Lecture 10, 01 Oct 2003

Chapter 4, 5 (Return Exam 1)

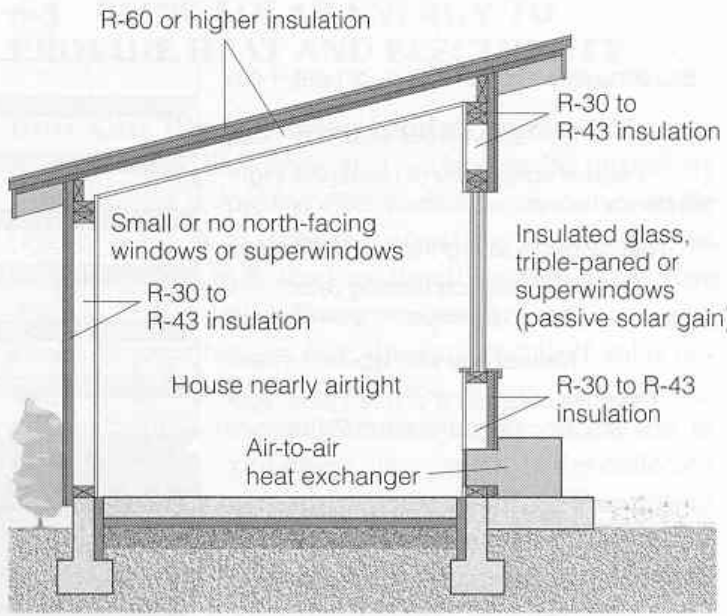
Conservation Biology
ECOL 406R/506R
University of Arizona
Fall 2003

Kevin Bonine

1. Biodiversity, Scale (Ch4)
2. Important Paradigms (Ch5)
3. Exams

Cheetah Talk Friday
Brazilian Ecosystems Course (Curitiba)
Guest Speakers Next Week
Readings

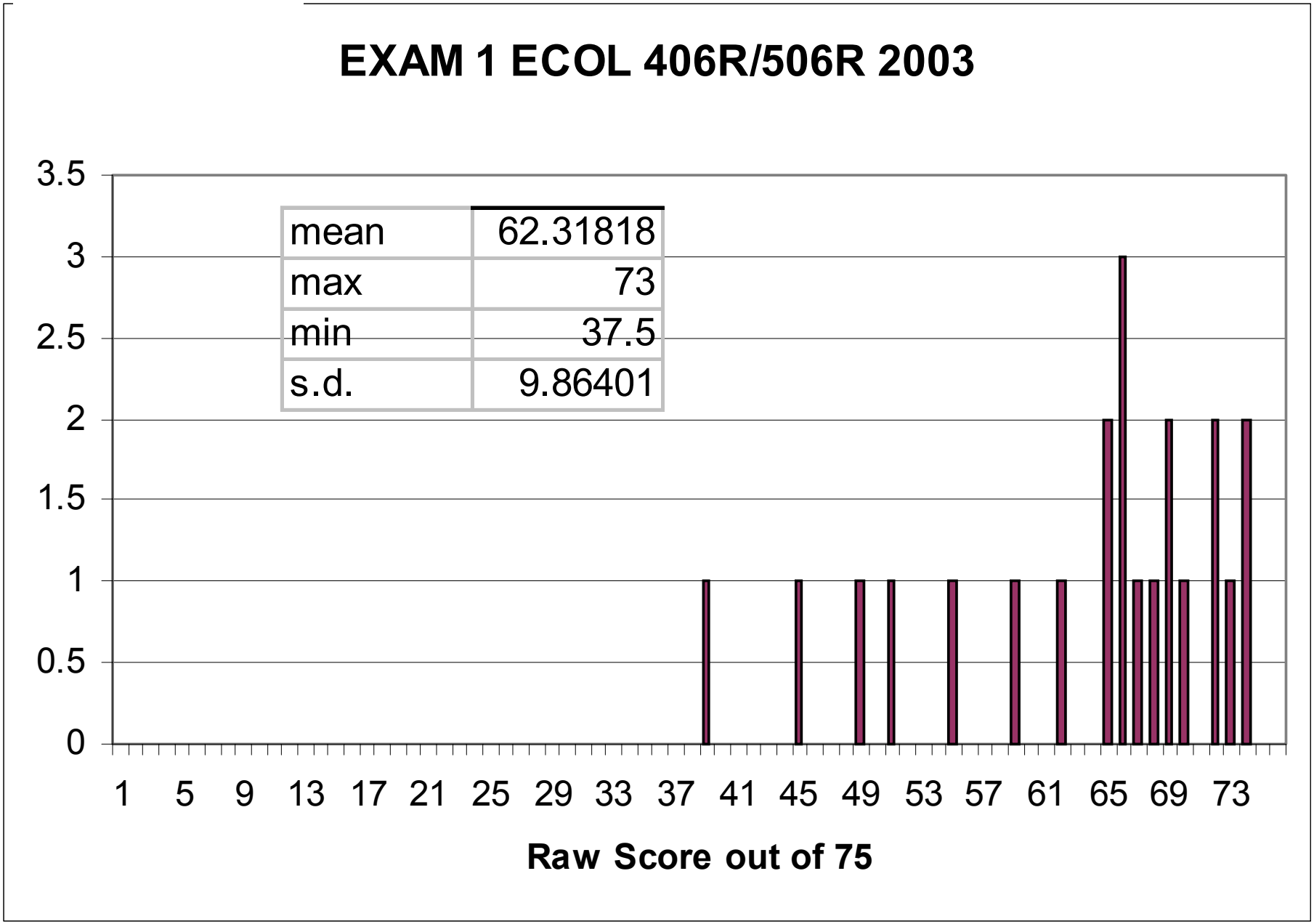
Seminar Noon Today (BSE)



Miller, 2003

Figure 6-9 Major features of a *superinsulated house*. Such a house is so heavily insulated and so airtight that it can be warmed by heat from direct sunlight, appliances, and human bodies, with little or no need for a backup heating system. An air-to-air heat exchanger prevents buildup of indoor air pollution.

