Ecological Redundancy and Long-Term Dynamics of Vertebrate Predators in Semiarid Chile

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Abstract: *In the semidesert of Aucó, Chile, four strigiform, six falconiform, and two fox species joined the suite of endothermic vertebrate predators at various times from 1987 to 1994. Different falconiforms entered and exited the suite at times roughly correlated with long-term fluctuations in the density of small mammals, but strigiforms and foxes remained resident throughout the 7 years. Using detailed data on diets (trophic guild structure) and on resident status of the 12 predator species, we assessed whether the combination of these two criteria, if obtained in a shorter study, would have been adequate to make reasonable decisions about which species should be conserved were it possible to conserve only a subset of the 12. In particular, we evaluated whether ecological redundancy, as gauged by high diet similarity, would provide a reasonable basis for concentrating on the conservation of some species more than others. Guild structure of the predator suite at Aucó remained consistent through the first 3 years of the study, but then shifted markedly, such that conservation strategies based on apparent ecological redundancy (in diet) early on would have been misguided in the long term. Although transient species sometimes were redundant with residents, in other years the same transients played unique trophic roles, so the apparently rational strategy of concentrating conservation efforts on less-mobile, resident species would have left gaps in ecosystem function. Likewise, a short-term, intensive inventory of Aucó's predators would have underestimated in some years and overestimated in others the richness of species, depending on prey resources there. We conclude that no short-term data would have provided adequate bases for focusing conservation efforts on some species or particular habitat patches. Although realistically no such decision-making process can be delayed until a 7-year (or longer) data set has been accumulated, we suggest that short-term studies of species assemblages be used cautiously when making conservation decisions.*

Redundancia ecológica y dinámica al largo plazo de los vertebrados de predadores en las areas semidesérticas de Chile

Resumen: *En la localidad semidesértica de Aucó (Chile), cuatro especies de strigiformes, seis de falconiformes y dos de zorros constituyeron un conjunto variable de depredadores endotérmicos en diversos períodos desde 1987 a 1994. Diferentes falconiformes ingresaron o salieron del conjunto en tiempos aproximadamente correlacionados con fluctuaciones de largo plazo en la densidad de micromamíferos, pero las especies strigiformes y los zorros permanecieron como residentes a lo largo de los siete años. Usando datos detallados sobre dietas (estructura gremial trófica) y estados residencia de las 12 especies de predadores, determinamos si es que la combinación de estos dos criterios, obtenidos en un estudio a corto plazo, hubiera sido adecuado para tomar decisiones razonables dada la eventual necesidad de conservar solo un subconjunto de dichas especies. Específicamente, evaluamos si redundancia ecológica, estimada como alta similitud dietaria, proveería una base razonable para concentrarse en la conservación de algunas especies más que en otras. La estructura gremial del conjunto de depredadores en Aucó permaneció constante durante los primeros tres años del estudio pero a continuación cambió marcadamente, de manera que estrategias de conservación basadas en la aparente redundancia ecológica (en dieta) encontrada al principio habrían sido inadecuadas largo plazo.*

Paper submitted September 26, 1994; revised manuscript accepted March 8, 1995.

Aunque las especies transitorias algunas veces fueron redundantes con las residentes, en otros años las mismas especies transtorias tuvieron papeles tróficos únicos, de manera que la estrategia aparentemente racional de concentrar los esfuerzos de conservación en las especies residentes menos móviles habría dejado vacíos importantes en la función del ecosistéma. De forma similar, un inventario intensivo a corto plazo del número de especies de depredadores de Aucó los habría subestimado en algunos años y sobrestimado en otros, dependiendo de los niveles de recursos presa. Concluimos que ningún estudio corto plazo habría provisto las bases adecuadas para enfocar los esfuerzos de conservación en algunas especies o en parches de hábitat particulares. Aunque realistamente ningún proceso de toma de decisiones debe paralizarse hasta que se acumule una base de datos de siete años o más, sugerimos que los estudios de corto plazo elosa de ensambles de especies deben usarse muy cautamente cuando se toman decisiones sobre conservación biológica.

Introduction

Biodiversity by almost any definition involves far more than just vertebrate predators (Noss 1990; Soulé 1991), but vertebrate predators continue to guide many conservation efforts (Meffe & Carroll 1994). Whether or not vertebrate predators truly act as keystones species, affecting the dynamics and composition of prey assemblages and thereby the dynamics of entire food webs (Paine 1966), they attract widespread public attention, often range over wide areas, and frequently exist at low population densities. Therefore, when conservation ecologists exploit the "charismatic," "umbrella," or "vulnerable" nature of vertebrate predators in their conservation efforts, they may be taking measures that protect biodiversity on a variety of spatial scales and levels of organization (Noss 1990; Tracy et al. 1994). If conservation efforts involve, directly or indirectly, suites of vertebrate predators rather than single species, how do we decide on the prime sites to conserve, set spatial limits on the conservation area, and decide on that subset of species most deserving of intensive conservation efforts?

