

FOR 332 INTRO. LECTURE

DISTURBANCE

DEFINITION of:

1. GRIME (1977): “DESTRUCTION of ABOVE-GROUND BIOMASS”
2. PICKETT & WHITE (1985): “ .., DESTRUCTION OF ONE OR MORE INDIVIDUALS THAT CHANGES ENVIRON. AND RESOURCES ELICITING A RESPONSE BY VEGET.
3. TEXT: DISCRETE EVENT THAT DISRUPTS COMPOSITION, STRUCTURE OR FUNCTION

TYPES of DISTURBANCE:

- | | |
|--------------------------|-----------------------------------|
| 1. FIRE | 8. LANDSLIDES & AVALANCHES |
| 2. WIND | 9. MUDSLIDES |
| 3. HURRICANES, TORNADOES | 10. WAVE ACTION [COASTAL EROSION] |
| 4. ICE STORMS | 11. RIVERINE EROSION, DEPOSITION |
| 5. FLOODS | 12. VOLCANOES |
| 6. INSECTS | |
| 7. PATHOGENS | |

SIGNIFICANCE of DISTURBANCES

1. CHANGE COMPOSITION
2. “ STRUCTURE
3. INFLUENCE LONG TERM PROCESSES LIKE SUCCESSION
4. CAN ACT AS SELECTIVE FORCE
5. SOME TYPES CAN INCREASE or DECREASE THE LIKELIHOOD OF OTHERS [SHORT-TERM]

NEED to VIEW as “DISTURBANCE REGIME” to FULLY UNDERSTAND

- DR = SUM OF [FREQUENCY, INTENSITY, AREAL EXTENT, VARIATION, TIMING]
- ➔ FOR SOME SPECIFIED TIME PERIOD & FOR A COMM. OR LANDSCAPE
 - ➔ NOT FIXED INDEFINITELY – CLIMATIC CHANGE --> FIRE FREQ. (e.g.)
 - ➔ USUALLY VARIES AMONG REGIONS FOR A SPECIFIC COMM.:

FOR EXAMPLE, PONDEROSA PINE:

SW: 1/ 4 – 6 Yr. N. ROCKIES, DOUG-FIR ZONE: 1/ 13 – 16

PNW: 1/15 TO 25 YR.

FOR 332

LECTURE NOTES: GENETIC VARIATION & ADAPTATION

READING ASSGN. CHAP. 4 [excluding pages 69-82]

TERMINOLOGY from TEXT

1. COEVOLUTION [LATER]
2. HERITABILITY
3. PHENOTYPIC PLASTICITY
4. SELECTION – EVOLUTION – differential and non-random reproduction of genotypes

STARTING POINT: DEFINITION of POPULATION (last period); And {“BRIEF HISTORY of PLANT EVOLUTION TIME LINE – Gensel & Andrews, 1987} <-- NOT USED in 2000

- I. FIRST SIMPLE PLANTS: 2 BILLION YR AGO
- II. FIRST LAND PLANTS: ≥ 460 MM {Late Ordovician}
- III. FIRST VASCULAR PLANTS: ~ 425 MM
- IV. FIRST ARBORESCENT SEED PLANT: ~ 375 MM
- V. CONIFER-TYPE SEED PLANTS: 215 – 295 MM {Permian & Triassic Period}
- VI. MODERN FLOWERING PLANTS: 100-130 MM {mid-Cretaceous}
- VII. APPEARANCE most MODERN TREE GENERA: 5-60 MM {Tertiary}
- VIII. RAPID INCREASE NO. FLOWERING PLANTS – QUARTENARY (< 2 MM)

WHAT IS BASIC UNIT of EVOLUTIONARY BIOLOGY? AND WHY? [O/H of Achillea populations – common garden]

- ➔ Local, interbreeding Population, due to genetic variation among individuals; **MORE SPECIFICALLY VARIATION THAT TRANSLATES INTO DIFFERENCES IN REPRODUCTIVE SUCCESS == SELECTION**
- ➔ Evolution = cumulative change; in simplest form a change in gene frequencies, **THUS** is a function of the number of off-spring by genotype, and the success (seedlings established) of one genotype versus all others
- ➔ TYPES OF “SELECTIVE FORCES” THAT RESULT IN EVOLUTION:
 1. CLIMATE -- O/H of 2 White pine/red pine populations (N.H. & N.C.)
 2. DISTURBANCE – O/H of JACK PINE SEROTINY
 3. BIOTIC INTERACTIONS:
 - a. COMPETITION
 - b. HERBIVORY
 - c. SEED PREDATION etc.
 4. LOCAL SOIL CONDITIONS – Oxy. Level, sodium, heavy metals, limiting nutrient
- ➔ **ACCLIMATION & ADAPTEDNESS**
 $P = G + E + G \times E$

HOW DO INDIVIDUALS W/I A POP. (or SPECIES) VARY GENETICALLY?

