The Effects Pathway: Determining Exposure

PHOTO: USFWS DIGITAL ARCHIVES

What's a Stressor?

Exposure Assessment

Direct or Indirect Interaction?

The Steps to a Successful Exposure Analysis

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WHERE WE ARE

Once you have drafted a deconstruction of your project's action AND deconstructed the biology of your affected species, it's time for the next big component of a Biological Assessment – A description of the manner in which the action may affect any listed species or critical habitat.

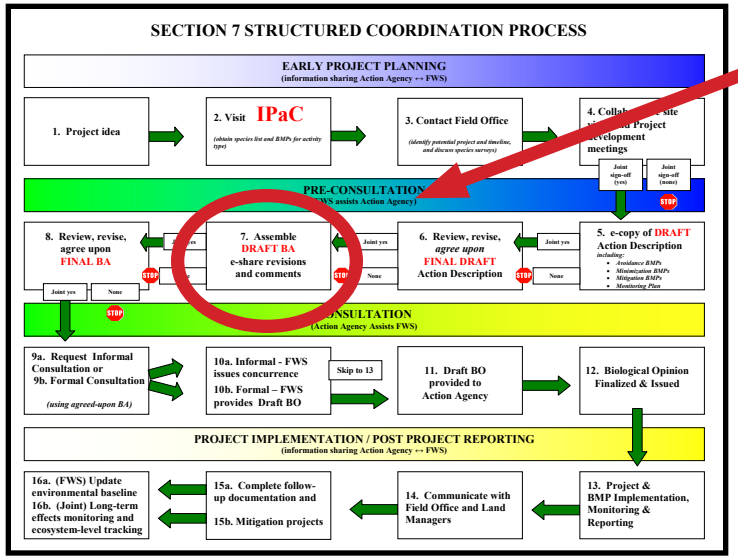
Essentially we are focusing on matching up the stressors from the action with how the listed species (and their resources) are exposed to them.

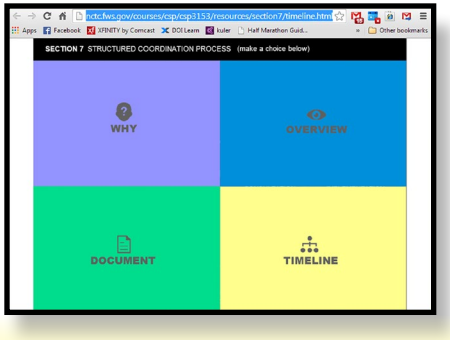
If you haven't reviewed the previous two eMags in the Effects Pathway series, they are available for your reading pleasure.

<< -- Describing the Action eMag -- >>

<< -- Describing the Listed Species eMag -- >>

We are still at step 7 of the Structured Coordination Process, where we are assembling all of the information needed to develop a complete BA. If you don't remember the process, check out the online Section 7 timeline by clicking on the image below. That will open up a new window and then click on "TIMELINE" on that site.





REMEMBER THE EFFECTS PATHWAY

First we identified all of the components involved in our action. Next we did our research to clearly understand the biology of the individuals and the resources and circumstances needed by the species in our Action Area.