Obtaining the answers to these questions is plagued with practical difficulties. Exhaustive, long-term data sets on dynamics of vertebrate assemblages over large geographic areas of the Western Hemisphere, although crucial (Hansen et al. 1993), are scarce outside the North Temperate zone; therefore decisions must often be based on short-term studies at one or a few restricted sites or on extremely short-term studies such as Rapid Assessment Profiles (Roberts 1991; Mittermeier & Forsyth 1994). Second, typical population densities and modal home-range sizes of target species are among the many criteria used to establish the minimum or ideal size of protected areas (Hansen et al. 1993), but these data are hard to obtain for large or mobile animals. Finally, conserving all members of the assemblage of vertebrate predators in a given landscape may be an unattainable goal, for example because adequate area to sustain viable populations is not available (Robinson & Wilcove 1989; Thiollay 1989).

Where such judgment calls are unavoidable and the functional roles (guild structure) of animal species can be identified, then one possible criterion for decision making is the extent of functional redundancy among species (Walker 1992). Species whose roles in food webs or other ecosystem processes can apparently be compensated by guildmates may merit less strenuous conservation efforts than species with unique roles. For example, in a vertebrate assemblage of four clearly defined trophic guilds with two members each but in which only four species can realistically be protected, all else being equal, the "redundancy strategy" (Walker 1992) would be to focus efforts on one species from each guild. Clearly, the robustness of any conservation decision increases with the number of years of data involved and the depth of natural history knowledge about the species concerned. Again, though, few long-term studies exist on assemblages of vertebrate predators, so decisions may need to be based on short-term profiles.

Some dry environments in the Neotropics are prone to inter-annual fluctuations in climate that affect the dynamics of all populations, including vertebrate predators (Barber & Chavez 1983; Diaz & Markgraf 1992). In such environments, short-term profiles completed at one point in time might provide a different picture than if performed at a different time (Wiens 1977, 1981). Yet vertebrates in Neotropical drylands require urgent conservation attention (Redford et al. 1990; Mares 1992). Since 1987 we have studied the food habits and trophic guild dynamics of the assemblage of vertebrate predators in a Chilean semi-desert scrub. We summarize this seven-year data set and emphasize the ever-changing, complex nature of guild structure even in this apparently simple ecosystem. We use the data set as a model to illustrate the ambiguities and dangers of basing conservation decisions on simple labels or rules of thumb. Using data on the food habits of the predators, we specifically evaluate whether the redundancy strategy would be an objective approach to this or an analogous assemblage.

Methods

Our continuing study takes place in the Reserva Nacional Las Chinchillas at Aucó, north-central Chile (details in Jaksic et al. 1992; Jiménez et al. 1992). The vegetation covering the rugged topography is semi-desert scrub, dominated by numerous columnar cacti (*Trichocereus chilensis* and *Echinopsis* sp.) and terrestrial bromeliads (*Puya berteroniana*) on north-facing (drier) slopes and by diverse shrubs and grasses on south-facing slopes. Annual precipitation at Illapel, 8 km south of Aucó, has averaged 175 mm over 20 years, with marked fluctuations (Fig. 1) probably associated with El Niño–Southern Oscillation phenomena. Annual rainfall is highly seasonal in a dry Mediterranean pattern, with almost all rain falling in autumn and winter (March to August). Most vertebrates breed during spring and summer; therefore we divide each years' data into breeding (September-February) and winter (March-August) seasons.

Small mammals constitute the principal food resource of most of Aucó's predatory vertebrates and have been continuously monitored since the beginning of the study (1987) through live trap grids (details in Jiménez et al. 1992). We kept qualitative visual tallies of avian predators (Falconiformes, Strigiformes), foxes (*Pseudalopex* spp.), the colubrid snake *Philodryas chamissonis*, and the teiid lizard *Callopistes palluma*. A given species was considered a site resident for a given season if we noted frequent occupation of roosts, perches, nests, or dens (raptors and foxes) and found at least five regurgitated pellets (raptors) or fresh feces (foxes) during the season. These criteria represent a conservative measure of residence status; often we recorded visual observations of a species in the region but were unable to find five or more pellets or feces in the microhabitats studied. We classified species as "resident," "transient," or "accidental," depending on whether they resided at the site, by the conservative definition, for at least 12, 6–3, or only 1 of the 14 total seasons, respectively.

To characterize predators' diets, we sampled each month's accumulation of regurgitated pellets at known roosts, perches, or nests or of feces along consistent transects. Contents were identified to the maximum level of resolution (species for vertebrate prey and fruits; species, genera, or family for invertebrate prey), and the minimum number of individual prey was computed per pellet or feces (details in Jaksic et al. 1993). For each season we computed diet similarity between each pair of predator species (see Equation 2 in Jaksic et al. 1993; see Marti 1987 for further details). Finally, we applied cluster analysis to each season's complete matrix of pairwise overlaps, using unweighted pair-group clustering with arithmetic averaging (UPGMA; Sneath & Sokal 1973).