1. Due to random assortment [recombination] at meiosis
2. Different sets of parents
3. Mutations (rare -- 1 per 10^6 - 10^7 ‘events’); chlorophyll deficiency occurs much more frequently – 1/100 to 1/10,000 {this is from Ricklefs text}
Mutations can be a) negative, b) neutral, c) positive; most are “b”
4. Polyploidy – historically quite important; apprx. 40% of current angiosperms
5. Gene flow – pollen transported up to 50-700 km; seeds – rarely up to 20 km

TRAITS THAT TEND to REDUCE VARIATION:

1. SELFING

2. POLYPLOIDY
3. LOW RATE of RECOMBINATION [what exactly does that mean?]
4. ASEXUAL REPRODUCTION

POLYPLOIDY

1. USUALLY ARISE BY HYBRIDAZATION FOLLOWED BY DOUBLING
2. SEEM ESPECIALLY SUCCESSFUL IN HARSH ENVIRON'S, & AS COLONIZERS
3. IS A UNIFORMITY-PRODUCING MECHANISM
 - A. ABSORB" MUTATIONS
 - B. SUPPRESS RECESSIVE PHENOTYPES
4. PREVALENCE: > 70% OF MONOCOTS, 80-90% OF GRASSES
5. AN EXAMPLE: BLACK BIRCH (2N), PAPER BIRCH (4N), YELLOW BIRCH (6N)

FITNESS-FLEXIBILITY COMPOMISE

APOMIXIS = ASEXUAL REPRODUCTION

- ➔ GENETIC VAR. PRODUCING TRAITS TEND to MAX. FLEXIBILITY WHICH SHOULD INCREASE CHANCES OF LONG-TERM SURVIVAL
- ➔ APOMIXIS [& OTHER VAR.-REDUCING TRAITS] TEND TO MAINTAIN THE CURRENT GENOTYPES WHICH HAVE A PROVEN 'FITNESS'

IMPORTANT REMINDERS:

1. WHAT WE SEE TODAY [by-n-large] IS PRODUCT OF PAST (i.e. VERY LONG AGO)
 2. NOT ALL TRAITS ARE ADAPTIVE
 3. DIFFERENT TRAITS UNDER DIFFERENT DEGREES OF GENETIC CONTROL
 4. MANY TRAITS ARE POLYGENIC
-

SECTIONS IN TEXT NOT EXPLICITLY COVERED: IV. GENETIC DIVERSITY OF WOODY SPECIES, AND V. GENECOLOGY

WHY DO LONG-LIVED WOODY SPECIES HAVE GREATER GENETIC DIVERSITY THAN HERBAC. PERENNIALS OR SHORT-LIVED WOODY SPCIES?

1. Large continuous pop's
 2. Longevity
 3. Large size
 4. Outcrossing
 5. Long distance pollen & seed transport
-

APPLICATION of THIS INFORMATION:

1. For many temperate and boreal zone trees, 75-90% of total species variation is found within each population. How might we use that information?
2. Why do horticulturalists use grafts?
3. What is more relevant to conserving the genetic diversity of a species – total population size or number of mature adults?
4. Follow-up to #3: how could two populations of same size have 2 very different levels of variation? A) # of parents, B) mutation rate, C) gene flow

FOR 332 FUNCTIONAL ROLE

COARSE WOODY DEBRIS

PART of COMMUNITY STRUCTURE

TWO BASIC PARTS to COMMUNITY STRUCTURE:

1. HORIZONTAL → coarse woody debris (CWD) on, or near, forest floor
2. VERTICAL → snags

Contribute to **heterogeneity**, thus increase diversity for many taxonomic groups
e.g., invertebrates, amphibians, secondary cavity nesters

FUNCTIONAL ROLES of COARSE WOODY DEBRIS

- 1) regeneration site for some plants – i.e., some regenerate more successfully on top of partially-to-well decayed tree trunks than on forest floor or mineral soil
- 2) under and right next to larger pieces → shaded, cooler, moist environment
→ amphibians, some inverts
- 3) hiding cover – small mammals
- 4) travel corridors -- mammals
- 5) contain modest amount of nutrients that are mineralized over long periods of time
- 6) primary [maybe sole] ‘substrate’, or habitat, for some fungi

COMPARATIVE COMM. RESPONSE to DISTURBANCE

OCT., 1999

PREVIOUS TOPIC(S): SUCCESSION & DISTURBANCE

WILL TAKE A "SUBSET" OF THAT TOPIC AND DIG IN A LITTLE DEEPER --> 2 QUESTIONS?