Exam Scores


EXAM 1 ECOL 406R/506R 2003
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min 37.5
s.d. 9.86401
3.5
3
2.5
2
1.5
1
0.5
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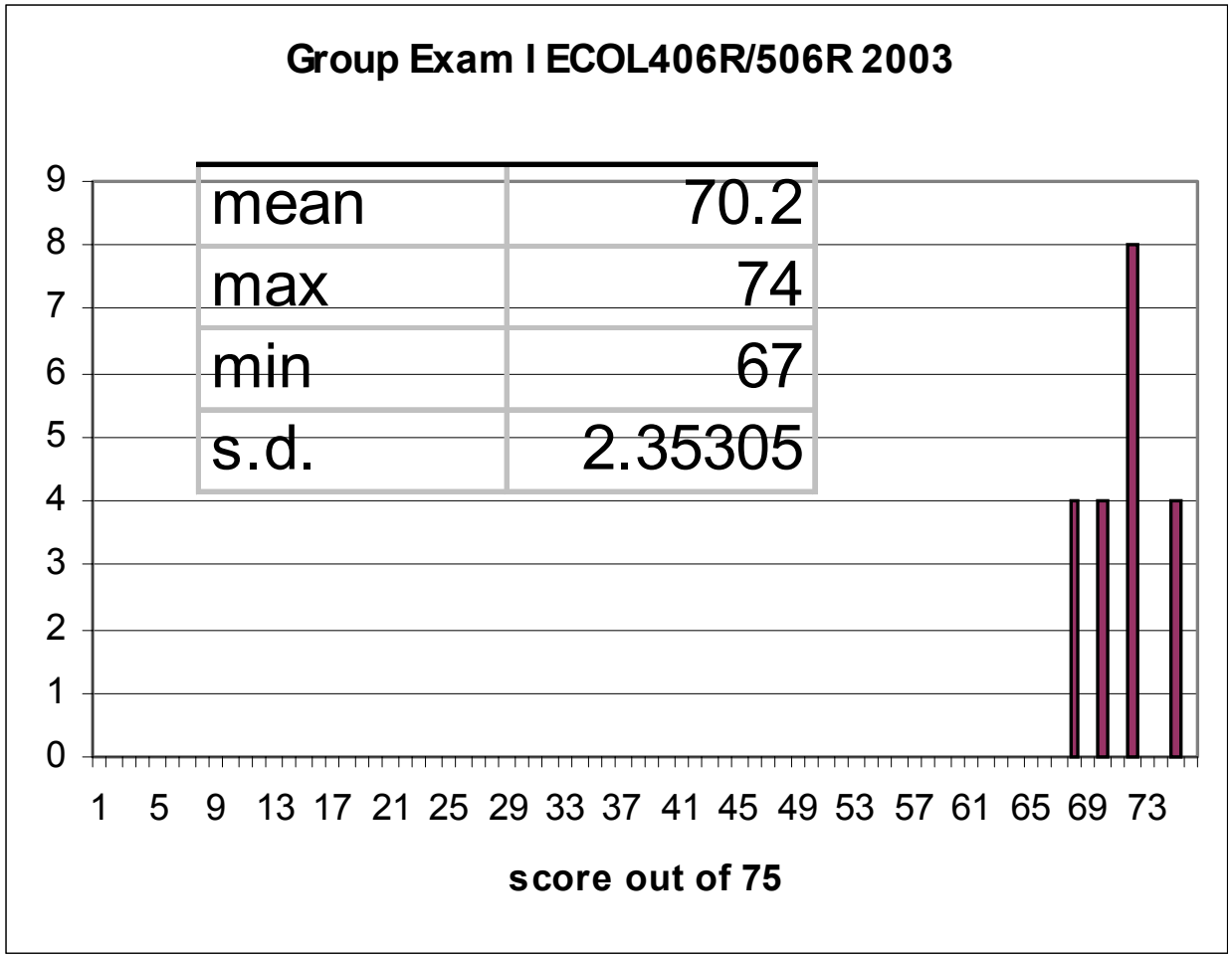
1 5 9 13 17 21 25 29 33 37 41 45 49 53 57 61 65 69 73
Raw Score out of 75

