Biology 30: Change in Populations and Communities

Concept 2 - Mixtures of populations that define communities may change over time / succession.

Introduction

Ecological succession is the process of community development. During succession a sequence of communities replace one another with the passage of time, culminating in a climax community that becomes self-perpetuating.

The process of developing a community where none have previously existed is termed primary succession. (This begins with an area such as sand dunes, barren rock or lava flow.) The initial seral stage requires development of a soil and is colonized by pioneer plants. These plants, such as algae, lichens and mosses, are adapted to withstand harsh conditions and their decay lays the base for soil formation.

An established soil base leads into secondary succession. Here the sequence of change becomes more rapid and predictable. Early colonizers establish populations which set the conditions for later-arriving species. Eventually a climax community evolves which, though dynamic, has minimal extinction or colonization of species into the community.

Seldom are large areas of climax communities found. Most areas, because ecological disturbances, are at seral stages below the climax level. In the boreal forest, fires are a natural disturbance that revert communities to earlier stages of secondary succession. Timber harvest is a human influenced form of ecological disruption.

The following set of activities will compare the ecological disruption and reestablishment of communities imposed by fire to the disruption and rate of reestablishment as a result of timber harvest. The graphs, tables and research information are taken from a study by the Alberta Research Council: Fire and Harvest Residual (FAHR) Project; The Impact of Wildfire and Harvest Residuals on Aspen-dominated Boreal Forests of Alberta.

Activity 1: Comparison of Soil Nutrients Between Wildfire and Harvest Stands. (T.H.)

Fire and timber harvesting alter the vegetation and soil mineral content of an area. This activity looks at the changes in mineral content in soil in three time periods - 1 year, 14 years and 28 years after disturbance by wildfire and harvesting. On the table LFH refers to the surface organic layer found above the mineral soil.

Table 4.1

Comparisons of mean soil properties measured at the wildfire and harvested stands at three ages using an ANOVA with a Student-Neuman-Kuels Porthoc test. Superscripts represent significant differences at P=0.05.

Year	NH4-N (mg/kg)		Total C (g/kg)		NO3rN (mg/kg)	
	Wildfire	T.H.	Wildfire	T.H.	Wildfire	T.H.
1	6.32^{a}	6.33^{a}	0.27^{b}	0.64^{a}	350.3^{c}	419.5^{a}
	(0.34)	(0.64)	(0.09)	(0.16)	(10.9)	(6.8)
14	4.48^{b}	3.81^{c}	0.07^{c}	0.38^{b}	399.5^{b}	338.2^{c}
	(0.20)	(0.31)	(0.01)	(0.12)	(0.4)	(8.7)
28	6.44^{a}	2.97^{d}	0.38^{b}	0.77^{a}	$429.9^{a,b}$	248.8^{d}
	(0.31)	(0.23)	(0.11)	(0.12)	(6.4)	(9.4)

Table 4.1 Cont'd—

Year	Total S (g/kg)		P mg/kg) in LFH		P (mg/kg) in mineral soil	
	Wildfire	T.H.	Wildfire	T.H.	Wildfire	T.H.
1	1.17[e]	1.77[b]	151.9[b]	99.0[d]	26.7[a]	24.5[a]
	(0.05)	(0.04)	(6.9)	(6.1)	(2.8)	(3.2)
14	1.39[d]	1.58[c]	171.1[a]	106.6[d]	19.3[b]	20.8[a,b]
	(0.05)	(0.05)	(9.6)	(5.7)	(1.9)	(3.2)
28	1.94[a]	1.52[c]	118.8[c]	90.9[d]	16.6[c]	18.4[b,c]
	(0.05)	(0.05)	(6.2)	(5.4)	(2.1)	(2.2)