1. WHY ARE DIFFERENT COMM'S IMPACTED TO DIFF. DEGREES BY SAME DISTURBANCE?
2. HOW DOES THE INITIAL, POST-DISTURB. ASSEMBLAGE COMPARE TO PREVIOUS?

THESE QUESTIONS ARE CLOSELY RELATED TO THE IDEA OF "STABILITY" BUT, IN REALITY THIS IS NOT A SINGLE CONCEPT

WHAT DO WE KNOW THAT'S IMPORTANT?

- I. DISTURBANCE CHARACTERISTICS – TYPE, SIZE, INTENSITY, TIMING ?
- II. MODES of COLONIZATION
- III. RANDOM EFFECTS – WEATHER, ANIMAL MOVEMENT, HISTORICAL EFFECTS.

STABILITY of a COMM. CAN BE GAUGED BY:

- I. ITS ABILITY TO WITHSTAND THE DISTURBANCE --> **RESISTANCE** or **INERTIA**
- II. RATE at which the pre-disturbance community (apprx.) re-established --> **RESILIENCE**
- III. HOW FAR FROM THE PRE-DISTURBANCE STATE the COMM. CAN BE MOVED by the DISTURBANCE AND STILL "BOUNCE BACK" --> **AMPLITUDE**

NUMBER 'III' VERY DIFFICULT TO DETERMINE, TAKES LONG-TERM RECORDS or MODELLING; SO WE WILL FOCUS ON RESISTANCE and RESILIENCE

EXMAPLE to ILLUSTRATE: HIGH INTENSITY FIRE, LAKE STATES

ASPEN HAS LOW RESISTANCE BUT HIGH RESILIENCE

WHITE & RED PINE HAS HIGH RESISITANCE AND MODERATE RESILIENCE

NOTE THAT A COMM. MIGHT HAVE HIGH RESISTANCE TO ONE TYPE OF DISTURB. BUT LOW TO ANOTHER – A SPECIES (or GROUP of SPP.) COULD BE VERY WIND-FIRM BUT READILY KILLED BY FIRE

GIVEN WHAT YOU NOW KNOW, IS IT VALID TO SAY THAT TROPICAL WET FORESTS ARE "VERY STABLE" [to all types]?

CAN A COMM. (SYSTEM) BE TOTALLY DIS-PLACED, i.e., NEVER RECOVER?

PROBABLY SO, BUT RARE. ARE SOME EXAMPLES of ESSENTIALLY NO RECOVERY FOR NUMEROUS DECADES:

1. HIGH ELEV. SPR.-FIR, APPLACHIANS AFTER CUTTING & FIRE
2. SHRUB-GRASSLAND COMM. of WEST – HEAVY GRAZING

SPP. TRAITS COMMONLY INVOLVED: size, bark thickness, rooting system, crown shape/depth + leaf phenology, asexual capacity, seed type

COMM. ATTRIBUTES: 1) redundancy, 2) richness, 3) physiognomy

FOR 332 – WITHIN COMM. DIVERSITY

READINGS: pg. 579-89; 609-10

I. DIVERSITY – WHAT IS IT & WHY IMPORTANT.?

REMINDER: DIV. = R + E @ COMMUNITY LEVEL [=ALPHA DIV.]

TWO MOST COMMON INDICES:

1. SHANNON-WEAVER INDEX $[H] = -\sum[P_i * \log P_i]$
IF EXPRESSED AS e^H THEN CAN COMPARE TO 'D'
IF NATURAL LOGARITHM USED
GIVES MORE WEIGHT TO RARE SPP.
2. SIMPSON'S $[D] = 1/[\sum(P_i^2)]$ {MAX. VALUE = # SPECIES}
IS A "DOMINANCE" INDEX

ALSO MEASURED @ OTHER SCALES:

- A. BETWEEN COMM. = BETA
- B. LANDSCAPE = GAMMA --> MOST DIFFICULT to ASSESS
- C. POINT DIVERSITY (in text, scale is 100-500 m²)

WHY IMPORTANT? [LET'S THINK ECOLOGICAL TERMS ONLY]

- A. SOME SPP. ARE SPECIALISTS (reminder: obligate mutualisms)
- B. GREATER DIV. MAY BUFFER STRESS, INCREASE 'STABILITY'
- C. GREATER DIV. [~ MAX] SHOULD MAXIMIZE UNKNOWN FUNCTIONS, "ECOSYSTEM SERVICES"