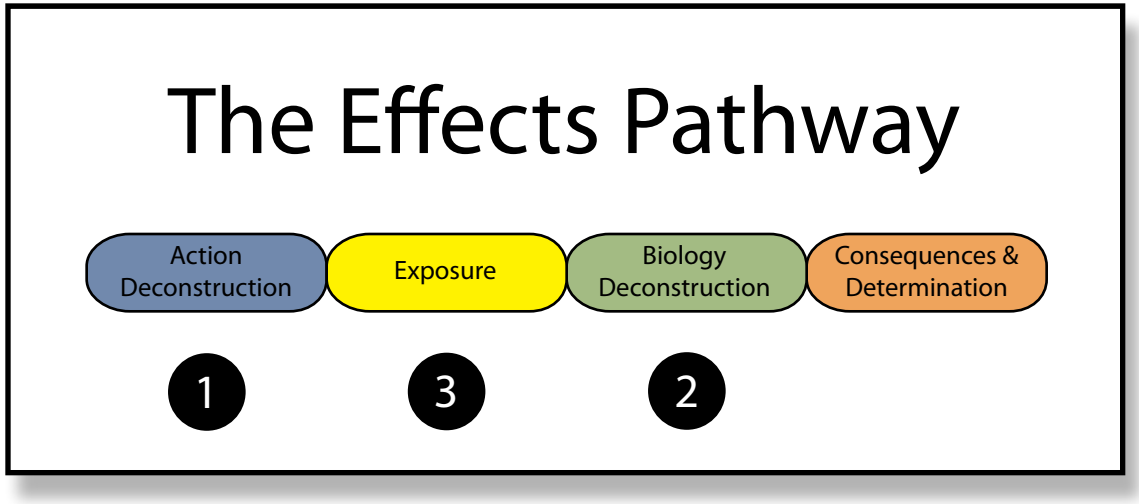


PHOTO: JANICE ENGLE, USFWS

Now we need to try and understand the manner in which the action may affect listed species in the Action Area or their critical habitat -- essentially the relationship between the ACTION and the BIOLOGY.

Specifically, how are the individuals and resources identified in our Biology deconstruction EXPOSED to changes in the environment resulting from the activities in our Action Deconstruction?

THE PROCESS

Determining Exposure in the Effects Pathway has 4 key steps:

1. Cut and Paste your Action Deconstruction to the Effects Pathway Matrix
2. Identify Stressors resulting from your actions
3. Identify Direct or Indirect Interaction
4. Identify Individual / Resource Exposure
5. Repeat for Critical Habitat.

Each of these steps will be explained in more detail in a little bit. Before getting into the process though, there are some key concepts and terms you need to understand.

WHAT IS A STRESSOR?

A stressor is any physical, chemical, or biological alteration (i.e., increase, decrease, or introduction) of the environment (or resource) that can lead to a response from the individual.

Stressors can act directly on an individual, or indirectly through impacts to resources.

So, what are these things we call stressors? What are some examples of stressors you can think of? Think about things you have seen on your own projects. Anything come to mind?
The main point in thinking about stressors is to identify the ***change in the resource*** that occurs or the ***direct impact to the individual.***

This is a very important point – this concept provides the "meeting point" of the chain of logic between the components of the action and how/ why the species and/or its resources responds.

CHANGE *(alteration)*	**in quality or quantity of**	***(RESOURCE)***
Increase	**in turbidity**	***(water)***
Increase	**in temperature**	***(climate)***
Removal	**of vegetative cover**	***(plant community)***
Introduction	**of invasive competitors**	***(prey)***
Change	**in microclimate to drier and hotter**	***(climate)***
Change	**in fire regime to more frequent**	***(climate)***
Alteration	**of channel morphology *increasing* velocity**	***(water)***
Removal	**of hibernacula**	***(habitat)***
Removal	**of soil**	***(substrate)***
Crushing		***(direct impact)***
Vehicle Strikes		***(direct impact)***

Here are a number of different stressors that you may encounter.

Notice that each of them involves some type of ***change*** in the ***quality or quantity*** of some resource.

In the first line we see the stressor, ***increase in turbidity,*** affects the quality of the resource, ***water.***

Looking down the list, the stressor, ***introduction of invasive competitors,*** affects the quantity of the resource, ***prey.***

EXPOSURE EXPLAINED

So when we talk about exposure, we mean how individuals of the listed species or the resources they depend upon are EXPOSED to the stressors from our action. For instance, because of the clearing of brush which provides habitat for fox during the heat of the day, there is an *increase in temperature*. The fox is exposed to this stressor (increase in temperature) because of our action.

PHOTO: LAMAR GORE, USFWS

The better we describe this relationship, between the species and the stressor, the better our analyses will be. The exposure assessment is perhaps the most important step in the analysis process.

Because we cannot know with 100% certainty how a listed resource will respond to a stressor once exposure occurs, exposure becomes the pivotal point where we have the potential to avoid or minimize the effects. We may be able to CHANGE how they are exposed.

This is why "conservation measures" generally target reducing or avoiding exposure.