To compare results among seasons and years we arbitrarily set the threshold for assigning predators to trophic guilds at 50% diet similarity (for rationale see Jaksic et al. 1993 and Marti et al. 1993). A key assumption is that the level of redundancy among predator species is adequately estimated by the symmetric measurement of their diet similarities. This is reasonable for the purposes of our analysis because prey composition in the diets was identified to detailed levels, and predators were considered to have similar diets only when their diet composition (simultaneously assessed by species and by proportional numerical representation) yielded an index about 50%. We are confident that when diet similarity is above 75% the predators in a group are preying on essentially the same prey species at approximately the same proportions. In this restricted sense we consider such species groupings to be redundant; in principle, any species deletion could be compensated by another predator in the same trophic guild, prey levels permitting.

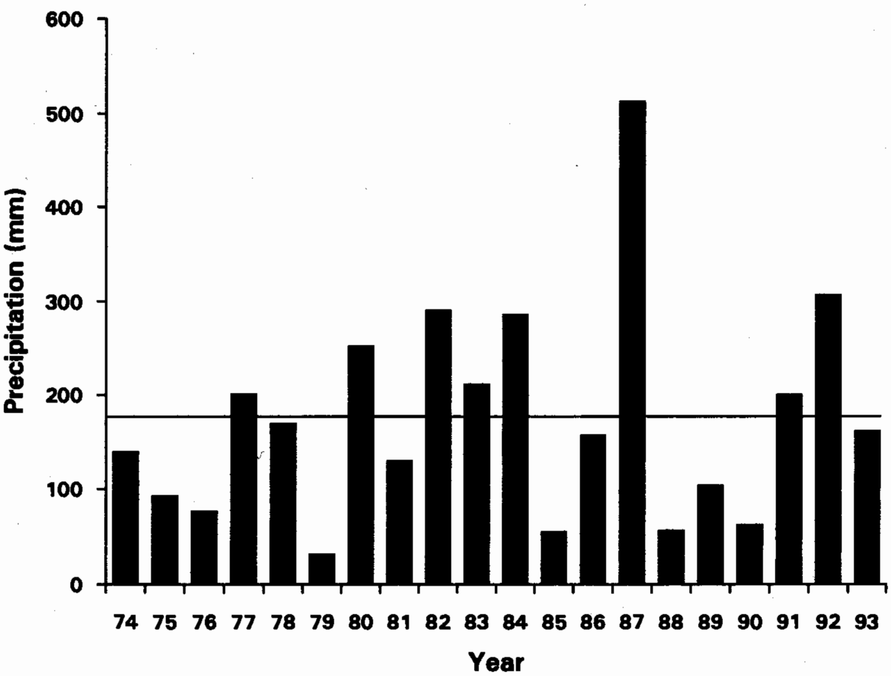

Figure 1. Estimated yearly precipitation at Aucó as measured in the nearest climatic station in Illapel (8 km S of Aucó). The horizontal line indicates the 20-year average.

Results

Predators, Prey, and Weather

Over the course of the study fourteen vertebrate predators resided at Aucó for one or more seasons. These included the snake *Philodryas chamissonis*, the lizard *Callopistes palluma*, two foxes (*Pseudalopex culpaeus*, *P. griseus*), six falconiforms (*Buteo polyosoma*, *Elanus leucurus*, *Falco femoralis*, *Falco sparverius*, *Geranoaetus melanoleucus*, *Parabuteo unicinctus*), and four strigiforms (*Athene cunicularia*, *Bubo virginianus*, *Glaucidium nanum*, *Tyto alba*). In addition, the falconiform *Milvago chimango* frequented areas nearby, and the mammals *Felis colocolo* and *Galictis cuja* were recorded in the Aucó region (J. E. Jiménez, unpublished data).We will not discuss the last three species or the two reptiles. Although the site hosted a permanent population of *Philodryas*, feces were infrequent, and we did not search for them. Likewise, many *Callopistes palluma* were seen throughout the warmer months, but after the first year of data collection (Castro et al. 1991) we collected too few feces for analysis. Omission of the two reptiles does not seriously impair our interpretation because both species are obviously restricted in spatial mobility.

Small mammals at Aucó included eight rodents (*Abrocoma bennetti*, *Abrothrix longipilis*, *Akodon olivaceus*, *Chinchilla lanigera*, *Octodon degus*, *Oligoryzomys longicaudatus*, *Phyllotis darwini*, *Spalacopus cyanus*) and the marsupial *Thylamys elegans* (Jiménez et al. 1992). As previously reported (Jaksic et al. 1993), other foods exploited by predators included birds, large insects, the toad *Bufo chilensis*, and fruits (particularly those of *Schinus molle* and *Schinus polygamus*), but we did not begin systematic monitoring of these groups until 1993. Aucó, like much of central Chile (Jaksic & Fuentes 1991), supports populations of the introduced European rabbit (*Oryctolagus cuniculus*) and European hare (*Lepus capensis*), but these lagomorphs infrequently appeared in predators' diets.

The amount of winter rainfall fluctuated greatly over the duration of the study (Fig. 2). Total rodent density roughly reflected this pattern, reaching the highest levels recorded just after the three-times-normal rainfall of the 1987 winter season (Figs. 1 & 2), presumably as a direct consequence of increased primary production (Jiménez et al. 1992). Thereafter, mammal densities declined steadily until the winter season of 1991, when winter rainfall and rodents in the following breeding season again increased. The increase in both continued through 1992, followed by a slight decline in 1993 (Fig. 2).