II. DIVERSITY – WHAT DETERMINES IT?

A. ABIOTIC

LOCAL ENVIRON – WEATHER: TEMP, RAINFALL, SNOWFALL,
SOIL – TYPE, DEPTH, etc
TOPOGRAPHIC POSITION
CHANCE EVENTS – e.g. LARGE FLOODS, VERY LATE FROST, etc
INVASION by EXOTICS → FLORA MAY INCLUDE A REL. LARGE # OF NON- FOR 22
MIDWESTERN NAT'L PARKS, AVG. IS ~ 27% (Bennett '96)

B. BIOTIC

EVOLUTION & EXTINCTION
REGIONAL POOL of SPECIES
INTERACTIONS: PREDATION, HERBIVORY, POLLINATION →
EFFECT CAN BE POSITIVE or NEG. e.g. monarch on butterfly weed
COMM- COMPOSITION & STRUCTURE

C. COMBINED CATEGORY

DISTURBANCE HISTORY – e.g., time since last fire
LAND USE HISTORY – EVER FARMED?

NOTE: THE **VARIATION** IN THESE FORCES MAY BE JUST AS IMPORTANT AS THE AVERAGES

III. DIVERSITY in TEMPERATE FORESTS

A. GENERAL PATTERNS & PRINCIPLES

1. HAVE SIGNIFICANT CHANGES W/ AGE IN ALL GROUPS STUDIED, PATTERN MAY VARY AMONG SITES → "DIVERSITY" IS NOT A CONSTANT

2. USUALLY ASSESS WITHIN EACH TAXONOMIC GROUP, i.e. NOT MUCH REVEALED BY LUMPING PLANTS AND BIRDS, OR MAMMALS + REPTILES
3. INVERTEBRATES DOMINATE NUMERICALLY; ~20 M IN WISC. [20-30% OF TOTAL FOR N. AMER.], AS OPPOSED TO APPRX. 2 M VASC. PLANTS [NATIVE]; [O/H] 250 LEAF-CHEWING INSECTS FOUND ON WH. OAK
4. BELOW-GROUND COMPONENT VERY POORLY KNOWN
5. CONVERSELY, PLANTS & VERTEBRATES (ESP. MAM, BIRDS) WELL DOCUMENTED
6. DIVERSITY INCREASES WITH SIZE OF FOREST **BUT** WEAK TREND; i.e. MANY OTHER FACTORS IMPORTANT [O/H from POLAND]
7. HETEROGENEITY W/I COMM.
8. DEGREE OF ISOLATION – a) woodlot richness in Poland; b) tree richness on islands created by filling of reservoir (Kadmon 95)
9. QUANTITATIVE DETERMINATION OF R, H' WILL UNDERESTIMATE BY 40-60%
10. FAVORABLE, MILD CLIMATE LEADS TO >> DIVERSITY [O/H, Fig.3]
11. COMPLETE ASSESSMENT OF "DIVERSITY" MUST BE DONE AT >= 3 SPATIAL SCALES – a) within each comm., b) betw. Comm's, c) across the landscape

RICHNESS OF POWER'S BLUFF = 135+ SPP. WHY SO MUCH GREATER?

1. GREATER SAMPLING INTENSITY
2. COMM. IS IN TENSION ZONE
3. INTERNAL HETEROGENEITY – ASPECT, ROCK OUTCROP, MOIST.

DETERMINANTS for BIRDS

→ "FOLIAGE HT. DIVERSITY" [~VERTICAL STRUCTURE] CORRELATES WITH 'H' IN MANY FORESTS (OVERHEAD Dickson et al., Fig. 1 pine plantation). MacArthur (61) credited with formally proving this relationship (Hunter, 90). Concept not usually applied to other taxa

BASIS OF: NICHE SEPARATION

HAS BEEN FOUND TO APPLY IN LIZARDS, MONKEYS, MICE
e.g., white-footed mouse lives below deer mouse (in VA, Hunter 90)

HOWEVER, OTHER FEATURES OBVIOUSLY IMP.--> (Fig. 2 from Dickson et al)
SITES FOR CAVITY NESTERS; ROOSTING SITES; FOOD BASE;
MATING/COURTSHIP HABITAT; ESCAPE SITES; PERCH SITES; COMPOSITION
(NOT COMMON e.g., PINES - RCW); THERMAL COVER
NESTING (A LAYER OR TREE SIZE, etc.); SIZE OF HABITAT

SNAGS: 31 SPP. OBSERVED ON ISOLATED OR CLUMPS LEFT IN ASPEN CLEARCUTS, CHEQUAMEGON N.F (RYAN, 95)

'SIMPLE STRUCTURE' EFFECT → (PROBST ET AL. 92, FEM 49:43-60).