Exam Scores


Group Exam I ECOL406R/506R 2003
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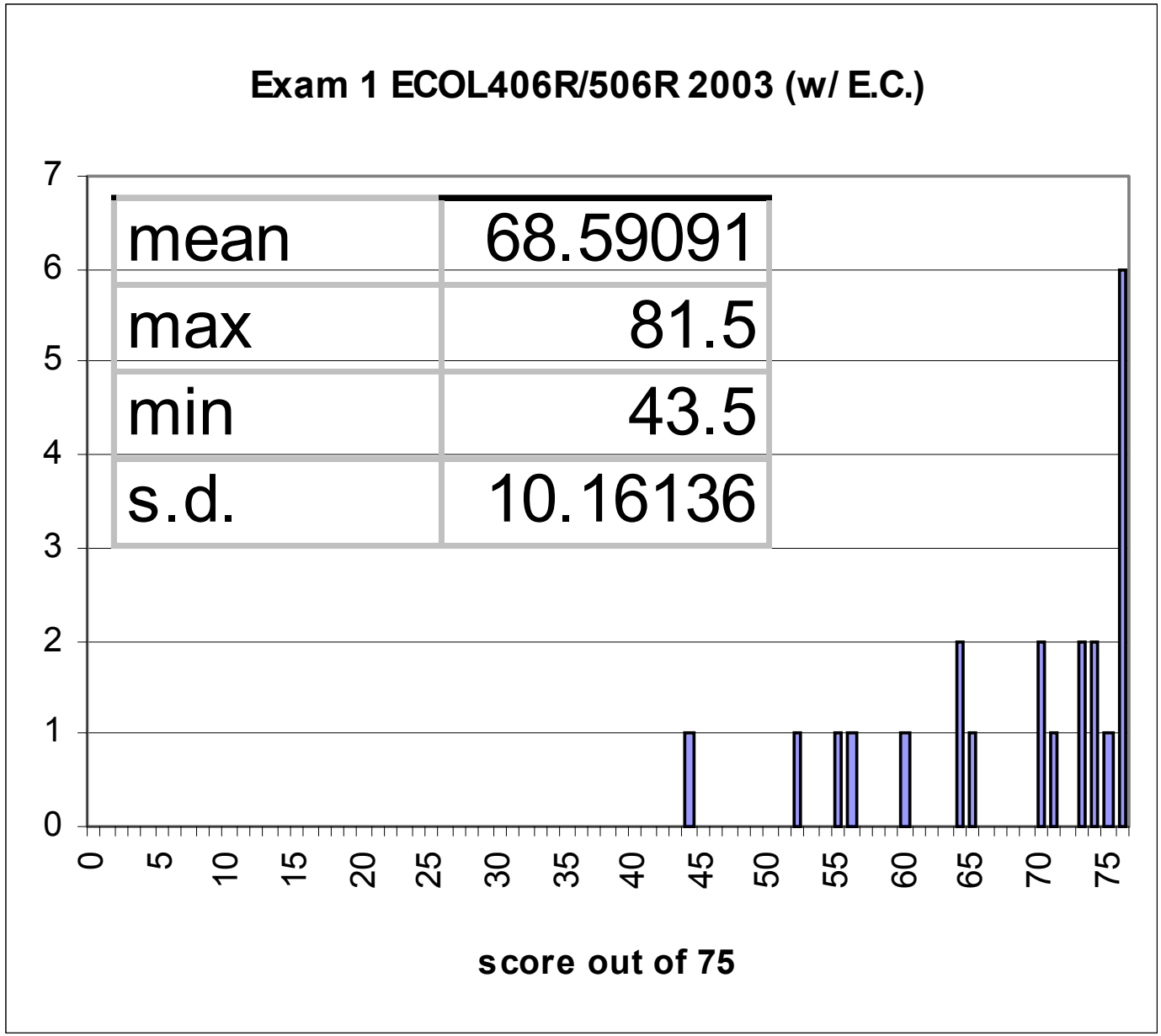
1 5 9 13 17 21 25 29 33 37 41 45 49 53 57 61 65 69 73
score out of 75

Exam Scores


Exam 1 ECOL406R/506R 2003 (w/ E.C.)
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min 43.5
s.d. 10.16136
0
1
2
3
4
5
6
7
0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75
score out of 75

Felis concolor

80-200 lbs. (m>f)
mts, forests, swamps
~nocturnal

top predator
ambush
deer etc.

may move 100 mi.

18 yrs?

avg 2 cubs

Mountain lions squeezed

AZ Daily Star
15 Feb 2003

Saguaro National Park

There's at least one: *An infrared camera caught this mountain lion on the prowl in Saguaro National Park, in mountains west of downtown Tucson.*

Scientists fear they're losing habitat in Tucson Mountains

By Mitch Tobin
ARIZONA DAILY STAR

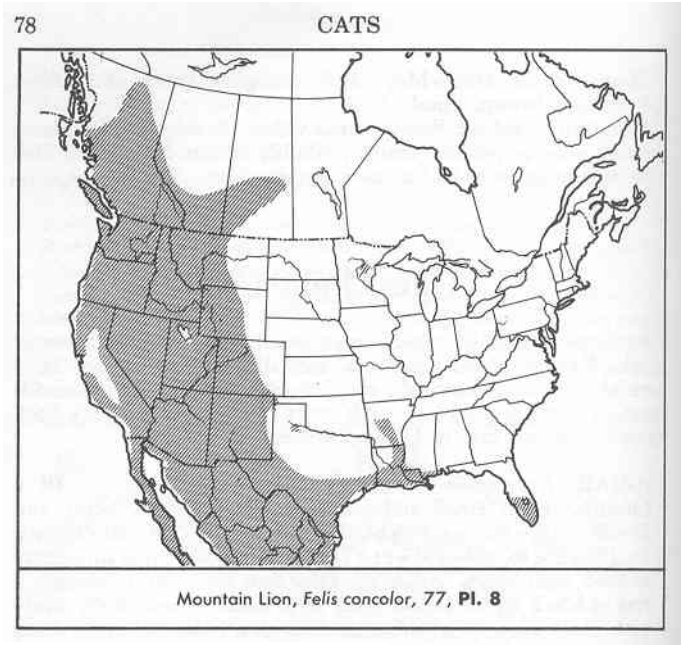
SAGUARO NATIONAL PARK WEST — At least one mountain lion still roams the Tucson Mountains, ambushing mule deer several times its size with a brute force honed by eons of evolution.

Precious little is known about the lion's status in the mountains just west of downtown.

But biologists say this much is clear: if the Tucson Mountains become an island of wilderness completely surrounded by a sea of suburbia, lions probably will disappear from the range, as has already happened with desert bighorn sheep.

