A Functional Assessment Model for Upland Habitats:
A New Tool Under Development to Measure Ecological Functions of Upland Habitats in California

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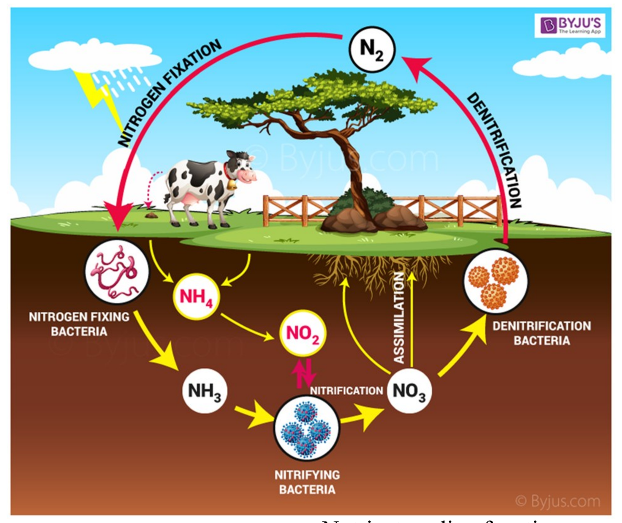
BIOLOGICAL AND ENVIRONMENTAL SERVICES

Upland Ecosystem Classes in California

- Herbland
  - Perennial Herblands
  - Annual Herblands
  - Lithomorphic Herblands
- Scrublands
  - Coastal Sage Scrub
  - Chaparral
  - Desert Scrub
  - Alpine Scrub
  - Tundra (not in lower 48 states)
- Woodlands
  - **Oak Woodlands**
    - Coast Live Oak Woodland
    - **Blue Oak Woodland**
    - Valley Oak Woodland
    - Oregon Oak Woodland
    - Black Oak Woodland
    - Canyon Live Oak Woodland
  - Pinyon Woodlands
  - Juniper Woodlands
- Forests
  - Conifer Forests
    - Yellow Pine Forest
    - Mixed Conifer Forest
    - Sugar Pine Forest
    - Sierran Mixed Conifer Forest
    - Cypress Forest
    - Monterey Pine Forest
    - Monterey Cypress Forest
    - Coast Redwood Forest
    - Giant Sequoia Forest
  - Broadleaf Evergreen Forests
  - Broadleaf Deciduous Forests

Definition of Habitat Function: the arrangement and capability of habitat features to sustain species, populations, and diversity of wildlife over time.

Habitat is the natural area inhabited by an animal, plant, or other type of organism. The basic elements of habitat include food, water, and shelter. Habitat is also a function of the physical environment related to factors such as temperature, elevation, soil condition, and hydrology. Habitat occurs at several scales including the landscape scale (e.g. large areas of contiguous forest), the community scale (e.g. deep rush marshes), and the fine scale (e.g. snags and logs).



Nutrient cycling function

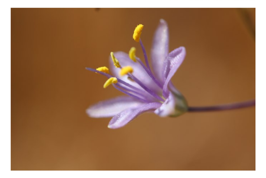
ABSTRACT/SUMMARY

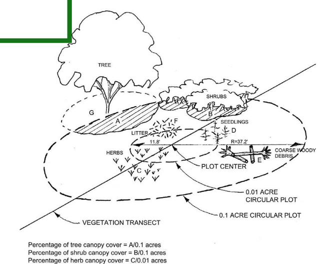
Biological consultants are often tasked with characterizing upland habitats and assessing whether various projects will significantly impact habitats onsite or nearby but to date have had no objective tools to do this. The authors are developing a set of models for measuring ecological functions in an objective manner to be used to establish baseline conditions, relative to the conditions in a region for the same habitat class, and then using the model to measure expected changes to each habitat function as a result of a specific project. This tool can be used to determine if the project would result in a significant change in one or more of the habitat functions. The functions would be measured and scored through measuring as set of observable variables. This model can then be used to identify specific actions that can be taken to improve habitat functions as potential mitigation measures. Finally, it can then be used to monitor changes of the site over time. This tool follows the basic approach used by the U.S. Army Corps of Engineers and U.S. Environmental Protection Agency in their Hydrogeomorphic Assessment Method (HGM) for wetland habitats.