Factors that are important to address in an exposure analysis for an individual include:

- How many individuals of which populations would be exposed and to what stressors
- What life-stage & sex would be exposed
- Where the exposure would occur and when
- The intensity, duration, and frequency of the exposure and
- The pathways of exposure (direct, indirect, or both)

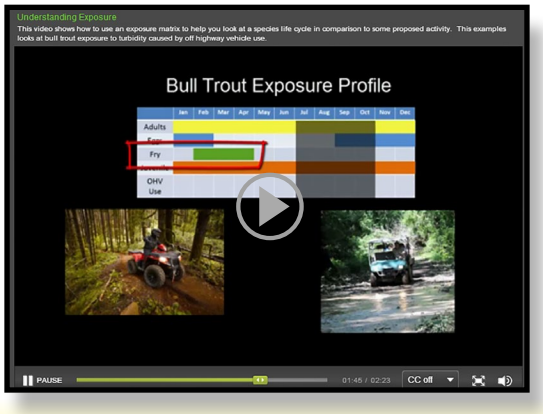
Each of these factors is important for assessing exposure.

PHOTO: JENNIFER STRICKLAND, USFWS

Factors also need to be considered for assessments relating to Critical Habitat (CH):

- Which portions of CH and which physical and biological features will be exposed and to what stressors,
- When the exposure would occur,
- The intensity, duration, and frequency of the exposure, and
- How the exposure would occur.

Here is an example with bull trout exposure to off highway vehicle use. Just click on the image to play the video.



DIRECT VS. INDIRECT INTERACTION

When analyzing exposure risks for an individual, you need to first determine whether the stressor is direct or indirect, and note, you MUST choose one or the other, an individual stressor cannot be both direct and indirect.

Direct interactions occur *directly to the individual*. For instance, if the action calls for mechanical removal of vegetation, foraging frogs could be crushed. Crushing is a direct interaction – it happens directly between something used in the action against the individual. Using a weed whacker on an endangered plant is a direct interaction. Hitting a deer with a car is a direct interaction.

PHOTO: TODD WESTON, USFWS

Indirect interactions are different. The individual is not directly exposed to the stressor, but the *resource* is. The change in the environment results in a resource quantity or quality change and the individual is indirectly impacted.

Going back to our mechanical removal of vegetation example, a decrease in insects because vegetation is removed can indirectly impact frogs – their prey isn't there anymore because the insects sheltered in the vegetation that is no longer present. The loss of vegetative cover can also impact the frog's habitat – there is less shelter. Frogs are also more susceptible to predators. The decreased vegetation can also cause an increase in the water temperature because of less shade. All of these are considered indirect interactions – they didn't happen directly to the frogs, but they are a stressor because the resource changed as a result of the action.

PHOTO: KEITH PENNER, USFWS

OK, SO HOW DO I PROCEED?

Let's go back to the steps that were listed earlier and walk through the process, now that you know about stressors, exposure, and direct and indirect interactions. The process that will be outlined here uses the Effects Pathway Matrix (Matrix) as a framework to consolidate your information to this point. It is not the only way to do this, but many action agencies have found it a useful tool to synthesize their work. Another nice thing about the Matrix is that it can be included as an appendix to your Biological Assessment.

Here is a short video that uses the example of the "Island Mouse" to show you how this all comes together.

<< -- LINK TO VIDEO -- >>

Here is a blank Word version of the Matrix.

<< -- DOWNLOAD DOCUMENT -- >>

We've also included a Matrix that is partially completed, so you can see how it could be filled out.