Residence Status and Guild Structure

Despite the dramatic fluctuations in at least their mammalian prey (Fig. 2), six endothermic predators, the foxes and strigiforms (in addition to the two reptiles) were residents (Table 1). All six falconiforms were transients or accidentals (Table 1). The timing of appearances at the microhabitats studied rarely coincided precisely among predator species, and several predators consumed mammals less frequently than other food items.

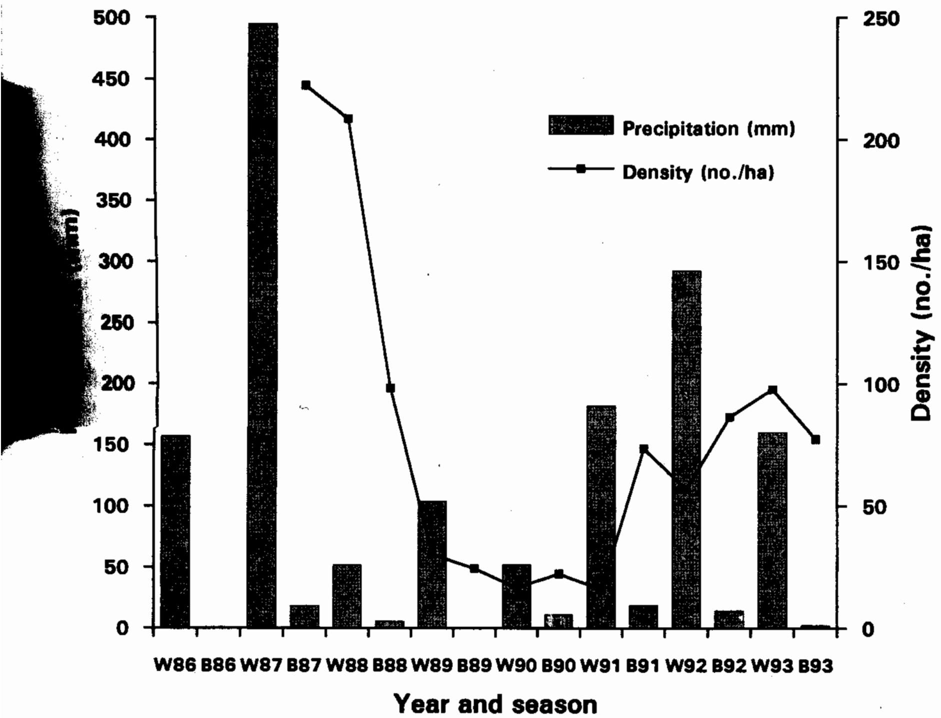

Figure 2. Estimated seasonal precipitation and small-mammal density at Aucó throughout successive biological seasons (W = wintering and B = breeding).

Table 1. Residence status of predators of Aucó, Chile, by season.[a]

			Year and season[b]														
			1987-1988		*1988-1989*		*1989-1990*		*1990-1991*		*1991-1992*		*1992-1993*		*1993-1994*		
Predator species[c]	*Mass (g)*	*Activity[d]*	*W*	*B*	*W*	*B*	*W*	*B*	*W*	*B*	*W*	*B*	*W*	*B*	*W*	*B*	*Total in 14 seasons*
Falco femoralis (F)	334	D										X					1
Elanus leucurus (F)	302	D													X		1
Parabuteo unicinctus (F)	876	D			X	X	X										3
Buteo polyosoma (F)	975	D		X	X	X										X	4
Geranoaetus melanoleucus (F)	2378	D	X	X	X							X				X	5
Falco sparverius (F)	116	D	X	X	X	X				X						X	6
Tyto alba (S)	307	N	X	X	X	X	X		X		X	X	X	X	X	X	12
Glaucidium nanum (S)	81	DCN	X	X	X	X	X	X	X	X			X	X	X	X	12
Athene cunicularia (S)	247	CN	X	X	X	X	X	X	X	X	X		X	X	X	X	13
Bubo virginianus (S)	1227	N	X	X	X	X	X	X	X	X	X	X	X	X	X	X	14
Pseudalopex culpaeus (C)	4317	DCN	X	X	X	X	X	X	X	X	X	X	X	X	X	X	14
Pseudalopex griseus (C)	2495	DCN	X	X	X	X	X	X	X	X	X	X	X	X	X	X	14

[a] *(n = 14) defined by the conservative criterion of at least five pellets or feces encountered in microhabitats.*
[b] *B = breeding season; W = winter season.*
[c] *F = falconiform; S = strigiform; C = carnivore.*
[d] *D = diurnal; N = nocturnal; C = crepuscular.*

Nevertheless, in general, predator species richness tracked small-mammal abundance (Fig. 3), ranging from 5 species during small-mammal lows to 10 just following the small-mammal peak (Table 1, Fig. 1). Residence status was not a simple consequence of dependence on small mammals, however. Two residents, *Tyto alba* and *Bubo virginianus*, depended almost entirely on small mammals, but others did not; transients and accidentals ranged from mammal eaters to bird and insect consumers (Table 2). Absence from Table 1 does not necessarily mean total absence from the Aucó area. Often, "absent" predators were sighted nearby but did not yield enough pellets to qualify for resident status. For example, *Geranoaetus*, *Buteo*, and *Parabuteo* remained in the general vicinity throughout. Sometimes, though, there was no evidence of a particular predator species anywhere in the Aucó region.

