Strategies/Actions				
Recommended Strategies/Actions *List strategies/actions recommended for incorporation into the INRMP (from worksheet 4.2).*	**Responsible Parties** *Who would have responsibility for or be involved in implementing the strategy/action?*	**Relationship to Existing INRMP Strategies** *Does this fit within a current INRMP strategy, or is it a new activity/project?*	**Project Planning Needs** *What preparations or requirements would be necessary before carrying out the recommended strategies/actions?*	**Timing and Sequencing** *When should the action/project be implemented (immediately or at some future time)?*
Dredge existing reservoirs (Action 1 for "improve riparian system capacity for flood protection groundwater recharge" strategy)	Environmental (contracted out)	Yes, this fits with an existing strategy/project.	Moderately high degree of planning and coordination.	5-10 year horizon for implementation. Start planning now (SOW, contract vehicle, where to put spoils, likely consultation, etc.)
Stream restoration: add grade control to reduce stream incising, and broaden floodplain (Action 2 for "improve riparian system capacity for flood protection groundwater recharge" strategy)	Environmental (contracted out)	Yes, this fits with an existing strategy/project.	High degree of planning, coordinating. Next action will need to focus on engineering design (including permitting, consultation, etc.)	15-20 year horizon for phased implementation. Start with site evaluation, restoration design (FY20). Develop initial SOW, cost estimate, etc. now. Permitting will follow design.

Worksheet 6. Climate-Informed Monitoring and Evaluation			
Adaptation Strategies/Actions *List the strategies, actions, or projects being implemented that will be the subject of monitoring and evaluation.*	**Expected Outcomes** *Include both near and long-term outcomes expected for the action or project*	**Indicators**	**Management Triggers** *What thresholds (based on your indicators) might cause you to adjust management practices or rethink strategies*
Stream restoration: add grade controls, reduce stream incising, and construct floodplain	• Level of stream will rise, start to silt in, groundwater table will rise • As floodplain expands, riparian habitat corridor will widen	• Reduced erosion rates • Reduced depth to groundwater • Elevated stream bottom • Expansion of wetland plant species that require higher water levels	• Monitor for elevated erosion beyond nuisance levels • If groundwater or streambed are not increasing, need to re-think what is happening, investigate why • Seedling establishment of native riparian plants in wider floodplain, adjacent habitat