To learn more about the lions, volunteers from around the coun-

Felis concolor

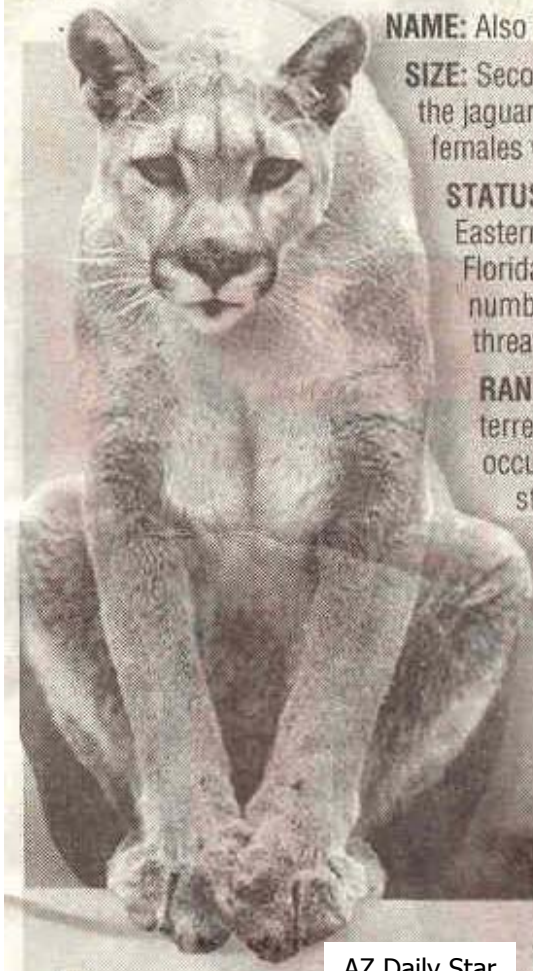


Burt and Grossenheider 1976

Very wide distribution

Wildcat needs wild lands

Mountain lions may disappear from the Tucson Mountains, biologists say, if urbanization surrounds the range and cuts off travel routes to other mountains.



NAME: Also called puma, panther and cougar.

SIZE: Second-largest cat in the Western Hemisphere, after the jaguar. Adult males weigh about 140 pounds, adult females weigh around 75 pounds.

STATUS: Lions have been largely extirpated from the Eastern U.S. and Canada, and their subpopulation in Florida is endangered. But lions still exist in healthy numbers in the West and are not considered threatened in Arizona, where they are legally hunted.

RANGE: One of the widest distributions of any terrestrial mammal in the Western Hemisphere, occupying habitat from the frozen Yukon to the steamy tropics.

DIET: Lions in Arizona mainly subsist on deer, but will also take javelina, bighorn sheep and small mammals. An adult male needs to kill a deer-sized animal every six to 12 days.

BEHAVIOR: They hunt by ambush, sneaking up on their prey, slamming into it and sinking their teeth into its neck. Their small heart and lungs limit their chase to about 300 yards. They will typically cover their kill, then return to feed on it over several days.

AZ Daily Star
15 Feb 2003

Cat territory

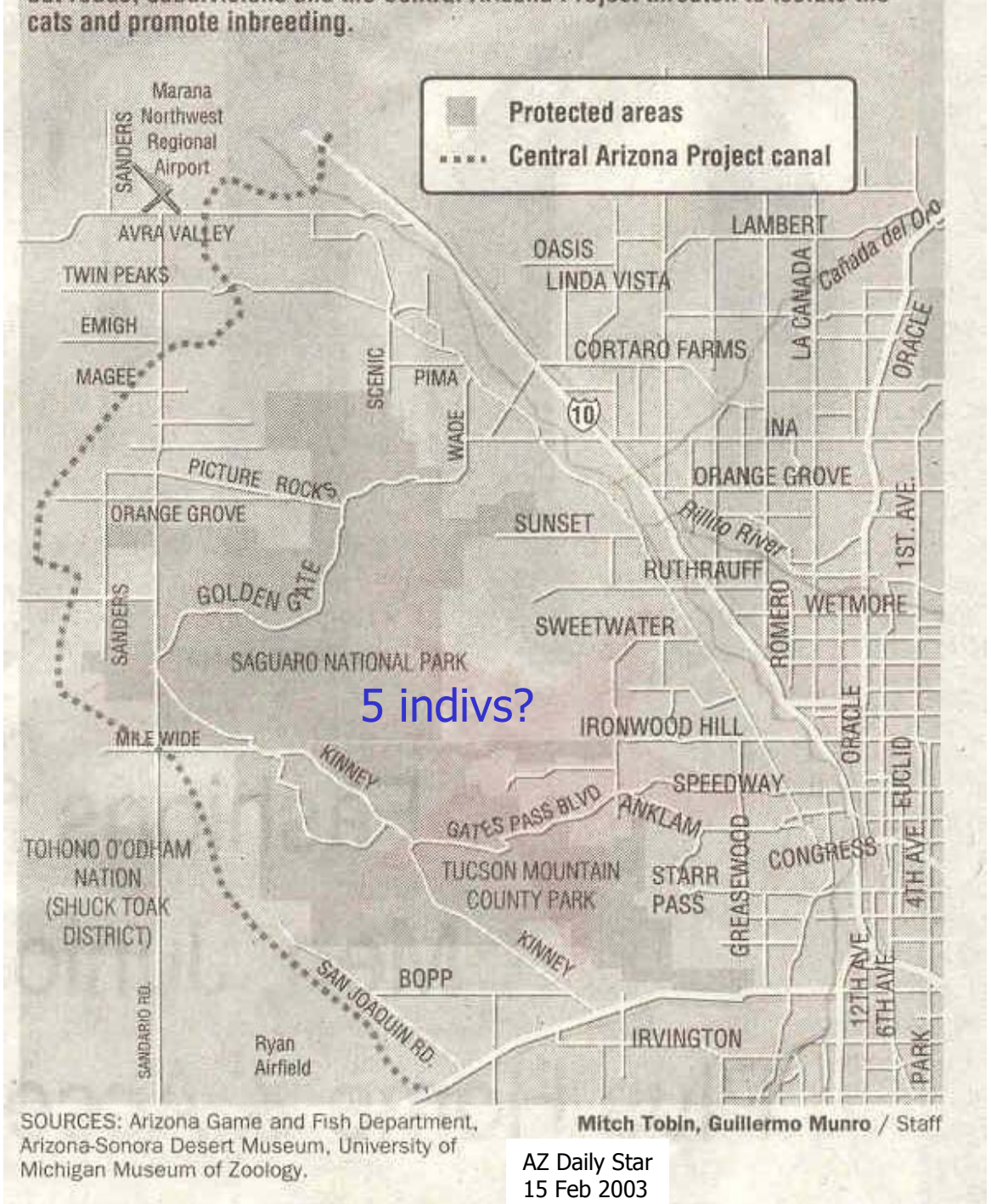
Scientists believe the Tucson Mountains can support up to five mountain lions, but roads, subdivisions and the Central Arizona Project threaten to isolate the cats and promote inbreeding.