	DENSITY OF MALES	RICHNESS
4-5 YR OLD STANDS	178	32
MATURE ASPEN	166	37

CONCL: BOTH REPRESENT A SINGLE STRATUM COMMUNITY

STRUCTURE' EFFECT → PRODUCTIVITY (Hunter, 90):

Mixed conifer forest, Arizona; tree richness and relative FHD similar

	Intact Forest	84% of BA Removed
Avian H'	2.72	3.16
Foliage Vol.	15	114
Density	628	750

ANOTHER EXAMPLE: ROLE OF COVER? IN A LOUISIANA BOTTOMLAND FOREST, 31% OF ALL BIRDS SIGHTED WERE IN GROUND STRATUM (< .6 m) [Hunter, M. 90]

AVIAN DIVERSITY in CONIFER PLANTATIONS, S. WISC. (Bielefeldt & Rosendfield 94)
32-55 yr old MOSTLY RED & WH. PINE, LITTLE SPRUCE (n= 13)
One year of point counts, plus 12 years of supplemental visits
TOTALS for ALL:
PT. COUNTS – 37 SPP.
OTHER VISITS – ADDITIONAL 22 SPP.
4 MOST COMMON: chipping sparrow, ovenbird, indigo bunting, towhee
30 of these – REGIONALLY UNCOMMON-to-RARE

SUCCESSION NOTES

WHY IS SUCCESSION IMPORTANT TO RESOURCE MNGT. ?

1. NATURAL & WILDERNESS AREAS
2. OFTEN WANT TO MAINTAIN A PARTICULAR STAGE – FOR. MNGT. & WILDLIFE MNGT.
3. SEPARATING NATURAL from HUMAN-INDUCED, UNINTENDED CHANGE

TRANSITION from COMMUNITY ATTRIBUTES/DIVERSITY UNIT : OLIVER'S STAND DEVELOPMENT MODEL (FIG., O/H) {NOTE!! This is not really a full-fledged successional model or theory }

HISTORICAL DEVELOPMENT of SUCCESSION:

I. CLEMENTS vs. GLEASON, EARLY 1900'S

<u>CLEMENTS</u>	<u>GLEASON</u>
PREDICTABLE	LESS
UNIDIRECTIONAL	NOT NEC'LY
STABLE ENDPT.	NOT STABLE LONG PERIODS
COMPOSITIONAL SIMIL.	VARIATION in COMPOSIT. by STAGE
CLIMATICALLY DRIVEN- LARGE SCALE	WEATHER & AUTECOLOGY
BIOTICALLY DRIVEN – SMALL SCALE	

CLEMENT'S BIOTIC MECHANISMS:

NUDATION (OUTCOME of DISTURBANCE
MIGRATION
ECESIS = ESTABLISHMENT of PIONEERS
COMPETITION
REACTION = INFLUENCE of PLANTS on SITE CONDITIONS
STABILIZATION in CLIMAX

- II. INITIAL FLORISTIC MODEL (EGLER, 1950's) = ALL SPP. PRESENT IN FIRST FEW YEARS; CHANGES OCCUR DUE TO LONGEVITY & COMPETITION (or more generally life history)
- III. POLYCLIMAX VIEW (LATE 1930's [Tansley], 1950's [Whittaker]) == MORE THAN 1 CLIMAX W/I A REGION; MAJOR CLIMATIC CHANGES, PHYSIOGRAPHIC DIFFERENCES LEAD TO DIFF. COMPOSIT.
- IV. CYCLIC SUCCESSION [O/H] – 1970's
- V. ALTERNATE MECHANISMS, PREVALENCE of DISTURBANCE 1970's

MODERN VIEW of SUCCESSION

MECHANISMS (def'n per text: an interaction or process that contributes to successional change)

Background: Clements claimed that reaction and competition dominated (see Fig. 17.2). We have come to learn that it is much more variable and complex than that, AND that Gleason was right in that there is an element of chance or randomness (weather, absence of an obligate mutualist). Since `1970's, attention has shifted away from the endpoint of succession and the mechanisms and variation found within one system or region.