The 14,170 pellets and feces analyzed to date provide much more-detailed diet information. Unfortunately, the two *Pseudalopex* foxes produce feces that could not

Table 2. Overall diets of predators at Aucó, Chile, from wintering season of 1987 through breeding season of 1993–1994 (*n* = 14 seasons).

	Prey[a]				
Predators	*Small Mammals (%)*	*Other vertebrates (%)*	*Invertebrates (%)*	*No. pellets or feces[b]*	*No. prey*
Transients					
P. unicinctus	62.5–100.0	0.0–37.5	0.0–0.0	70	92
B. polyosoma	41.1–69.8	16.7–30.9	3.8–36.9	165	407
G. melanoleucus	33.3–62.9	22.0–48.0	0.0–34.1	79	157
F. sparverius	0.0–16.7	11.8–100.0	0.0–82.3	185	748
Accidentals					
F. femoralis	0.0	57.5	42.5	43	40
E. leucurus	20.6	17.7	61.7	23	68
Residents					
T. alba	92.0–100.0	0.0–8.0	0.0–1.0	2709	3784
G. nanum	8.8–73.0	1.9–30.4	41.9–90.9	845	2102
B. virginianus	69.1–100.0	0.0–5.7	0.0–30.9	3007	5025
A. cunicularia	0.3–25.8	1.1–7.7	70.6–98.4	2469	17442
Pseudalopex spp.	6.2–92.5	1.7–14.6	0.0–92.1	4575[c]	25971

[a] *Percentages are calculated based on numbers of distinct prey items per category, not biomass.*
[b] *Only in the case of foxes.*
[c] *7.9–75.0% of feces had fruits.*

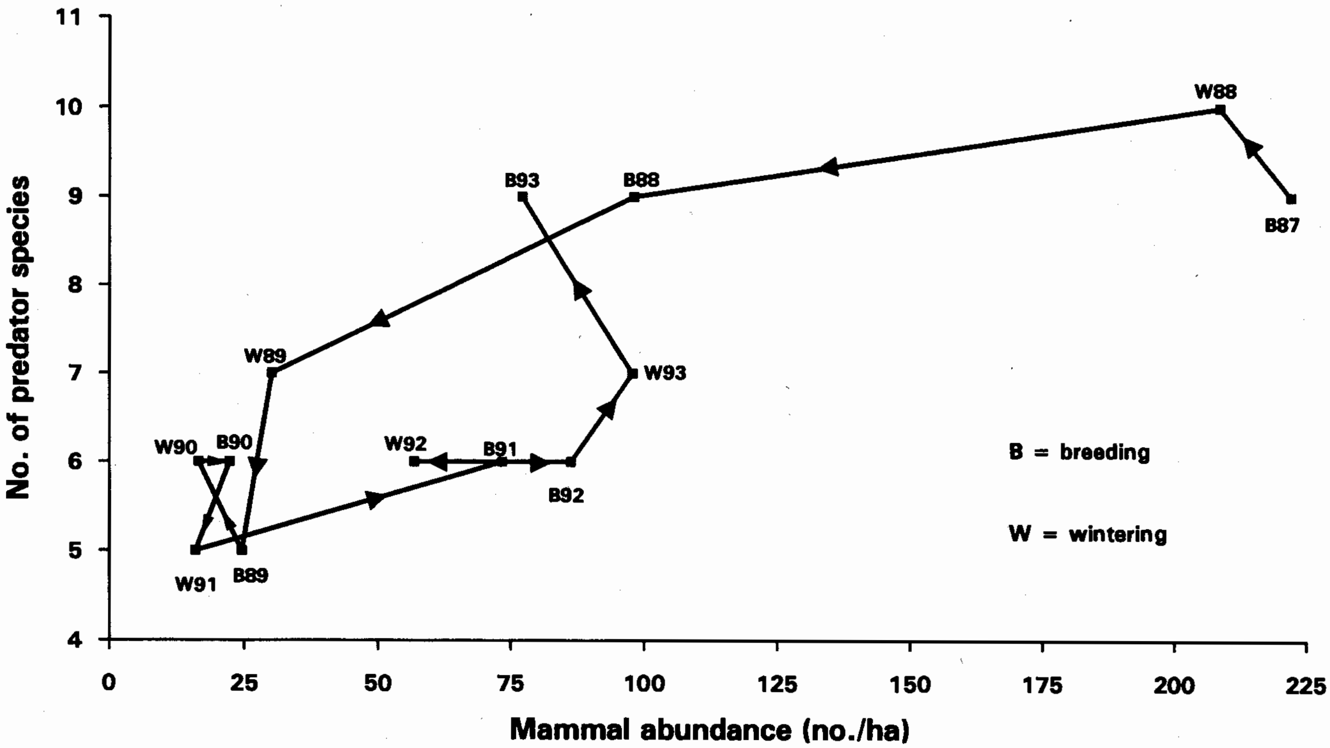

Figure 3. Trajectory of predator diversity by year (1987–1993) and season. Number of predator species, with residency defined as described for Table 1, in relation to the abundance of small mammals at Aucó. Note the counterclockwise trajectory that suggests a pre-driven system.

easily be distinguished by field personnel, so from Table 2 on we lump results for the two. More-detailed studies (Jiménez 1993*a*) document a degree of habitat and diet divergence between the two foxes, with *P. culpaeus* preying somewhat more heavily on mammals and less heavily on insects than does its smaller congener.