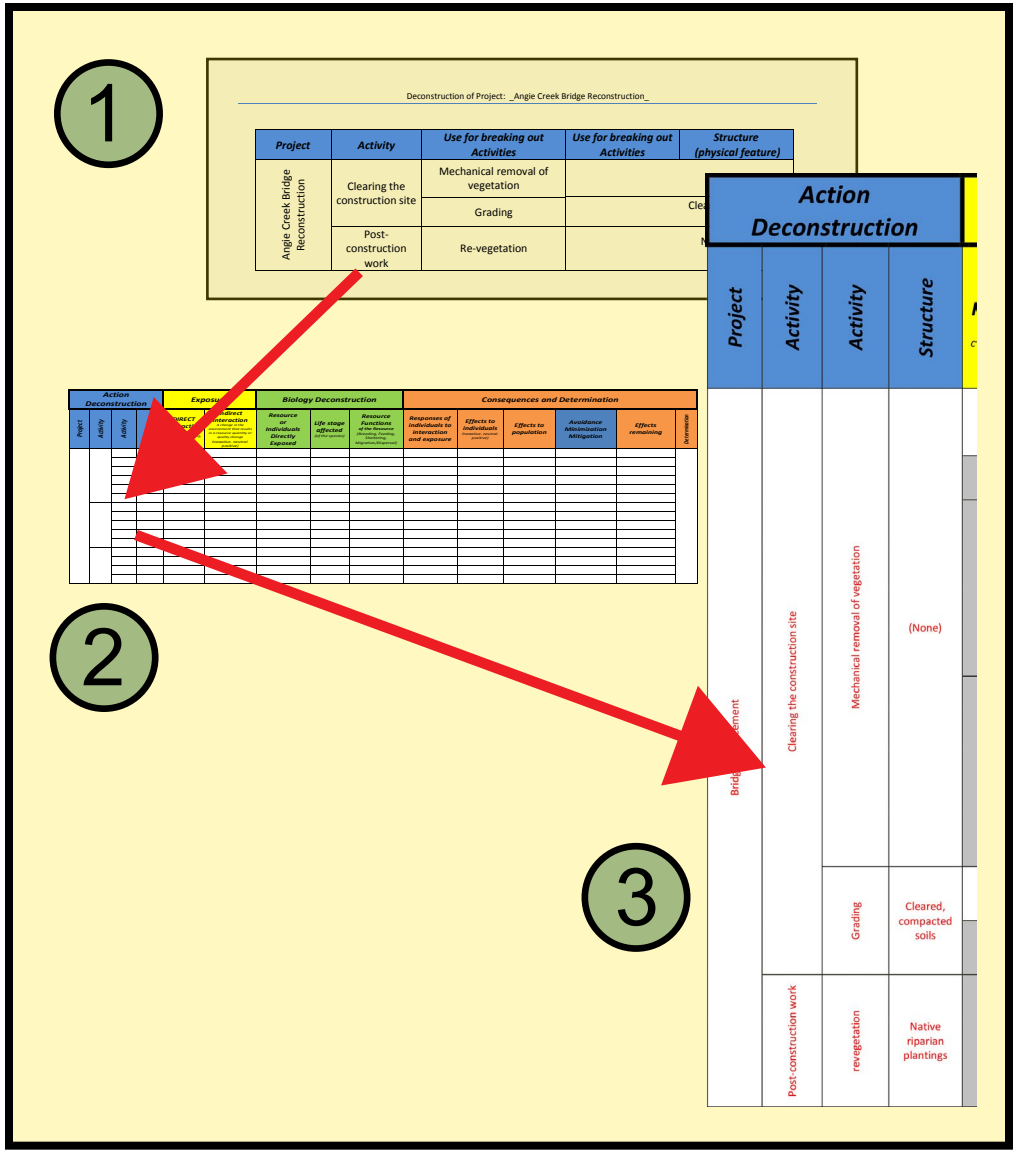
<< -- DOWNLOAD SAMPLE MATRIX -- >>

STEP 1: INCORPORATE YOUR ACTION DECONSTRUCTION INTO THE EFFECTS PATHWAY MATRIX

This step requires you to move your Action Deconstruction information from the table you created previously (or from wherever you wrote that information) and put it in the first BLUE section of the Matrix.

Put the project name in the first column and then add your activities and subactivities to the appropriate columns and also add the structure – if there will be one resulting from this activity.

You can see in the example we have completed this section for a portion of a bridge replacement project. We have completed the activity “Clearing the construction site” and the subactivities “Mechanical removal of vegetation” and “Grading”.



STEP 2: IDENTIFY A STRESSOR FOR ONE ACTIVITY / SUBACTIVITY / STRUCTURE

Using the Action Deconstruction you have just transferred to your Matrix, identify what stressors could result from each activity, subactivity, or structure.

STEP 3: IDENTIFY WHETHER THAT STRESSOR CAUSES A DIRECT OR INDIRECT INTERACTION

Identify if the stressor you identified for the activity/subactivity/ structure exposes the species directly or indirectly. If it's direct, put the stressor in the "DIRECT Interaction" column. If it's indirect, put it in the "Indirect Interaction" column.

You can see how that was done in the example Matrix that was available to you on page 9.

Continue steps 2 and 3 until all stressors have been identified and entered into the appropriate column on the matrix.