Felis concolor

Urbanization

Habitat Loss
and Fragmentation

Metapopulation



AZ Daily Star
15 Feb 2003

Extant Herp Groups

To Fishes and Ancestor

Tetrapoda

Amniota

Lissamphibia

Anura — 'frogs'

Urodela — salamanders

Gymnophiona — caecilians

Synapsida

Mammalia

Reptilia

Testudines — turtles

Diapsida

Lepidosauria

Squamata

'Lizards'

'Lizards'

Amphisbaenia

Serpentes — snakes

'Lizards'

'Lizards'

Rhynchocephalia — tuatara

Archosauria

Crocodylia — crocs etc.

Aves — birds

See Fig 2-1 (Pough et al., 2001)

Rhynchocephalia

- evolved before dinosaurs

- world-wide distribution in Mesozoic

- most extinct at end Cretaceous (65mya)

Sphenodontidae

- 1 extant genus (*Sphenodon*)
- 2 extant species

- restricted to small islands of New Zealand

- long lived

Measuring Biodiversity

- alpha - beta - gamma

Alpha

species within a community

community

- all populations occupying a given area at a given time
- often broken into taxonomic groups or functional roles

1) Species Richness (# of species)
2) Species Evenness (how many of each type?)

Shannon Diversity Index (richness and evenness)

$$H' = -\sum_i p_i \ln (p_i), \quad (i = 1, 2, 3 \ldots S)$$

p_i = proportion of total community abundance represented by ith species

Table 4.3 Abundance (individuals/10 ha) and diversity (Shannon index, $H' = -\Sigma(p_i \ln p_i)$ of avian species from two tallgrass prairie sites at DeSoto National Wildlife Refuge, Iowa. Note that site A, with fewer species (8) and two highly abundant species (common yellowthroat and field sparrow), has a lower value of diversity than site B, which has more species (11) that are more equally abundant. Van Dyke 2003

SPECIES	SITE A	SITE B
Common yellowthroat	8.24	1.21
Field sparrow	2.94	2.84
Dickcissel	1.18	2.23
Red-winged blackbird	0.29	0.81
Brown-headed cowbird	2.06	1.82
American goldfinch	1.47	1.02
Ringneck pheasant	0.59	1.63
Mourning dove	1.18	0.61
Eastern kingbird	—	1.60
Grasshopper sparrow	—	4.48
Northern bobwhite	—	2.64
Shannon diversity (H')	1.64	2.25

Shannon Index in Tallgrass Prairie

(indiv spp abundance relative to total abundance)

What if removed three species from B?

1.64					2.25			
a	prop	ln	propxln		b	prop	ln	propxln
8.24	0.459053	-0.77859	-0.35741		1.21	0.057922	-2.84865	-0.165
2.94	0.163788	-1.80918	-0.29632		2.84	0.13595	-1.99547	-0.27128
1.18	0.065738	-2.72208	-0.17894		2.23	0.10675	-2.23727	-0.23883
0.29	0.016156	-4.12546	-0.06665		0.81	0.038775	-3.24999	-0.12602
2.06	0.114763	-2.16488	-0.24845		1.82	0.087123	-2.44043	-0.21262
1.47	0.081894	-2.50233	-0.20493		1.02	0.048827	-3.01947	-0.14743
0.59	0.032869	-3.41522	-0.11226		1.63	0.078028	-2.55069	-0.19902
1.18	0.065738	-2.72208	-0.17894		0.61	0.029201	-3.53357	-0.10318
					1.6	0.076592	-2.56927	-0.19678
					4.48	0.214457	-1.53965	-0.33019
					2.64	0.126376	-2.06849	-0.26141
17.95	1		**-1.64391**		20.89	1		**-2.25177**
drop top 3					drop bottom 3			
b	prop	ln	propxln		b	prop	ln	propxln
					1.21	0.099425	-2.30835	-0.22951
					2.84	0.233361	-1.45517	-0.33958
					2.23	0.183237	-1.69697	-0.31095
0.81	0.055441	-2.89243	-0.16036		0.81	0.066557	-2.70969	-0.18035
1.82	0.124572	-2.08287	-0.25947		1.82	0.149548	-1.90014	-0.28416
1.02	0.069815	-2.6619	-0.18584		1.02	0.083813	-2.47917	-0.20779
1.63	0.111567	-2.19313	-0.24468		1.63	0.133936	-2.01039	-0.26926
0.61	0.041752	-3.176	-0.13261		0.61	0.050123	-2.99327	-0.15003
1.6	0.109514	-2.2117	-0.24221					
4.48	0.306639	-1.18208	-0.36247					
2.64	0.180698	-1.71093	-0.30916					
14.61	1		**-1.8968**		12.17	1		**-1.97163**

Pricing Biodiversity

$R_I = (D_i + U_i)(\text{delta}P_i/C_i)$

D = distinctiveness
U = utility
delta P = enhanced probability of survival
C = cost of strategy

Direct limited funds…
Ecological Contribution?