When we resolved the 25,971 prey items to the finest level possible and lumped the two foxes together, the cluster analysis showed that resident predators typically formed two distinct trophic guilds (up to a point; Fig. 4). First, two strigiforms (*Tyto alba* and *Bubo virginianus*) formed an almost strictly mammal-eating guild (in particular *Phyllotis darwini*), but the level of diet similarity ("redundancy") between the two varied widely. Second, foxes and the other two strigiforms (*Athene cunicularia* and *Glaucidium nanum*) formed an omnivore guild (Fig. 4), but only through the fourth year of the study, the last year examined in previous reports (Jaksic et al. 1993). Afterward, first *Glaucidium* and then *Athene* temporarily left the area, and in three of the four seasons since both reappeared, the original trophic guild structure has not been evident (Fig. 4). The four falconiform transients demonstrated even less consistency in feeding roles. *Falco sparverius* often joined the omnivore guild but sometimes displayed a unique diet. *Geranoaetus melanoleucus* twice converged on mammalivores, twice on omnivores, and once remained isolated. During the few seasons they were in residence, *Buteo polyosoma* and *Parabuteo unicinctus* showed little consistency in prey preference relative to other predators or each other (Fig. 4). The two accidentals, *Falco femoralis* (see Jiménez 1993*b*) and *Elanus leucurus*, preyed mostly on birds and insects and on insects, small mammals, and birds (by numbers), respectively.

Discussion

At Aucó the species composition and trophic guild structure of vertebrate predators fluctuated greatly through seven years, roughly correlating with fluctuations in small mammals and probably in other prey as well (Figs. 2–4). Aside from the usefulness of this data set to basic ecology, has it shown anything new? Some arid and semiarid environments are already notorious for having erratic fluctuations in climate and resources that greatly affect the ecology of resident vertebrates (Pearson 1975; Whitford 1976; Wiens 1977, 1981, 1993; Péfaur et al. 1979; Baker-Gabb 1984; Korpimäki 1984; Fuentes & Campusano 1985; Corbett & Newsome 1987; Jiménez et al. 1992; Meserve et al. 1995). In some such environments, detailed, long-term studies have already revealed