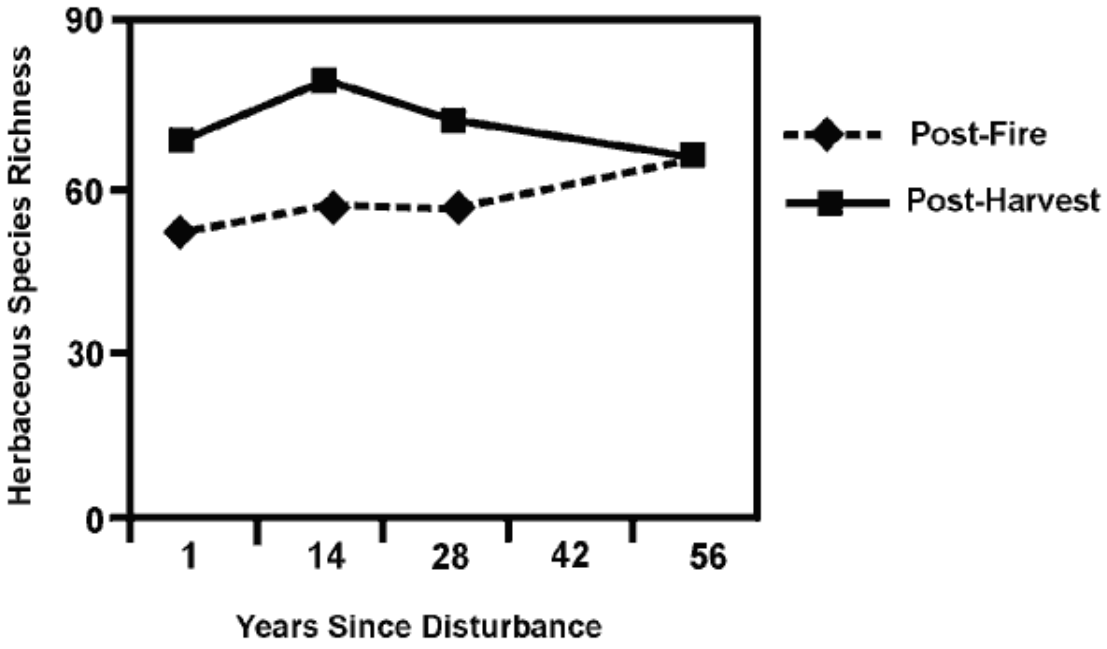
Standard errors are in parenthesis.
T.H. timber harvesting.

Questions

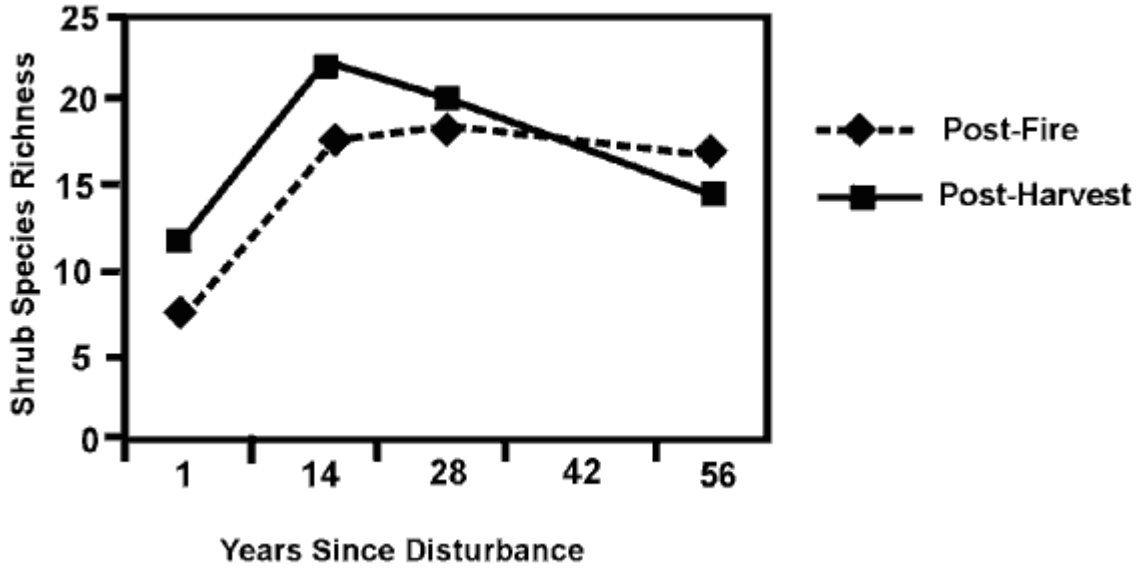
1. Nitrogen is a component in protein structure and is essential in plant growth. In what form is nitrogen found in soil? Describe the changes that occur to nitrogen in the form of nitrates (NO_3) both wildfire and harvested stands over the 28 years. Why might the harvest stands have greater amounts in Year 1 when compared to wildfire stands?
2. Carbon compounds compose the greatest amount of biomass in trees. Compare the relative amounts of carbon (C) in the soil for both stand types for the three time periods studied, What could account for the differences?

Activity 2: Comparison of Early Successional Understory Plant Communities Following Fire and Harvest.

One of the early colonizers in secondary succession are herbaceous plant species. Low understory growth which includes herbaceous plants is graphed showing species richness through four time periods - 1 year, 14 years, 28 years and 60 years. The richness of tall understory is also presented for the same time intervals.