Action Deconstruction				Exposure	
Project	Activity	Activity	Structure	DIRECT Interaction (vehicle strike, crushing, trampling, etc.)	Indirect interaction A change in the environment that results in a resource quantity or quality change (negative, neutral, positive)
Bridge Replacement	Clearing the construction site	Mechanical removal of vegetation	(None)	Crushing foraging frogs	
					Decrease in insects (negative)
					Loss of vegetative cover (negative)
					Increase in water temperature (negative)
		Grading	Cleared, compacted soils	Crushing foraging frogs	
	Post-construction work	revegetation	Native riparian plantings		Increase in vegetative cover (positive)
					Increase in insects (positive)
					Decrease in water temperature (positive)

STEP 4: IDENTIFY INDIVIDUAL / RESOURCE EXPOSURE

Using the deconstructed biology you developed earlier as a "pick list", list which individuals or ***resources*** could be exposed to those Direct interactions or Indirect interactions (respectively).

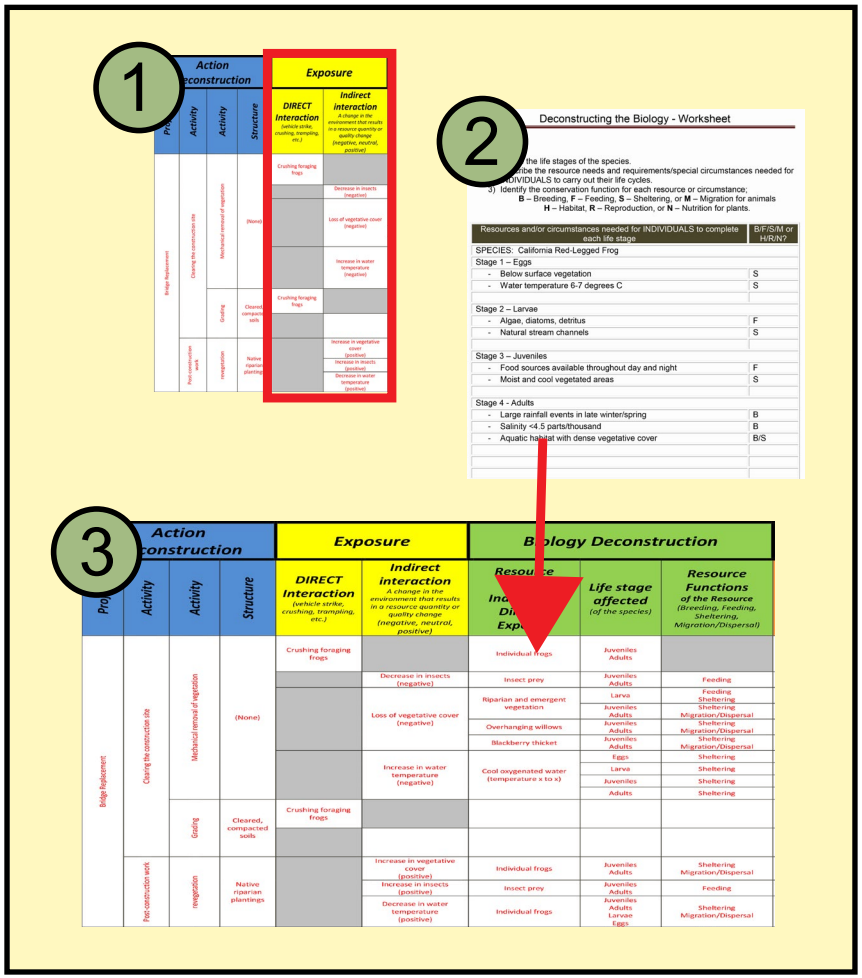
For each stressor you listed in the YELLOW column, go back to your biology deconstruction and complete the GREEN columns with the appropriate information.

In essence, you're using your biology deconstructions as a "pick list". For each stressor, identify the resource or individuals exposed, at what life stage, and list the resource functions.

You may need to add more rows to your Matrix because more than one life stage or resource may be exposed to a single stressor.

The video and example document (from page 9) shows you how this could look and there is a small segment of the Matrix on the next page.

Continue the process until each stressor is completed for every activity, subactivity, or structure.