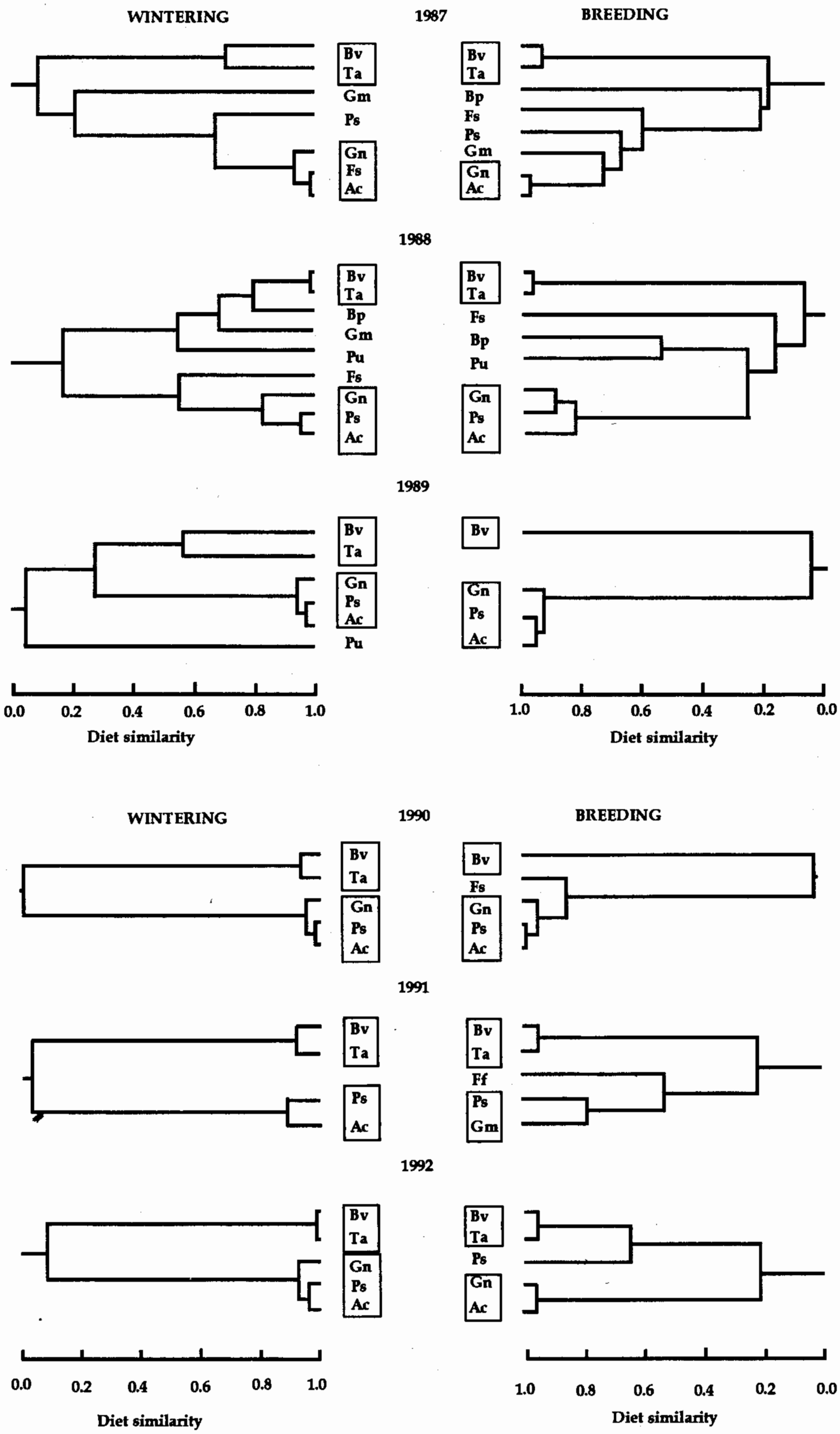

Figure 4. Trophic guild structure of predators throughout 14 biological seasons (wintering and breeding) at Aucó. A diet similarity close to 1 indicates a high overlap in diet; one close to 0 indicates a distinct diet. Trophic guilds recognized are demarcated by rectangles, using the criterion of ≥ 50% diet similarity (note that usually similarity exceeded 75%). Species abbreviations are Bv, Bubo virginianus*; Ta,* Tyto alba*; Gm,* Geranoaetus melanoleucus*; Ps,* Pseudalopex culpaeus and griseus*; Gn,* Glaucidium nanum*; Fs* Falco sparverius*; Ac,* Athene cunicularia*; Bp,* Buteo polyosoma*; Pu,* Parabuteo unicinctus*; Ff,* Falco femoralis*; and El,* Elanus leucurus.

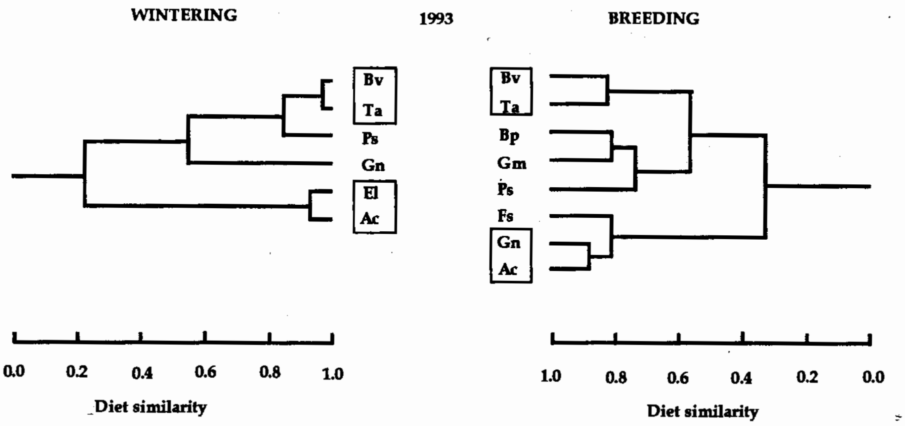

Figure 4. Continued

pronounced shifts in guild structure at least among granivorous birds (Wiens and Rotenberry 1979, 1980, 1981; Pulliam 1983; Dunning 1986). Likewise, the dramatic responses of vertebrate predators worldwide to fluctuations in prey density are well-known in ecology (Elton & Nicholson 1942; Errington 1946, 1956; Solomon 1949; Holling 1959; Pearson 1966; Murdoch 1969; Hamerstrom 1979; Erlinge et al. 1984; Sinclair et al. 1990). What is different about Aucó, however, is that the shifts were unexpected and revealed only by the full 7 years of data accumulated to date. Further, the Aucó results sound a warning note: Conservation measures based on short-term studies must be undertaken with extreme caution.