Low understory (includes all herbaceous species, shrub species ≤0.5 m tall, and tree species ≤0.5 m tall) species richness in one, 14, 28, 42 and 56 year old post-fire and post-harvest stands.



Tall understory (includes all shrub species >0.5 m tall and tree species between 0.5 m and 1.4 m tall) species richness in one, 14, 28, 42 and 56 year old post-fire and post-harvest stands.

Questions

1. Describe the difference in herbaceous species richness in post-fire and post-harvest over the 60 years. What might account for higher levels in post-harvest stands from years 1 to 28?

2. Describe the pattern of tall understory richness for both types of stands. Explain why the richness decreases after 14 years.

Activity 3: Changes in Bird Communities Within Boreal Mixedwood Forest.

Vegetation structure and composition determine the type of habitat available to bird species. As successional changes occur in stands, habitat changes occur resulting in corresponding changes in bird communities. (Weins and Rottenberry, 1981) Generally the greatest changes between bird communities occur immediately after disruption and gradually convergence occurs with the passage of time. The form of disturbance, whether fire or harvest can affect the rate of convergence. The table below shows a collection of density data for select birds in post-fire and post-harvest sites.

Mean density (number of individuals per 100 ha) ± SE of birds detected in residual patches within forested habitat 2, 15, 30 and (60-years post-fire and the same ages post-harvest within mixedwood boreal forest in Alberta, Canada during 1997 and 1998. Densities in old forest are included for comparison. Bird species were classified based on their use of dead trees, the habitat type in which they were most common, and their use of coniferous versus deciduous forest.

Species Name	Species Code	Use of[a] Dead Trees	Habitat[b] Type	Forest Type	Density Post-Fire 2	15	30	60	Density Post-Harvest 2	15	30	60	Density in Old Forest
Rose-breasted Grosbeak *(Pheucticus ludovicianus)*	RBGR	N	Young	D	0	1±1	8±3	7±3	3±2	25±4	21±5	10±5	10±3
Chipping Sparrow *(Spizella passerina)*	CHSP	N	Old	C	2±2	2±2	1±1	8±4	8±3	0	1±1	9±3	19±4
Clay-colored Sparrow *(Spizella pallida)*	CCSP	N	Shrub	-	0	0	0	1±1	17±8	0	0	0	0
Le Conte's Sparrow *(Ammodramus leconteii)*	LCSP	N	Open	-	0	0	0	0	41±9	0	0	0	0
Song Sparrow *(Melospiza melodia)*	SOSP	N	Shrub	-	0	0	0	0	4±2	0	0	0	0
Lincoln's Sparrow *(Melospiza lincolnii)*	LISP	N	Open	-	2±2	14±5	0	1±1	30±5	7±4	2±2	0	2±1
Swamp Sparrow *(Melospiza georgiana)*	SWSP	N	Riparian	-	0	2±2	0	0	0	0	0	0	0
White-throated Sparrow *(Zonotrichia albicollis)*	WTSP	N	AllForest	B	53±11	35±8	32±10	29±7	50±6	35±6	42±6	28±6	69±9
Dark-eyed Junco *(Junco hyemalis)*	DEJU	N	AllForest	C	5±3	10±4	1±1	7±4	2±2	0	2±2	11±4	6±2
Red-winged Blackbird *(Angelaius phoeniceus)*	RWBL	N	Riparian	-	0	3±2	0	0	0	0	0	0	01±1
Rusty Blackbird *(Euphagus carolinus)*	RUBL	N	Riparian	D	0	0	0	0	0	0	1±1	0	0
Brown-headed Cowbird *(Molothrus ater)*	BHCO	N	Park	D	0	1±1	3±3	0	0	0	0	3±2	3±1
Northern Oriole *(Icterus galbula)*	NOOR	N	Park	D	0	0	0	0	0	0	0	0	1±1
Purple Finch *(Carpodacus purpureus)*	PUFI	N	Old	C	0	0	0	0	0	0	0	0	1±1
Downy Woodpecker *(Picoides pubescens)*	DOWO	Y	Allforest	D	0	3±2	3±3	0	0	0	0	0	1±1
Hairy Woodpecker *(Picoides villosus)*	HAWO	Y	Old/Burn	D	8±4	7±3	4±3	2±1	1±1	1±1	4±3	0	3±1
Three-toed Woodpecker *(Picoides tridacrylus)*	TTWO	Y	Old/Burn	C	7±4	0	0	0	0	1±1	0	0	1±1
Black-backed Woodpecker *(Picoides arcticus)*	BBWO	Y	Burn	C	22±6	0	0	0	0	0	0	0	0
Northern Flicker *(Colaptus auratus)*	NOFL	Y	Park	D	10±4	2±2	3±2	0	3±2	0	1±1	0	1±1
Pileated Woodpecker *(Dryocopus pileatus)*	PIWO	Y	Old	B	0	0	0	0	0	1±1	0	1±1	1±1
Olive-sided Flycatcher *(Contopus borealis)*	OSFL	N	Park	B	0	0	0	0	0	0	0	0	1±1
Western Wood-Pewee *(Contopus sordidulus)*	WWPE	N	Park	B	0	0	0	0	0	0	0	0	1±1
Yellow-bellied Flycatcher *(Empidonax flaviventris)*	YBFL	N	Young	C	0	0	0	0	0	0	0	0	1±1
Alder Flycatcher *(Empidonax alnorum)*	ALFL	N	Shrub	D	0	3±2	0	1±1	28±10	6±3	10±6	0	1±1
Least Flycatcher *(Empidonax minimus)*	LEFL	N	Open	D	0	22±14	39±14	6±6	3±3	1±1	8±5	5±5	20±6
Tree Swallow *(Tachycineta bicolor)*	TRSW	Y	Park	D	0	11±6	1±1	0	0	0	0	0	0
Gray Jay *(Perisoreus canadensis)*	GRJA	N	Old	C	5±3	1±1	1±1	11±6	1±1	2±2	4±3	4±3	4±1
Blue Jay *(Cyanocitta cristata)*	BLJA	N	Park	B	0	0	0	0	0	5±3	0	0	1±1
American Crow *(Corvus brachyhynchos)*	AMCR	N	Park	B	0	1±1	0	0	1±1	0	0	0	1±1
Common Raven *(Corvus corax)*	CORA	N	Old	B	0	0	0	0	0	1±1	0	1±1	3±1
Black-capped Chickadee *(Parus atricapillus)*	BCCH	Y	AllForest	D	7±3	10±4	3±2	9±4	0	16±6	2±2	10±5	5±1