Action Deconstruction				Exposure		Biology Deconstruction		
Project	**Activity**	**Activity**	**Structure**	**DIRECT Interaction** *(vehicle strike, crushing, trampling, etc.)*	**Indirect interaction** *A change in the environment that results in a resource quantity or quality change (negative, neutral, positive)*	**Resource or Individuals Directly Exposed**	**Life stage affected** *(of the species)*	**Resource Functions** ***of the Resource*** *(Breeding, Feeding, Sheltering, Migration/Dispersal)*
Bridge Replacement	Clearing the construction site	Mechanical removal of vegetation	(None)	Crushing foraging frogs		Individual frogs	Juveniles Adults	
					Decrease in insects (negative)	Insect prey	Juveniles Adults	Feeding
					Loss of vegetative cover (negative)	Riparian and emergent vegetation	Larva	Feeding Sheltering
							Juveniles Adults	Sheltering Migration/Dispersal
						Overhanging willows	Juveniles Adults	Sheltering Migration/Dispersal
						Blackberry thicket	Juveniles Adults	Sheltering Migration/Dispersal
					Increase in water temperature (negative)	Cool oxygenated water (temperature x to x)	Eggs	Sheltering
							Larva	Sheltering
							Juveniles	Sheltering
							Adults	Sheltering
		Grading	Cleared, compacted soils	Crushing foraging frogs				
	Post-construction work	revegetation	Native riparian plantings		Increase in vegetative cover (positive)	Individual frogs	Juveniles Adults	Sheltering Migration/Dispersal
					Increase in insects (positive)	Insect prey	Juveniles Adults	Feeding
					Decrease in water temperature (positive)	Individual frogs	Juveniles Adults Larvae Eggs	Sheltering Migration/Dispersal