→ MUCH LARGER GROUP of POTENTIAL MECHANISMS

- Facilitation – as per Clements [C&S 1977]. Example: nitrogen fixing species after fire; nurse plant (see Fig. 17.6)
- Inhibition – the original mix actively excludes further invasion (competition, allelopathy) until some action (wind, insect, etc) eliminates one or more
- Resource-Ratio Hypothesis (Tilman 1985) [Not very clear or thorough in his explanation]. Basis for his hypothesis: relative availability of resources changes over time (w/i a sere)

above-ground vs. below ground resources. The mechanism for the plant is the trade-off it has to make – above-ground vs. below ground, it can't be good at gathering both or very different ratios --> adapted to one range

- Herbivory
- Mortality caused by pathogen/insect [possible – seed predation]
- Disturbance(s)
- Weather – mortality, seed dispersal

IMPORTANT COMPONENTS of MODERN VIEW:

1. MULTIPLE PATHWAYS
2. MULTI-DIRECTIONAL
3. MAY BE ARRESTED
4. SEVERAL MECHANISMS IMP. W/I A SERE
5. MOST IMPORTANT MECHANISM USUALLY CHANGES
6. UNCOMMON TO HAVE A LONG-TERM STABLE, LATE SUCCESSIONAL STAGE
7. DISTURBANCE REGIME IS AN INTEGRAL PART & USUALLY DETERMINES PATHWAY(S)
8. SOME DEGREE of UN-PREDICTABILITY
9. SOME INFLUENCES [can be mechanisms] OPERATE AT A SPATIAL SCALE LARGER THAN A COMMUNITY [weather, herbivory, seed predation/input, disturbance]

More recent thoughts (Barnes et al. 1998)

1. **Biological legacies** a) organic debris, b) biologically derived soil patterns
2. **Higher Order Interactions**

FOR 332 ECOSYSTEM UNIT

INPUTS & OUTPUTS

INPUTS (ADDITIONS) [pages in text: 526-33]

VIA 3 CATEGORIES of PROCESSES

1. GEOLOGIC (= WEATHERING)
2. HYDROLOGICAL (~ ATMOSPHERIC)
3. BIOLOGICAL

GENERALLY, THEY PROVIDE ONLY 5-30% OF ANNUAL REQUIREMENT [NOTE EXECPTIONS BELOW]

NONETHELESS, A SMALL AMOUNT OVER 100 yr OR LONGER (ATMOS., WEATHERING) CAN BUILD UP THE NUTRIENT CAPITAL

SOURCES (ORIGINATING FROM)

1. ATMOSPHERIC

- 3 “TYPES” [numbers 1 & 3 occur essentially everywhere]
 - i. WET – i.e., RAIN, SNOW (Fig. 19.2)
 - ii. CLOUD – CLOUDS & FOG; --> imp. only in coastal, & high elev.
 - iii. DRY – PARTICULATE, AEROSOLS
DRY IS MORE VARIABLE, SPATIALLY, THAN WET – POINT SOURCE EFFECT, SETTLES OUT [SEE FIG. 19.3]
- IMPORTANCE = SUPPLIES, **IN SOME AREAS**, A SIGNIFICANT AMOUNT, RELATIVE TO NEEDS of PLANTS FOR NITROGEN & SULFUR
- DISTINCTION BTW. ‘WET’ & ‘DRY’ USUALLY NOT IMPORT. To ECOSYS. FUNC.

2. WEATHERING

- OCCURS VERY SLOWLY – DRIVEN BY CLIMATE [TEMP., PRECIP], BIOL. ACTIVITY
- TYPE of PARENT MATERIAL IS KEY (SEE TB. 19.1)
MINERALS DIFFER IN THEIR SOLUBILITY
- SOME PAR. MAT. HIGHER THAN AVG. IN MACRO-NUTR.
- THE OLDER THE PAR. MAT., THE LOWER THE INPUT RATE [GENERALLY]
- IN NEW HAMP., WEATHERING of GLACIAL TILL PROVIDES 85% of ANNUAL INPUT FOR: CALCIUM, POTASSIUM, MAGNESIUM (see Tb. 19.1 for amounts)

3. FIXATION

- = BIOLOGICALLY DRIVEN PATHWAY FOR ‘N’ TO ENTER SYSTEM; due to symbiotic relationship
- TWO MAJOR GROUPS OF ORGANISMS INVOLVED:
 1. BACTERIA (Rhizobium) ASSOC'D WITH LEGUMES – at least 16,000 sp.
 2. ACTINOMYCETE (FRANKIA) ASSOC'D WITH WIDE VARIETY of OTHER SPECIES
SUCH AS ALDER, Ceanothus (mostly out West), Comptonia, Eleagnus etc.
- INPUT AMOUNTS RANGE FROM 10-300 for FORESTS [PERRY '95]
- CAN LEAD to VERY LARGE DIFFERENCES in “NITROGEN CAPITAL” (Tb. 19.2)

LOSSES [OUTPUTS] – UNDISTURBED CONDITIONS (pages 562-65)