BACKGROUND

The lead author has been performing biological assessments since the 1980s and struggled with how to capture the importance and functions that natural habitats play in the world dominated by human actions. Most of us know, on some level, that natural habitats are vital to how our world functions, but that describing the state of those habitats has generally fallen to the prose and opinions of biological consultants and environmentalists given the lack of a framework that is objective, holistic, repeatable, and which regulators and the public can trust. The U.S. Army Corps of Engineers (Corps) functional assessment model for wetlands (HGM), which the lead author has used extensively, provides a very good approach on how to do the same thing for upland ecosystems. We have taken the basic approach used by the Corps and adapted it for upland ecosystems.

The ecologic functions model assumes that each ecosystem provides several functions or processes in three basic categories, physical, biochemical, and biotic. The specific functions an ecosystem provides is dependent on the habitat class. Habitat or ecosystem classes are classified by the basic structure of the ecosystem, using the most dominant or characteristic plant form, being Forest, Woodland, Shrub, or Herb. Subclasses focus on the dominant species, such as *Quercus agrifolia*, *Pinus jeffreyi*, *Adenostoma fasciculatum*, etc. The model outlined below is for a Blue Oak Woodland dominated by *Q. douglasii*, Blue Oak, which is a characteristic and widespread oak woodland type in California.





HABITAT FUNCTIONS OF A WOODLAND ECOSYSTEM

Physical Functions

Definition: characterized by, produced by, or involving physical conditions of the habitat type

1. Maintains hydrology
2. Maintains energy dissipation or normal energy absorption
3. Maintains landform characteristics
4. Retaining/trapping air and water borne sediments
5. Maintains soil surface temperatures
6. Maintains typical wind exposure/protection

Biochemical Functions

Definition: characterized by, produced by, or involving chemical reactions in living organisms

7. Maintains Element Cycling
8. Maintain Carbon Sequestration
9. Maintains Nutrient Cycling

Biotic Functions

Definition: characterized by, produced by, or involving plants and wildlife using and living in habitat class

10. Maintains Characteristic Vegetation
11. Maintains Spatial Structure of Habitats
12. Maintains Characteristic Vertebrates
13. Maintains Characteristic Invertebrates
14. Maintains Characteristic Amphibian Populations
15. Maintains Characteristic Reptile Populations
16. Maintains Characteristic Avian Populations
17. Maintains Characteristic Mammalian Populations
18. Maintains Populations of Sensitive Taxa
19. Maintains Habitat Interspersion and Connectivity
20. Maintains Species Diversity
21. Maintains Species Richness
22. Maintains Structural Complexity
23. Maintains Rare Species That Use Habitat Class

Anthropogenic Stressors

This model focuses on how human actions have degraded habitat functions through measuring the results of anthropogenic stressors. That is, the condition of the assessment area compared to sites of the same habitat type that has not been significantly altered or affected by direct or indirect human actions or activities. Predominant anthropogenic stressors affecting the structure and functioning of upland ecosystems include: level of human use, livestock/large herbivore stocking rates, fire-regime alteration, invasive exotic plants, adjacent land use activities, air pollutants, and global atmospheric changes (Miller 2005).

Miller, Mark E. 2005. The Structure and Functioning of Dryland Ecosystems – Conceptual Models to Inform Long-term Ecological Monitoring. U.S. Department of the Interior, U.S. Geological Survey. (Scientific Investigations Report 2005-5197.) Reston, Virginia..

Example - V1 + V2 + V3 = Function Index Score

Each Function is scored independently

Measurable Variables to Inform Habitat Functions

Number of Amphibians (VAMPH#)	Litter Cover and Depth/Thickness (VLITTER)
Bird Species Richness (VBIRDTAXA)	Number of Mammals (VMAMMAL)
Bryophyte Habitat Diversity (VBRYHD)	Number of Plant Classes (VPCLASS#)
Bryophyte Species Richness (VBRYO)	Plant Species Richness (VPLANTTAXA#)
Buffer Conditions (VBUFCOND)	Native:Nonnative Plants Ratio (VRATIO)
Buffer Continuity (VBUFFCONT)	Regeneration (VREGEN)
Buffer Size (VBUFFSIZE)	Number of Reptiles (VREPTILE)
Buffer Width (VBUFFWIDTH)	Shrub Density (VSHRUB%)
Number of Decaying Wood Classes (VCWD)	Number of Standing Tree Snags (VSNAGS)
Volume of Coarse Woody Debris (VCWDVOL)	Soil Integrity (VSOILINTEG)
Number of Fungal Taxa (VFUNGI)	Soil type (VSOILT)
Geology (VGEOL)	Special-status Plant Species (VSSPS)
Habitat Integrity (VHABBREAKS)	Special-status Wildlife Species (VSSWS)
Shape of Core Habitat (VHABSHAPE)	Vegetation Strata (VSTRATA)
Habitat Fragmentation (VHFRAG)	Tree Age Classes (VTREEAGE#)
Number of Invertebrates (VINVERTS)	Tree Basal Area (VTREEBA)
Presence of Keystone Species (VKEY)	Tree Canopy Cover (VTREECC)
Landform (VLANDF)	Tree Density (VTREES)
Land Use (VLANDUSE)	Number of Vascular Plant Taxa (VVACP#)
Number of Lichen Taxa (VLICHEN#)	Percent Cover Vegetation Layers (VVEGCOV)
Number of Lichen Type Classes (VLICHENCL#)	Number of Vegetation Layers (VVEGLAYERS)
Lichen Habitat Diversity (VLICHENHD#)	Number of Wildlife Classes (VWCLASS#)