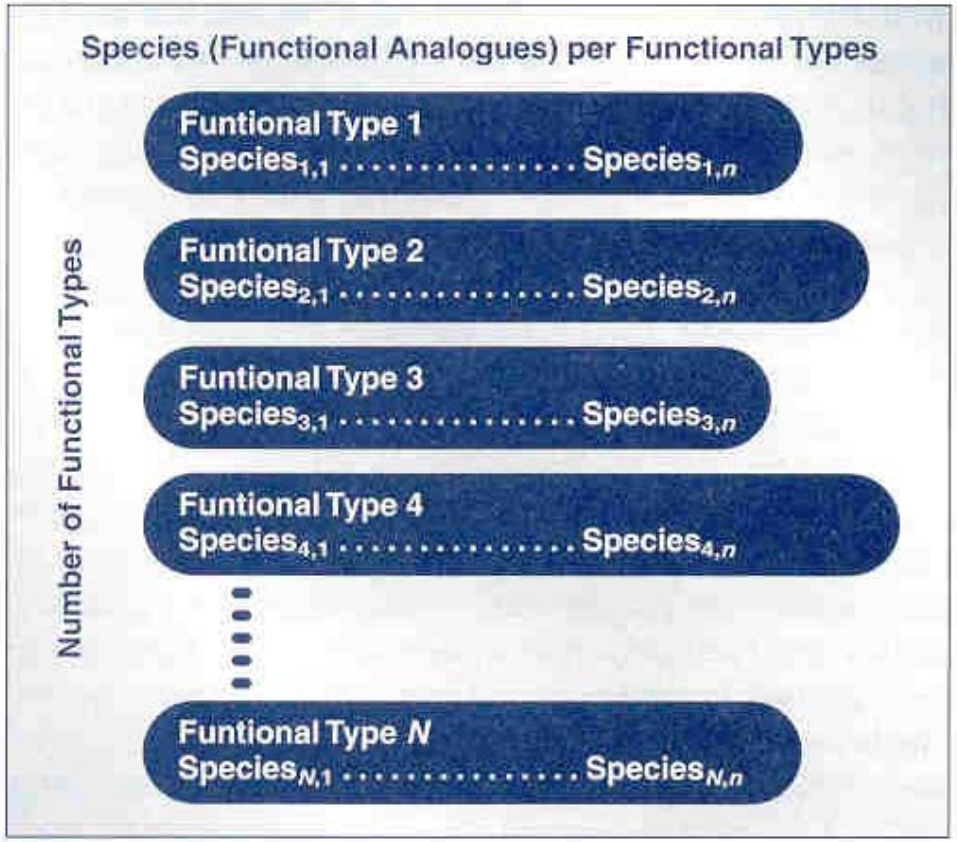


Figure 4.3
Total species diversity can be measured as the product of the number of functional types and the number of species per functional type. Two populations may have the same species diversity and still differ. For example, one may have many functional types and few functional analogues, and the other may have many analogues but few functional types. The relative number of functionally analogous species within each functional type is indicated by the width of the oval. Van Dyke 2003

Process and Pattern

1 Functional Types
2 Functional Analogs

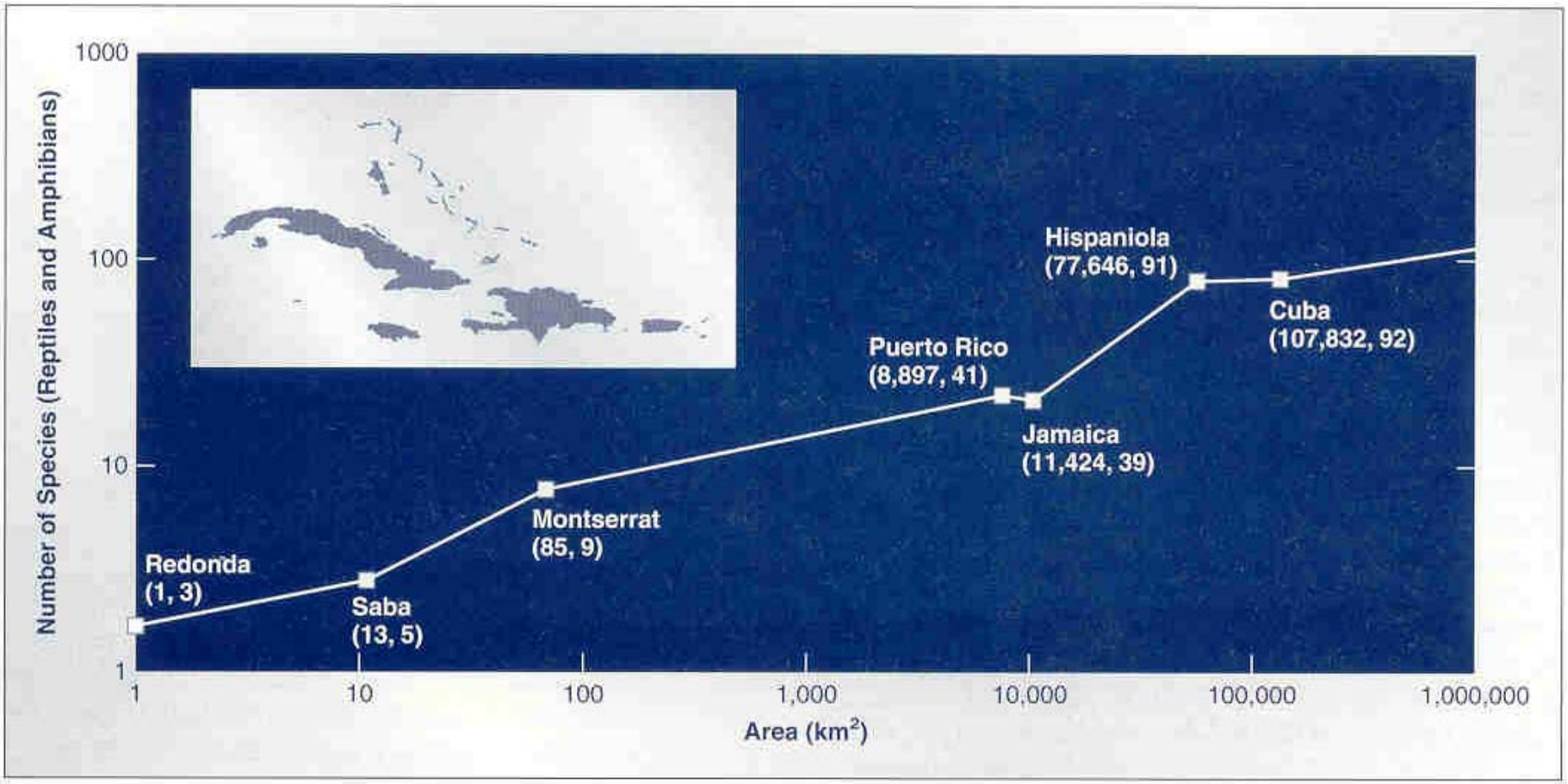
Increase either to increase biodiversity

Which to preserve?