POSSIBLE PATHWAYS

1. LEACHING
2. TO ATMOSPHERE – DENITRIFICATION

LEACHING

- DISTINGUISH BETW: LIMITING, ESSENTIAL & NON-LIMITING, AND NON-ESSENTIAL NUTRIENTS (see Tb. 19.8)
- PROCESS IS DOWNWARD MOVEMENT OF WATER, THUS:
 1. AMOUNT of PRECIP.
 2. RATES of TRANSPIRATION & EVAPORATION
 3. SOIL TEXTURE
 4. UPTAKE RATE
 5. AMOUNG in SOIL SOLUTION

RATES for NITR. & PHOS. USUALLY VERY LOW (TABLE 17-2 from PERRY '95)

LEACHING RATE CAN EXCEED INPUT RATE: Ca, K, Si for a N. HWD. ECOSYSTEM IN NEW HAMPSHIRE (Tb. 19.8)

DENITRIFICATION

- BIOLOGICAL PROCESS: NO_3 is CONVERTED TO N_2O or N_2 WHICH DISPERSES into ATMOS.
- USUALLY SMALL AMOUNTS LOST IN UPLAND FORESTS
- KEY ENVIRONMENATL CONDITION = O_2 LEVEL in SOIL

EXOTIC PLANT INVASION of NAT'L PARKS/NAT'L AREAS

WHY ARE WE CONCERED?

1. 27% (95 spp.) of the TAXA in 22 MIDWEST PARKS WERE NON-NATIVE
 2. ARE 235 "INVASIVE" WOODY SPP. In U.S.: ONLY 3% ARE NATIVE
 3. VAST MAJORITY ARE FROM EURASIA – WHY? → a) similar climate, b) population movement, c) many of same genera
 4. WHAT IMPACT CAN THEY HAVE?
 - a. ALTER STRUCTURE
 - b. REPLACE a SPP. And CAUSE LOCAL EXTINCTION → R, H'
 - c. FORM SINGLE-SPECIES STANDS
 - d. ALTER NUTRIENT AVAIL. [EX: black locust in Indiana Dunes – Peloquin and Hiebert 99]
 - e. CHANGE TRAJECTORY of SUCCESSION
- E2. CHANGE DISTURBANCE REGIME

DISCUSSION of WESTMAN, W. 1990. Park management of exotic plant species: problems and issues. *Conserv. Biol.* 4(3): 251-60

INTRODUCTION & BACKGROUND

CONTROL/MNGT of EXOTICS is POLICY MATTER & INVOLVES MANY DECISIONS and MAKING HARD CHOICES [OFT.] – CAN'T CONTROL ALL, SO WHAT DO YOU DO?

THE **LEOPOLD REPORT (1963)** SET THE TARGET for PARK SERVICE AS THE "CONDITION(S) AT TIME of EUROPEAN SETTLEMENT"

BIOLOGICAL ISSUES RE: CONTROL of EXOTICS:

1. HOW SHOULD WE DEFINE EXOTIC?
 - A. NOT PREVIOUSLY IN THAT LOCALE?
 - B. NOT KNOWN TO PARK/STATE?
 - C. FROM ANOTHER COUNTRY?

[WESTMAN (90) suggests: 'present long enough so that mutual co-existence and dispersal over a significant duration is demonstrated']
2. "... CONTINUALLY VARYING NATURE OF PLANT ASSEMBLAGES"
 - A. THINK ABOUT – REGIONAL POOL, NATURAL FLUCTUATIONS, ECOLOGICAL AMPLITUDE of SPECIES
 - B. IMPLICATIONS of this FACT ARE:??
 - i. Don't assume a new species is an "invader"
 - ii. Don't assume that the loss of a native is evidence of exotic impact
3. WHAT ECOLOGICAL INFLUENCE SHOULD WE USE TO DECIDE THAT AN ALIEN SPECIES MERITS ATTENTION?
 - i. Presence but no impact
 - ii. Small decrease in Rel. Abundance of 1 native; no functional impact
 - iii. Large decr. In RA of 1-2 spp. + some functional impact
 - iv. ALTERS COMPOSITION by displacing 1 native
 - v. Alters composition and structure OR
 - vi. Alters composition and function
 - vii. Alters function only but not structure
4. SHOULD THE PROCESS of ACCOMODATION BTW. An INVADER and a NATIVE BE VIEWED AS NATURAL? [relates to #3]
5. HOW SHOULD BE VIEW THE 'INVASION' IF IT PROVIDES CRITICAL HABITAT or SUBSTRATE?
6. DISTURBANCE IS COMMON AND OFTEN FREQUENT

