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# *Bioassessment of stream conditions and response to land use in Los Padres National Forest*

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The United States Forest Service (USFS) manages Los Padres National Forest, in central and southern California, for multiple uses, including water supply, recreation, rangeland, oil extraction, and endangered species habitat.


Our project uses biological methods to assess stream conditions at sites across the Forest, identifies land uses which may threaten the aquatic ecosystem, and evaluates the performance of two prominent bioassessment techniques. Our findings are used to generate a set of management recommendations for the United States Forest Service.

## Background

Bioassessment analyzes aquatic habitat using species and communities as indicators of ecosystem quality. The assemblage of organisms integrates different types of stressors through time and space.

Our project implements and compares two dominant bioassessment models currently used in the field by state and federal agencies:

- **IBI**
  (Index of Biotic Integrity)
- **RIVPACS**
  (River Invertebrate Prediction & Classification System)

Both models focus on benthic macroinvertebrate communities in the stream bed (BMI). We used an existing IBI model specific to southern California, and constructed a pilot RIVPACS model using data from sites in Los Padres National Forest.

## Bottom-Dwelling Bugs

The stream bed is occupied by adult and larval insects, worms, and other arthropods. Many BMI taxa exhibit known responses to pollution, excessive sedimentation, thermal loading, nutrient enrichment, and other human disturbances.

**Ephemeroptera**: indicative of high habitat quality

**Chironomidae**: indicative of degraded stream condition

The mayfly, stonefly, and caddisfly taxa (Ephemeroptera, Plecoptera, and Trichoptera Orders) and beetles (Coleoptera) typically decrease when stream habitats are impaired or

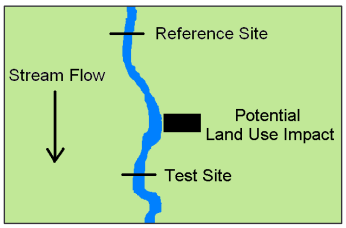
polluted. More tolerant groups such as nematodes, oligochaetes and chironomids increase with sedimentation or lowered oxygen levels associated with disturbance[1].

The IBI model uses the abundance of these and other groups, as well as BMI feeding preferences, to score sites based on a 0-100 rating system. IBI metrics are derived from BMI communities at individual sites, which allows integration of stressors over time without regard to spatial scale or geography.

The RIVPACS model uses site-specific environmental and geographic features to predict the BMI community that would occur in the absence of impairment. The expected taxa (***E***) are compared to the taxa observed (***O***) in the field sample. The RIVPACS score is calculated as the ratio of observed to expected taxa: ***O/E.*** RIVPACS integrates more spatial and watershed-scale variables than the IBI.

## Sites

BMI and habitat data from 50 stream sites were collected in 1999 and 2000. Many sites were paired, with a "reference" site upstream and a "test" site downstream of a potential stressor. Other test sites were unpaired, or potentially impacted by multiple disturbances.




Disturbances included USFS activities and natural phenomena: recreation, campgrounds, grazing areas, roads, oil extraction, gravel mines, fires, and landslides.

## Method

The scores from IBI and RIVPACS were compared with the potential disturbances for each site. We also analyzed each test-reference pair for the change in scores from upstream to downstream location. The performance of each model was evaluated for potential use as a forest management tool.

BMI samples were taken from the stream bed and identified by the Utah State University National Aquatic Monitoring Center.

## Findings - IBI

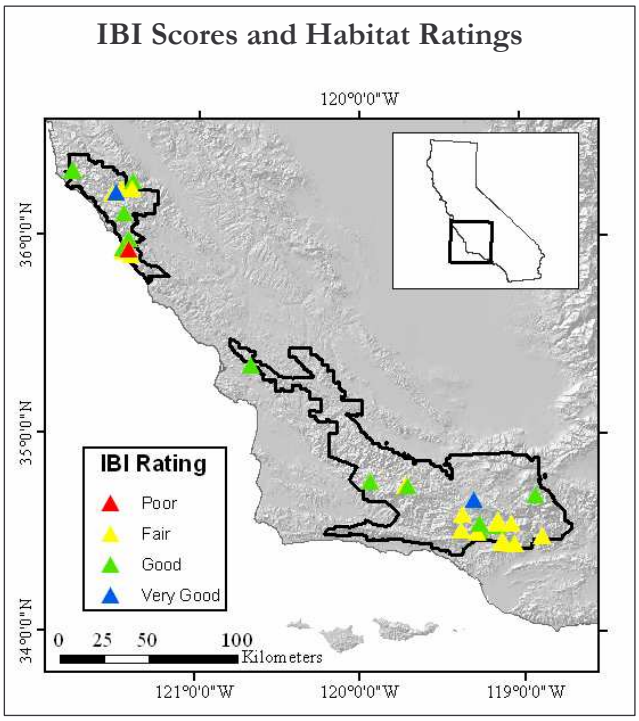
The IBI scores showed the majority of sites to be in good condition. Only one site, along Prewitt Creek in a grazing zone, was of poor quality.