Niche:
Ecological role of a species in a community

Pisaster (predatory sea star)
Paine
15 vs. 8 spp.

Other Correlates of Diversity
-Intermediate Disturbance
(shifting mosaic, no climax)
-Habitat Heterogeneity
(e.g., foliage height and birds)



Van Dyke 2003

Figure 4.4

A general species-area relationship among some Caribbean islands. Note that species richness on islands increases with increasing area.

Based on data from Darlington (1957:483).

Species-Area Relationship

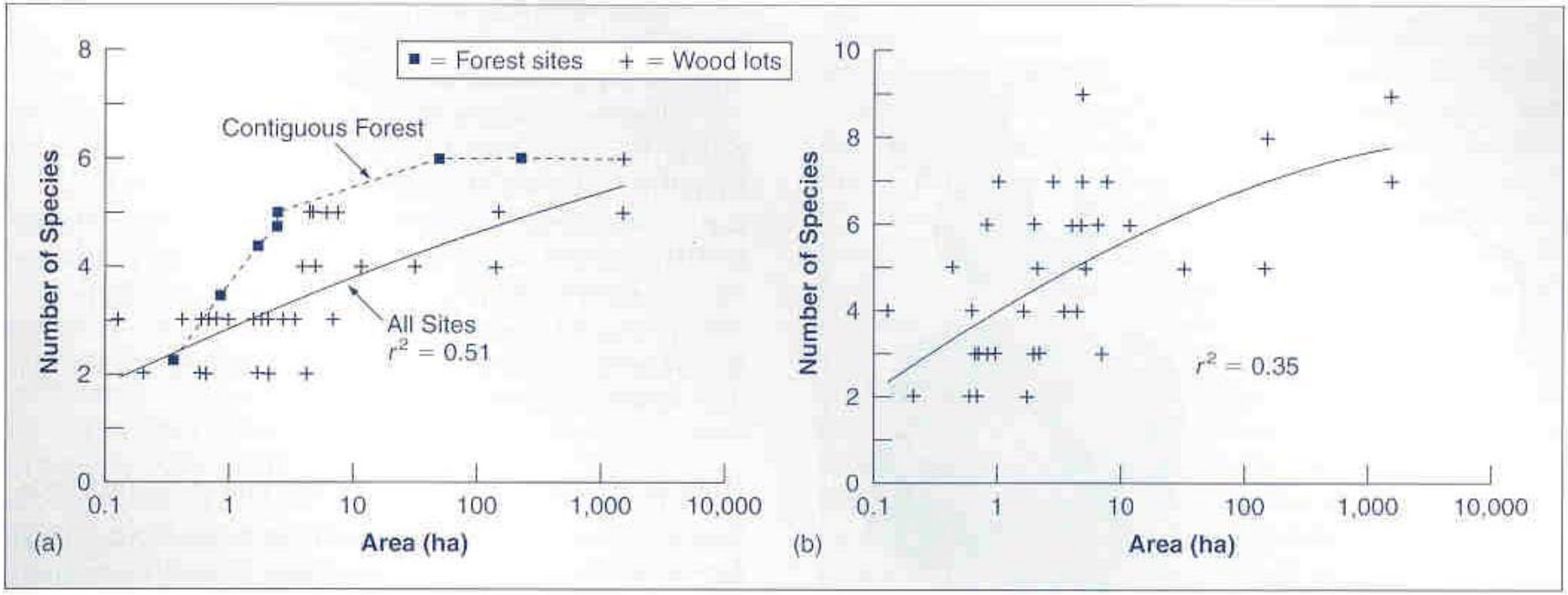


Figure 4.5

An illustration of the relationship between area and species richness of (a) granivores and (b) all small mammal species in woodlots (crosses) and contiguous forest sites (squares). Species richness increases with woodlot area. In (a), note that granivore species richness increases with area more rapidly in contiguous forest than in woodlots. This pattern suggests that species richness not only declines with habitat loss, but also with habitat fragmentation.

After Nupp and Swihart (2000).

Van Dyke 2003

Woodlots vs. contiguous forest

Species-Area Relationship

$$S = cA^Z$$

S = species richness
c = taxon specific constant
A = area
Z = extinction coeeficient for taxon

3 step loss of biodiversity (Rosenzweig)

1. Endemics
2. Sink populations
3. Stochasticity

Therefore end up with lower steady state species richness and loss of biodiversity