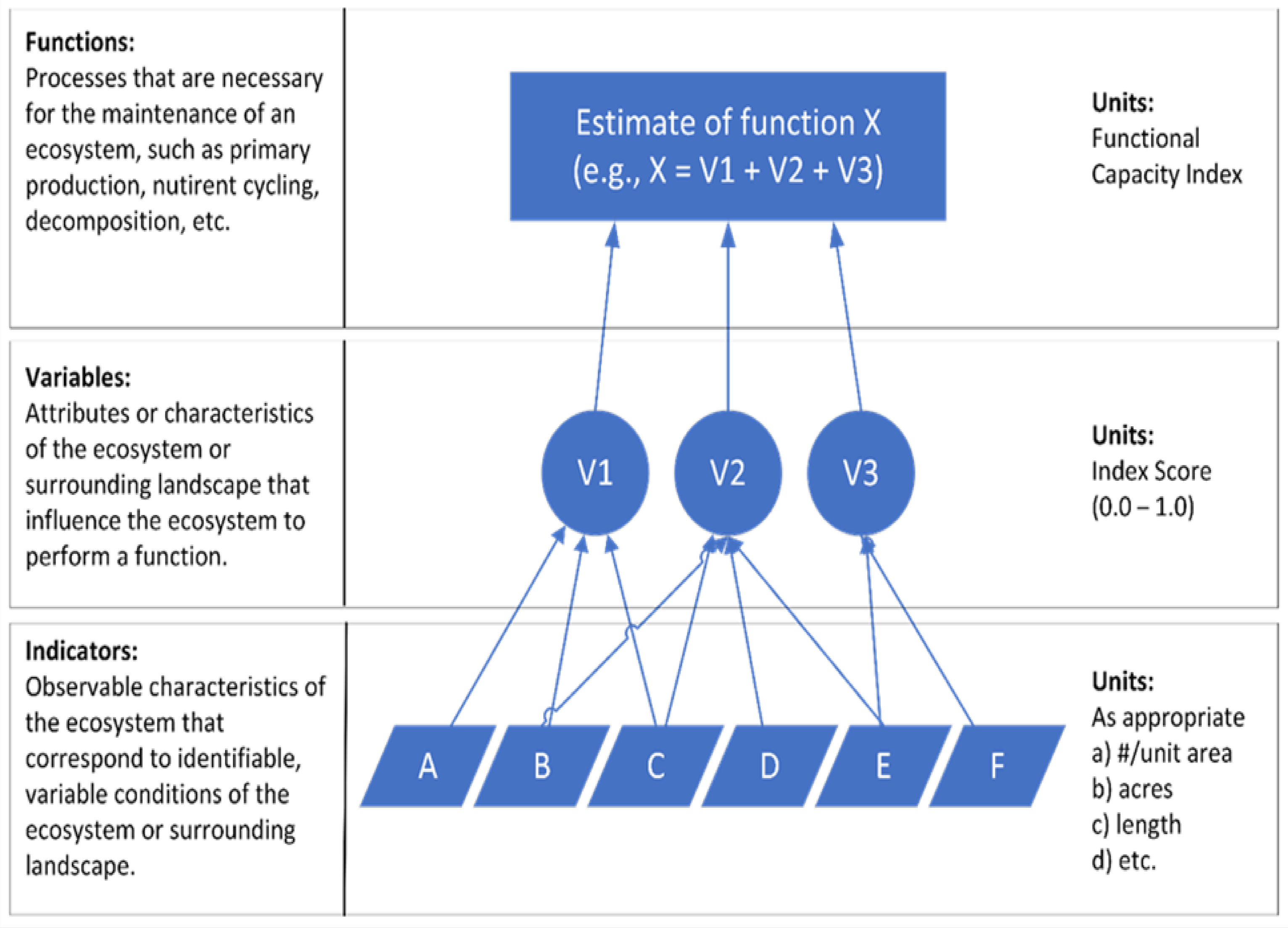
Variables to Inform Functionality

A suite of variables will be used to characterize each of the 23 functions, as illustrated in the flow chart below. Most of the functions will be scored by the values for one or more variables, with the scoring calibrated based on reference data collected within the reference domain. At this point, we have identified 44 specific variables to use, listed in the table below.

Observable-measurable indicators will be used to measure each variable. A score for each variable is assigned compared to the range of conditions of the reference data, with variables with little or no degradations from anthropogenic stressors given the highest scores. The resulting value from the variables used will provide the Functional Index Score (FCI).

Each variable is scaled between 0 and 1.0, with 0 representing a variable no longer functions or contributing to the ecosystem and not recoverable. A score of 1.0 represents the best known condition for that variable, or at Reference Standard.

Scaling is determined by selecting one of 6 predetermined levels.

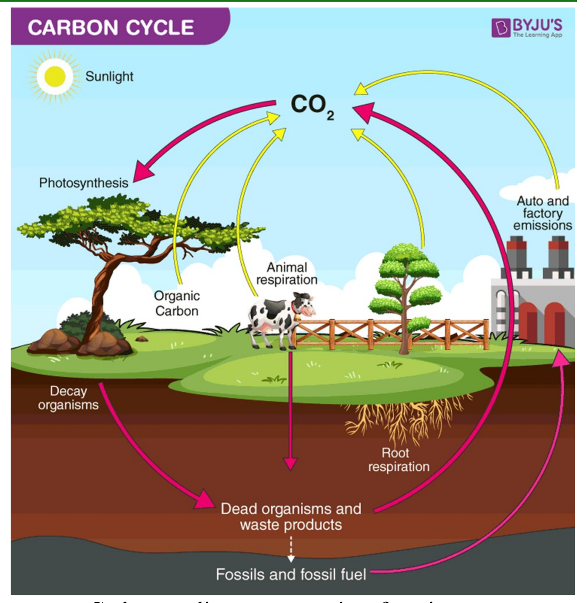


Example Variable Scaling

Tree Canopy Cover (% canopy cover—VTREECC)

VTREECC is the % canopy cover of trees (single stem woody species with >3” DBH and > 10 ft tall).

MEASUREMENT CONDITION FOR VTREECC	INDEX
a. Average tree canopy cover >90% **and** b. Vegetation within the VAA is unaltered.	1.00
a. Average tree canopy cover > or = 30% and <90% **and** b. Vegeation withing the VAA is unaltered by human activities.	0.75