a - Y = yes, N = no
b - Old = forest >120 years old, Young = forest 20 - 70 years old, All Forest = found in similar density is all forest types, Park = parkland habitats, Burn = found predominately in habitats that have recently burned, Shrub = shrubby habitats, Open = non tree and non-shrub habitats, Riparian = riparian (Godfrey 1986, Campbell et al. 1990, 1997. Semenchuck 1992. Gauthier and Aubry 1996)
c - D = deciduous forest, C = coniferous forest, species that live predominately outside the forests are indicated by - (Godfrey 1986, Campbell et al. 1990, 1997, Semenchuk 1992, Gauthier and Aubry 1996)

Questions

1. Explain why the Hairy Woodpecker densities are greater in post-fire stands rather than in post-harvest stands. At about what post-disturbance period does convergence occur?
2. Which species of bird is found at highest densities immediately after disturbance has occurred?
3. List some birds that are found in similar density throughout the different age periods. Does the type of disturbance have any effect?

Answers

Activity 1

1. Nitrogen is found in compound form as ammonium (NH_4) and nitrates (NO_3). In both stand types the amount decreased from year 1 to year 28. Fire affects the organic layer in soil more than the removal of trees does.
2. In Year 1 the carbon content was higher in harvest stands. In year 1 lower levels were found in the wildfire stands could be the result of carbon lost into the atmosphere due to burning. By year 28 the amount contained in the previously standing snags is being recycled into the soil increasing the soil content in the post-fire stands. The amounts in harvested stands increased because of recycling vegetation.

Activity 2

1. Herbaceous species richness includes shrubs and tree species < 0.5 m tall. Since soil is not greatly disturbed in harvested areas recolonization and suckering of deciduous trees is more rapid. Fires may result in some depletion of organic materials in soils thus reducing growth richness.
2. Tall understory requires a minimum height of 0.5 m. At Year 1 the amount at this height will be lower than in following years. In post-harvest stands the richness plateaus at 14 years because greater amounts begin exceeding the maximum height for vegetation classified as tall understory. Sixty year old stands are mature forest which has greater canopy and less understory.

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Activity 3

1. Woodpeckers require standing dead trees and the post-fire stands will have a higher amount of these. At about 30 years the density is similar in both types of stands.

2. In post-harvest stands the white-throated sparrow are most dense in the early stages of recolonization. They prefer the open and shrub types of habitat and these have greater richness in early stages after disruption.

3. Any of the species of bird listed in the “All Forest” habitat category. One example is the White-throated Sparrow. It is not affected by the type of disturbance. Other examples include the Black-capped Chickadee and the Dark-eyed Junco