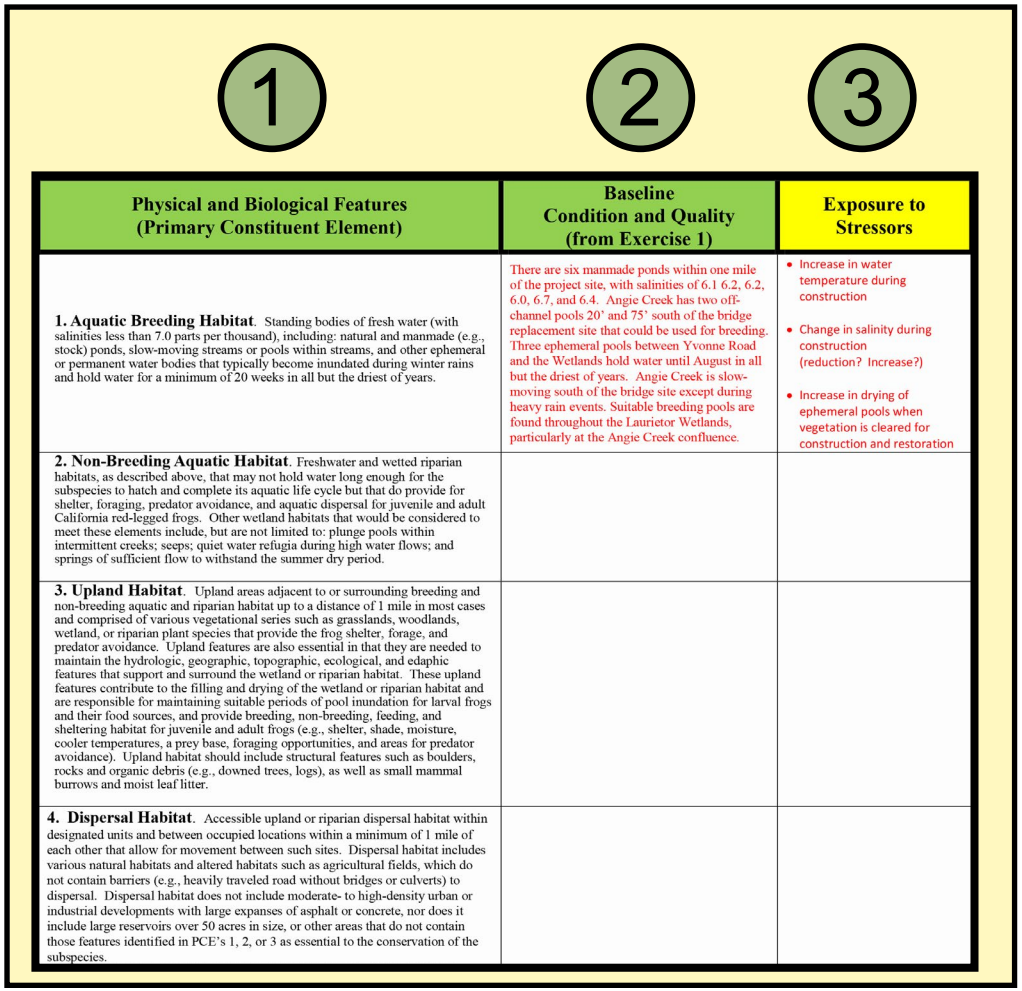
STEP 5: CONTINUE FOR CRITICAL HABITAT

Use the second page of the Matrix for Critical Habitat.

1. Transfer your PBFs to the first column in the table.

2. Add the information you identified on the baseline condition and quality.

3. Describe how the PBF is exposed to the stressors you identified.



1 Physical and Biological Features (Primary Constituent Element)	2 Baseline Condition and Quality (from Exercise 1)	3 Exposure to Stressors
1. Aquatic Breeding Habitat. Standing bodies of fresh water (with salinities less than 7.0 parts per thousand), including: natural and manmade (e.g., stock) ponds, slow-moving streams or pools within streams, and other ephemeral or permanent water bodies that typically become inundated during winter rains and hold water for a minimum of 20 weeks in all but the driest of years.	There are six manmade ponds within one mile of the project site, with salinities of 6.1 6.2, 6.2, 6.0, 6.7, and 6.4. Angie Creek has two off-channel pools 20' and 75' south of the bridge replacement site that could be used for breeding. Three ephemeral pools between Yvonne Road and the Wetlands hold water until August in all but the driest of years. Angie Creek is slow-moving south of the bridge site except during heavy rain events. Suitable breeding pools are found throughout the Laurietor Wetlands, particularly at the Angie Creek confluence.	• Increase in water temperature during construction • Change in salinity during construction (reduction? Increase?) • Increase in drying of ephemeral pools when vegetation is cleared for construction and restoration
2. Non-Breeding Aquatic Habitat. Freshwater and wetted riparian habitats, as described above, that may not hold water long enough for the subspecies to hatch and complete its aquatic life cycle but that do provide for shelter, foraging, predator avoidance, and aquatic dispersal for juvenile and adult California red-legged frogs. Other wetland habitats that would be considered to meet these elements include, but are not limited to: plunge pools within intermittent creeks; seeps; quiet water refugia during high water flows; and springs of sufficient flow to withstand the summer dry period.		
3. Upland Habitat. Upland areas adjacent to or surrounding breeding and non-breeding aquatic and riparian habitat up to a distance of 1 mile in most cases and comprised of various vegetational series such as grasslands, woodlands, wetland, or riparian plant species that provide the frog shelter, forage, and predator avoidance. Upland features are also essential in that they are needed to maintain the hydrologic, geographic, topographic, ecological, and edaphic features that support and surround the wetland or riparian habitat. These upland features contribute to the filling and drying of the wetland or riparian habitat and are responsible for maintaining suitable periods of pool inundation for larval frogs and their food sources, and provide breeding, non-breeding, feeding, and sheltering habitat for juvenile and adult frogs (e.g., shelter, shade, moisture, cooler temperatures, a prey base, foraging opportunities, and areas for predator avoidance). Upland habitat should include structural features such as boulders, rocks and organic debris (e.g., downed trees, logs), as well as small mammal burrows and moist leaf litter.		
4. Dispersal Habitat. Accessible upland or riparian dispersal habitat within designated units and between occupied locations within a minimum of 1 mile of each other that allow for movement between such sites. Dispersal habitat includes various natural habitats and altered habitats such as agricultural fields, which do not contain barriers (e.g., heavily traveled road without bridges or culverts) to dispersal. Dispersal habitat does not include moderate- to high-density urban or industrial developments with large expanses of asphalt or concrete, nor does it include large reservoirs over 50 acres in size, or other areas that do not contain those features identified in PCE's 1, 2, or 3 as essential to the conservation of the subspecies.		

NEXT STEPS

There is actually no writing you need to do with your BA at this time. The entire Exposure step in the Effects Pathway will be incorporated into a variety of sections as you continue this process.

If you're continuing to work through the pathway, the next step is to look at Consequences and finally, make a Determination.