a. Average tree canopy cover >30% but <90% **and** b. Vegeation withing the VAA is altered by human activities (e.g. partial clearling/degradations/trampling of vegetation by grazing of domestic livestock, crop productions, parks, uurban/suburban development, flood control access, etc..	0.50
a. Average tree canopy cover < or = 30% and >5%.	0.25
a. Average tree canopy cover < or = 5% **and** b. Variable is recoverable to reference standard conditions and sustainable through natual processesif the existing land use (e.g. site cleared/degraded/trampled through heavey grazong of domestic livestock, developed park, crop productions) is discontinued and no restoation measurs are applied.	0.10
a. Average tree canopy cover < or = 5% **and** b. Variable is not rocoverable or sustainable to reference standard conditions through natural processes if the existing land use (e.g. parking lot, roads, livestock pens, etc.) is discontinued and no restoation measures are applied.	0.00



Carbon cycling/sequestration function

Benefits of an Ecologic Functions Assessment Model

The primary benefit of use and applying an ecological functions model is to have an ***objective*** means to characterize and measure habitat functions of habitat(s) on a project site that is repeatable and has multiple utilities.

Measuring a discrete set of variables at multiple sites of the same habitat class provides a means for comparison and calibration.

Applying this tool for impact assessments provides decisionmakers with an unbiased measurement of how the environment is affected to help guide project development or revision as well as how best to mitigate adverse impacts. It can also be used to measure success or failure of mitigation measures intended to improve habitat functions.

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