7. RELATIONSHIP BETW. RICHNESS AND RESISTENCE TO INVASION **IS NOT IRON-CLAD**;
BASIS FOR THIS HYPOTHESIS IS COMPETITIVE EXCLUSION
8. PRESENCE OF A NATIVE IN SPECIFIC LOCALE DOES **NOT MEAN** THAT IT IS “WELL
ADAPTED” TO THOSE CONDITIONS (text, pg. 439)
9. ISLAND COMMUNITIES ARE MORE SUSCEPTIBLE

10. NOT ALL INVADERS ARE SUCCESSFUL – WHY? (not explained by Westman)
 - A. NOT ABLE TO COMPETITIVELY DIS-PLACE NATIVE(S)
 - B. ATTACKED BY INSECT or PATHOGEN to WHICH IT IS NOT ‘ADAPTED’
 - C. LACKING AN OBLIGATE MUTUALIST
 - D. CAN’T REPRODUCE WELL DUE TO SMALL NUMBERS
 - D2. GENETIC BOTTLENECK

2. SUCCESS of DIFF. INVADERS DUE, **IN PART**, TO THEIR LIFE HISTORY TRAITS; e.g.,
 - a. Time to reproduction (short)
 - b. Generalist pollination system
 - c. Large # of seeds
 - d. Widely dispersed
 - e. Rapid growth rate

Introduction to Landscape Ecology – FOR 332

Three Primary Characteristics of the Landscape:

1) Structure = spatial relationships of elements

Patches -- area, shape and size

biotic features – e.g, a) ht. of vegetation,

b) broad community type (forest, grassland, agric.)

Corridors =~ linear patch BUT they connect 2+ patches

Riparian zone & fence row

Matrix = the “background” or template in which patches, corridors are imbedded

2) Function

- Nutrient, carbon and water movement between Landscape Elements

- Animal and Plant Movements Across the Landscape

3) Dynamics:

A. Change in patch condition – e.g., age class or successional change

B. Conversion from one type to another : Grassland → forest; Forest → agric.

C. Increase/decrease in a spatial feature – e.g., width of corridor

ECOSYSTEM UNIT – Notes for IntraSys. Cycle

TRANSFERS

1. ABOVE-GR. LITTERFALL
Amount in Forests = ~ to 3 – 5 M lb/ac, leaves = 60-75%; correlates with ANPP (O/H)
Apprx. 45% is Carbon
Contains ‘signif.’ Quantities of all macro-nutrients
Nutrient conc. (N, P, etc) as: Leaves >> twigs, bark >> large branches > bole
Evergreens [needle-type] have greater LA & foliar standing crop (FSC) which partially offsets the retention of some needles annually
Nutrient conc. Generally higher in leaves of angiosperms than in conifer [P, Mn can be exceptions; O/H]
2. BELOW-GR. LITTERFALL
** Know much less about this than about ABOVE-GR.
** Table 19.3: fine root litter = 40 – 330% of leaf litter, typical value is ~ 100 – 120%
** N & P conc. Of fine roots oft. Equals or exceeds level in leaves
Fine root component: 2-to-several “cohorts” per yr.
 - 2) relatively high quality organic matter (nutrient conc., lignin)
 - 3) turnover rate usually varies with litter N-conc. → lower N in leaves corresponds to a slower turnover rate [i.e., plant tries to conserve limiting resource]
3. DECOMPOSITION
OM Quality = f(nutr. Conc., C/N ratio, % lignin & other complex tissues) – O/H
Rate is depend. On a) quality, b) temp., c) moisture – O/H
➤ 90% of Macro-nutrients in fine litter will eventually cycle
4. UPTAKE – f(amount of vegetation, composition, amount of translocation, & temp) → see Figure 19.4 [boreal]
** is an active, energy-demanding process
** root exudates influence avail. In rhizosphere
** Form of nutrient (ammonium vs. nitrate) plays a role
5. IMMOBILIZATION - DECOMPOSERS COMPETE with PLANTS
6. RETRANSLOCATION - moderately high for N, modest for P, none for Ca, little to modest level for K
 - Perry (1995) says 10-90% of annual need for N, P, K can be met
 - Perry (95) says translocated nutrients stored in older leaves (evergreens) and wood (angios); Barnes et al. say ‘adjacent branches, bole & large structural roots’ (p. 544)
 - *** Barnes et al rely way to much on tropical patterns/examples in text, but the “N-Use Efficiency Figure (19.9a) is useful for temperate/boreal
 - For temperate species, range of ‘retranslocation efficiency’ [phrase from text] is:
 - A. Apprx. 20-90% for N
 - B. Approx. 10- 70% for P