Endemism and Islands (Tuatura, Silversword)
Island Biogeography

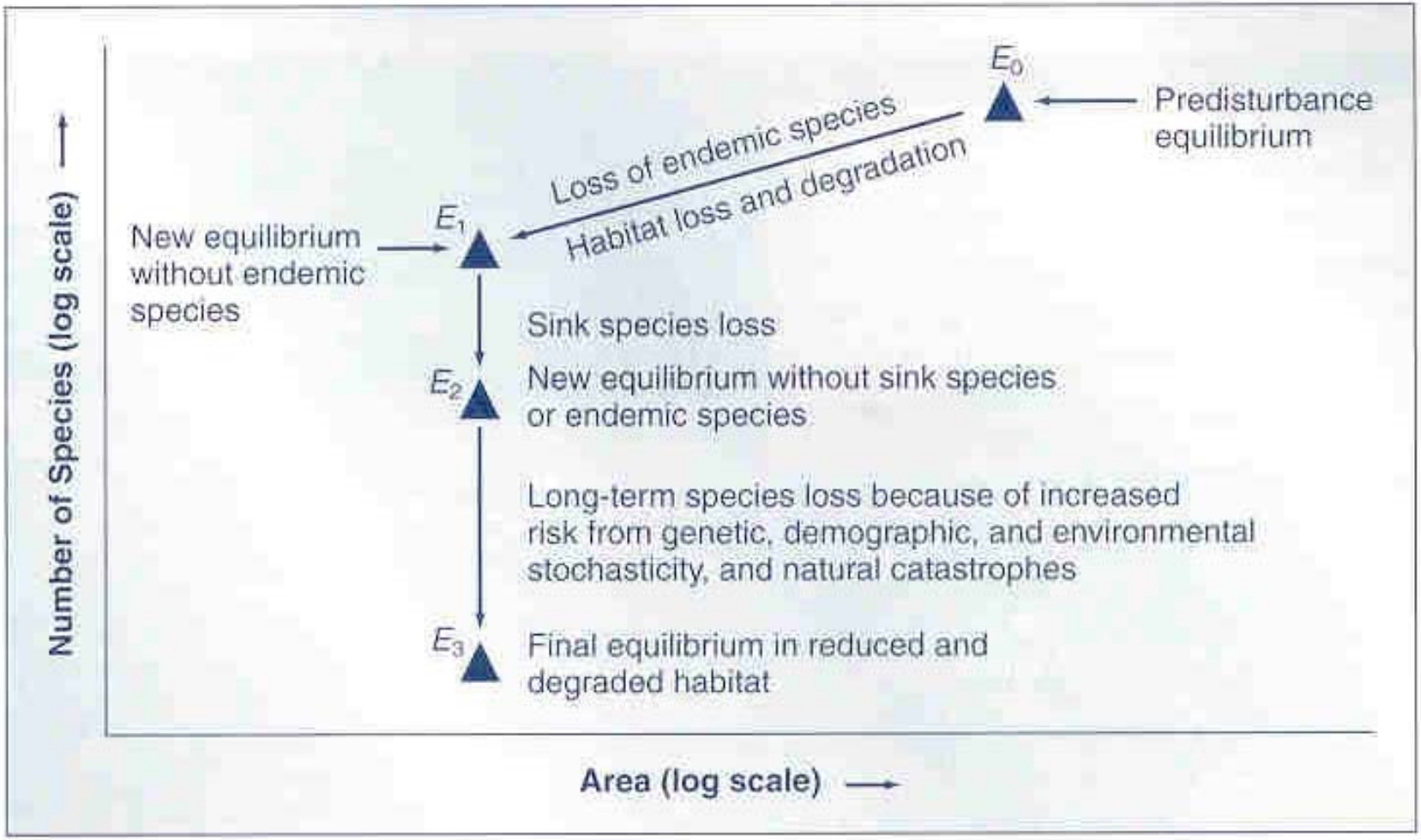


Figure 4.6

When the size of a natural area is decreased, the first species lost are endemics. Next, sink species (those that are not reproducing fast enough to replace themselves) go extinct locally. Finally, failure to replace accidental losses fast enough brings the province to a still lower steady state of biodiversity.

After Rosenzweig (1999).

Van Dyke 2003

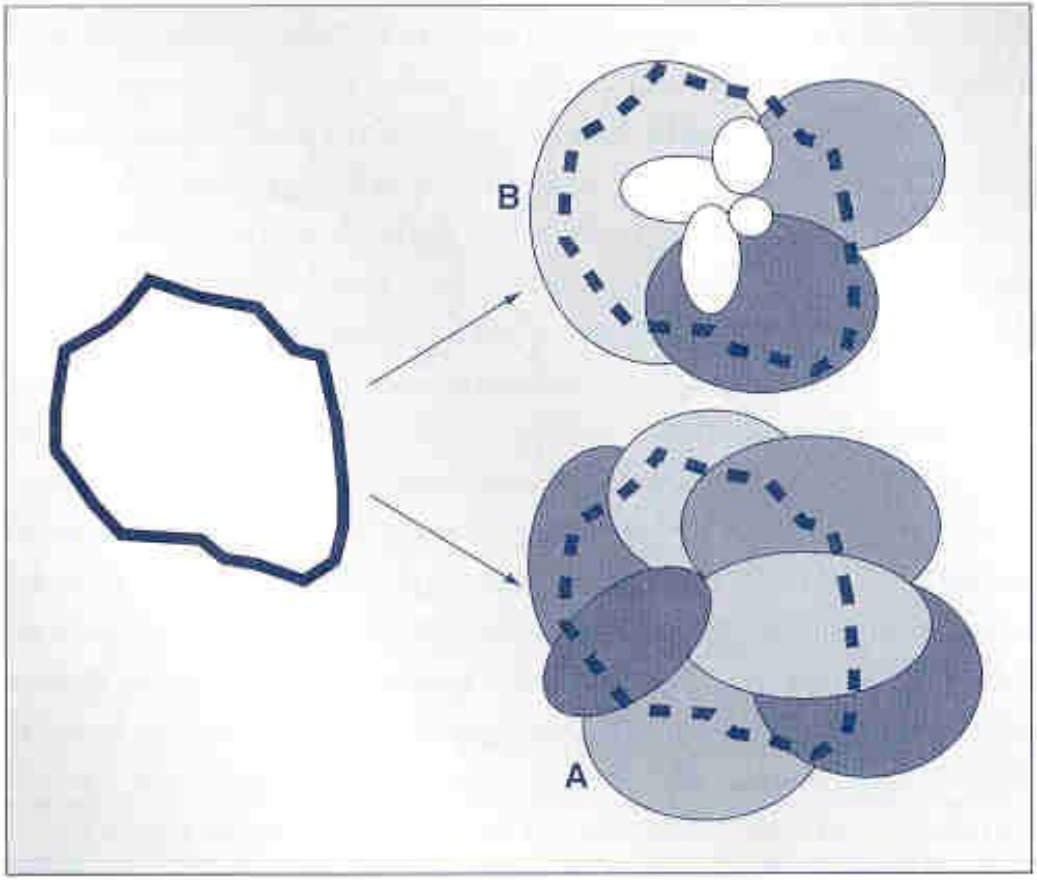


Figure 4.7
The "cookie cutter" model of the effects of habitat loss on endemic species. If the cookie cutter strikes at subarea A, seven species lose habitat but none is exterminated. In contrast, if the cookie cutter strikes subarea B, an area containing species with more restricted ranges, seven species lose habitat, and four species are exterminated. Thus, random habitat loss produces a disproportionately high rate of extinction in endemic species.

After Pimm (1998).

Endemics
Habitat Size
Habitat Loss

Van Dyke 2003

END