IBI scores were significantly different (paired t-test, $p < 0.05$) for test and reference sites, indicating that the model can differentiate among sites upstream and downstream of the particular disturbances analyzed in the study. In addition, two land uses significantly affected variation in IBI scores across all sites (ANOVA, $p < 0.05$):

- Grazing areas (within 75 meters)
- Fire history (burned 0-1 year or 2+ years before sample)

Sites near grazing areas exhibited lower scores, possibly due to soil compaction, increased erosion, runoff, nutrient enrichment or bacterial contamination. Sites near recent burns (0-1 year)

earned higher scores than sites near older burns. BMI response to fires is variable[2,3]. Longitudinal studies of these sites could reveal fire recovery trends.




Road crossings within 25 meters of sites and road type were not significant factors in IBI score variance ($p = 0.09$, $p = 0.07$), but the influence decreased as distance from roads increased. Proximity to roads may have a negative influence on IBI scores through sedimentation/runoff or physical alteration of stream flow.

## Findings - RIVPACS

Five environmental parameters were found to be significant predictors of BMI communities in the RIVPACS model.

- Annual Precipitation
- Stream Order
- Elevation
- Latitude
- Longitude

The RIVPACS scores for six sites indicated impairment, possibly due to the dominant land use or other disturbance in the area:

| Impaired Site | Land Use/Disturbance |
|---|---|
| Chorro Creek *Test* | Gravel mine |
| Matilija Creek *Test* | Wheeler Gorge campground |
| Santa Paula Creek *Reference* | Recreation zone |
| Sespe River - at Tule Creek *Test* | Landslide |
| Sisquoc River *Test* | Recreation zone |
| Tar Creek *Test* | Oil operations |

RIVPACS scores did not show a consistent difference between test and reference sites, and none of the land uses showed a significant overall effect on RIVPACS scores (ANOVA, $p > 0.05$). The model does not appear attuned to the disturbance zones in the study design.

## Model Comparison

Comparison of individual site scores for both models did not show correlation between RIVPACS and IBI ($R^2 = 0.0015$). The models interpret BMI communities differently, are sensitive to different parameters, or perform inconsistently. The pilot RIVPACS model developed in this project is limited by small sample size, thus we place more confidence in the IBI model output.

Changes in either IBI or RIVPACS scores depend on increases or decreases in BMI taxa. RIVPACS analysis shows inconsistent response to stressors among several taxa. The quantitative change in diversity and abundance should also be examined when using either model.

## Management Implications

Our project shows that bioassessment methods can be used to monitor stream conditions and responses to anthropogenic activity in Los Padres

National Forest. Bioassessment results can be used to identify impaired sites and watersheds, and prioritize restoration and conservation efforts.

The IBI has shown to be an applicable tool for streams in Los Padres National Forest. The model can detect disturbances in test sites located downstream of management activities and certain natural disturbances. The model is sensitive to grazing and fire history, and possibly distance to particular types of road crossings.

Los Padres managers can use bioassessment, particularly IBI, to monitor fire recovery. The recovery trend is not yet apparent based on the current data set, but the results show a significant response in IBI scores through time.

The effect of grazing areas appears to be small and isolated. We recommend that grazing allotments be excluded from endangered species habitat or highly sensitive areas. Otherwise, grazing should be monitored along with other impacts.

Because invertebrate taxa are sensitive to different stressors through time, bioassessment can be effective in evaluating aquatic habitat for endangered or threatened species. Fewer site visits are necessary, and the stream is exposed to less research-related disturbance. For example, the endangered arroyo toad (*Bufo californicus*) is found at the Sespe River sites near Lion Campground. The campground was closed as part of recovery efforts. Samples in 1999 and 2000 show a fair IBI condition rating. Ongoing BMI samples can monitor the ecosystem conditions over time.

## Future Paths

While the current RIVPACS model is suspect, a more robust model could be created following the same method with a larger sample size and additional environmental parameters. Sites sampled in 2004 would increase the sample size for the RIVPACS model as well as allow assessment of temporal variations in site quality.

Sites were resampled in summer 2004 as part of ongoing bioassessment research. New data can be used in refining RIVPACS and tracking sites through time.

Additionally, custom RIVPACS scores for Los Padres sites can be compared with the existing Region 5 USFS model.

A 2005-2006 Bren School group project proposes to use our data and results in further examination of environmental stressors in different regions and changing conditions through time. Further applications could include use of both models in habitat evaluation for steelhead trout.

[1] Aquatic Bioassessment Laboratory (ABL). 2004. Quality assurance project plan for the California stream bioassessment procedure. California Department of Fish and Game. Water Pollution Control Laboratory.

[2] Spencer 1991 Spencer J, Jr., Kingsley N. 1991. The oak resource in the upper Midwest: An overview. University of Minnesota, St. Paul: 11-17.

[3] Minshall 2003 Minshall G. 2003. Responses of stream benthic macroinvertebrates to fire. Forest Ecology and Management 178: 155-161.