10b. Biodiversity Ecosystem: Cumulative Change

Goal: Maintain healthy forest ecosystems by maintaining a mix of habitats at different spatial scales capable of supporting the full range of naturally occurring flora, fauna, and ecological processes native to Southeast Alaska.

Objective: Maintain a Forest-wide system of old-growth forest habitat to sustain old-growth-associated species and resources.

Background: Epiphytic lichen communities are highly sensitive to changes in environmental pollution and climate, making them excellent candidates for long-term monitoring of ecosystem integrity (Root et al. 2014; 2015, Gauslaa 2014, Jovan 2008, Geiser and Neitlich 2007). They lack roots to store water and their physiology is completely dependent on humidity and rainfall occurring at times when temperatures favor photosynthesis (Palmqvist et al. 2008). They are intricately tied to many ecosystem processes such as wildlife food, habitat, and nesting material, nutrient cycling and enhancing biodiversity (Figure 1).

Recently completed models with Forest Inventory and Analysis (FIA) data relate lichen communities to climate gradients in Southeast and Southcentral Alaska (Root et al. 2014). Lichen communities and individual species showed strong differences in composition and abundance within a fairly narrow climatic window from wet areas with warm winters and maximum temperatures to dry places with cold winters and minimum temperatures (or a shift from oceanic to sub-oceanic climate regimes) (Figure 2). This suggests that rapid turnover exists in lichens with relatively small changes within these climate regimes. This work by Root et al. (2014) offers new opportunities to use Forest Service lichen data as indicators of climate and climate change in R10 in collaboration with SE Alaska National Park Network (SEAN), Chugach National Forest, FIA and Oregon State University (OSU). Region 10 has a database of epiphytic lichen community data collected during air quality biomonitoring work from nearly 200 plots from Ketchikan to the Kenai Peninsula. Some Tongass plots in wilderness have had three repeat visits at roughly 10-year intervals since 1989. The data consists of epiphytic lichen communities, elemental content of lichens, and vascular plant community information. To answer the biodiversity question, we hope to explore the lichen data for its utility as a potential indicator of climate and therefore ecological integrity and biodiversity in old growth forested habitats.

Biodiversity Ecosystem Photo 1. Old man's beard lichen Usnea longissima and others of similar morphology are tied to many ecosystem functions such as nesting materials for birds and food for ungulates.

Biodiversity Ecosystem Question: *Are the effects on biodiversity, shown through the cumulative change in old-growth by biogeographic province, consistent with the estimates of the Forest Plan (change could include effects of timber harvest, land exchanges or conveyance, windthrow, insect and disease, climatic changes, etc.)?*

Evaluation Criteria

Currently, this question is being answered by evaluating compositional changes in the biodiversity of old-growth lichen indicator species in relation to climate change (Biodiversity Evaluation Criteria, USDA 2008b, pages 6-8). In 2015, further refinements to help answer this question will be developed by modeling the existing lichen community data from old-growth habitats to identify climate zones and indicator species to climate. The model can be used in the future to score biomonitoring plots based on species' presences and their climatic tolerances. Biodiversity of lichen communities in old-growth forests may be influenced by climate and therefore climate change.

Sampling/Reporting Period

The sampling period is 2014 and 2015 with a reporting and evaluation period every five years.

Monitoring Results

The R10 data are housed in the Region 6 Lichen and Air Quality Monitoring database found at http://gis.nacse.org/lichenair/index.php. In 2014, the lichen community and plot databases were substantially edited to catch up on back log of data entry. A small contract was written for a lichenologist to help identify the samples without full identification. These results were also entered into the R10 data base. The National FIA lichen indicator coordinator worked with Tongass staff to develop the Joint Venture Agreement that FIA will have with OSU to do this work in 2015. Modelers from the OSU Plant Biology department will perform most of the model development work.

Evaluation of Results

Currently the work is in progress. The R10 data are being evaluated for accuracy and refinements are being made for using the data to develop the model. Some of the database work that will be done by the OSU group is nomenclature validation and the addition of vascular plant data from original plot cards. To date, the OSU group has identified climate indicator species and conducted a lichen community analysis in relation to climate gradients using FIA data. Continuing to work the data into the model and score the plots will take about 3 months in 2015 (OSU and FIA researchers). To interpret the results and write a peer reviewed paper including how to use the model in the future would take approximately 5 months including review by the Tongass. Estimated completion of the model is September 2015 and review in 2016.

Biodiversity Ecosystem Photo 2. Two common lichens of the Tongass, Witch's hair (Alectoria sarmentosa on left) and Ticker Tape (Hypogymnia duplicata on right). Witch's Hair does not associate strongly with any particular climate variable and is common in many habitats throughout the region. Ticker tape is associated with oceanic climates with cool summer days and low summer precipitation.

Action Plan

The use of R10 lichen data will be explored to determine if it can be incorporated into the SE Alaska Lichen-Climate model (using nonparametric multiplicative regression) developed by Root et al. (2014). To further address this Forest Plan question for Biodiversity, the lichen plots are first scored based on the

model so each location receives a climate score. As plot monitoring continues over time, this score will indicate whether a warming or cooling trend exists in regards to lichen species composition.

Future work outside the scope of this current project include:

1. If changes are detected, which suite of species is displaying a decline or increase, and is this change attributed to known climatic changes (temperature and precipitation climate shifts) in the region?
2. If specific species are displaying climatic thresholds in the region, are these species tied to ecological functions such as wildlife forage, nutrient cycling or are rare or sensitive species?
3. If so, what cascading effects are possible with the present or predicted changes in climate?

Citations

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