Our study does not deal directly with conservation status or management of the vertebrate predators concerned. In Chile, at least, none is in serious danger at present (Jaksic & Jiménez 1986; Glade 1988). The semiarid habitat of north-central Chile was altered centuries ago by mining, deforestation, and overgrazing and faces few further threats (Miller 1980; Fuentes et al. 1988; Fuentes 1990). In fact, today's predator assemblage may be a recent development, an artifact of that habitat conversion (Simonetti 1988, 1989*a*; but see Meserve 1988). Nevertheless, Aucó serves as a model for sites where conservation is the primary concern. The 12 endothermic species are quintessential vertebrate predators: hawks and falcons, owls, and foxes. Whether or not they actually regulate prey populations and determine prey species diversity is debatable (Jaksic et al. 1992, 1993; Jiménez et al. 1992), but certainly their high-volume consumption influences the population abundance and habitat selection of prey (Jaksic 1986; Jaksic & Simonetti 1987; Simonetti 1989*b*), and thereby much of Aucó's food web, justifying the label of keystone species. The most spectacular (*Geranoaetus melanoleucus*, *Parabuteo unicinctus*, and *Buteo polyosoma*) could serve as flagship species (Glade 1988). The same three, owing to their extensive home ranges, may act as umbrella species. Finally, at least *Buteo* and *Geranoaetus* are vulnerable, although not yet endangered, in Chile (Jaksic & Jiménez 1986), and outside protected areas the two foxes often experience heavy hunting pressure (Iriarte & Jaksic 1986; Jiménez 1993*a*).

At Aucó, would a short-term, intensive study have adequately inventoried the vertebrate predators? A census taken early in the study (Table 1, Fig. 3) would have overestimated the richness of species capable of residing in the Reserva Nacional Las Chincillas and might have diverted attention from the need to conserve other habitats apparently crucial at other times to several of the species. Differences in Aucó's species composition between seasons in a given year were relatively slight, implying that seasonal migration is not pronounced (Jaksic et al. 1990) and further diverting attention from the fact that movements over longer time scales, necessarily involving other sites, apparently occur. Conversely, a census taken during 1990 or 1991 (Table 1, Fig. 3), would have underestimated the richness of species that depend on or at least utilize Aucó prey during some years. A data set adequate to fine-tune conservation strategies for such an assemblage would need to involve not only a long series of years but also a much broader geographical area than we examined (Holmes et al. 1986; Whitford & Steiberger 1989; Meserve et al. 1993).

Likewise, data on home-range size, even taken over an entire year, would seriously underestimate the true habitat requirements of at least half the predator species we examined. For example, calculations based on the small home ranges typical of *Falco sparverius* for the first two years of the study (Table 1) would differ greatly from calculations including the species' longer-term movements, were these known in detail. Perhaps even the eye-opening calculations of areas needed to conserve falconiforms of tropical rainforests (Robinson & Wilcove 1989; Thiollay 1989) vastly underestimate the actual requirements, if such birds act at all like their Chilean cousins by engaging in long-term movements.

Finally, if immediate decisions on conservation were necessary, would information on guild structure and residence status provide any basis for selecting the predator species most critical to conserve? The first 4 years of data suggest so. During that time two strigiforms in one case and two other owls plus the foxes in the other case had quite redundant diets (Fig. 4). By the redundancy criterion (Walker 1992), admittedly oversimplified here, limited efforts could reasonably be focused on a single member of each trophic guild. The last three years of data, however, suggest that such a decision for the owls-plus-foxes grouping, at least, would have been misguided (Fig. 4). Again, long-term shifts in the predator assemblage would have confounded tactics based on short-term studies.

Another use of the redundancy strategy (Walker 1992) would be to focus on the guilds' least-mobile species because these would presumably require the least extensive habitat in the long term and best enable realistic conservation measures to be undertaken (Hansen et al. 1993). If mobile (transient) species entering a site consistently played roles redundant with those of residents—joined or formed trophic guilds with residents—then choices would be clear-cut: all else being equal, focus on residents and omit attention to transients. For example, the first three seasons' data suggest that *Falco sparverius* merged with the omnivore guild of residents (Fig. 4), thus adding little to the functional diversity of Aucó predators. In the fourth season, though, *F. sparverius* changed position and played a unique trophic role. Other transients were even less consistent than *F. sparverius* in their diet relations with other species, often consuming unique combinations of foods (Fig. 4). In short, concentrating conservation efforts on residents would greatly diminish the functional diversity of the Aucó predator assemblage. Detailed information on trophic guild structure reveals no easy solutions, and in particular any decisions based on patterns of diet redundancy during one time period would be erroneous in light of patterns during other time periods.

What are the lessons Aucó has for conservation biologists? Few conservation decisions can afford to await the accumulation of a seven-year data set. Obviously, we do not suggest that the decision-making process be postponed until all the facts are known or that short-term studies are irrelevant to this process. We do suggest, though, that a little knowledge is a dangerous thing: "snapshots" of consumer assemblages may miss features critical to long-term phenomena (Wiens 1981) and, unless conservation biologists tread cautiously, may lead to misguided action. In conservation as in basic ecology there is no substitute for knowledge of natural history (Bartholomew 1986; Greene 1986) or, we may add, for long-term data series. How long is long enough is an elusive issue. At least in our system, a full cycle from one El Niño event to the next (which has yet to occur in Aucó), seems barely adequate. After all, as prolonged as it looks, one cycle constitutes just one observation with no replication.

Acknowledgments

This study has been supported by grants DIUC 87-0[illegible] from the Dirección de Investigación, Universidad Católica de Chile; INT 88-02054 and 92-14085 from the U. S. National Science Foundation; BES 90-760 from the British Ecological Society; WWF-1297 from the World Wildlife Fund—U.S.; FONDECYT 90-0725, 92-0038, and 193-0639 from Fondo Nacional de Desarrollo Científico y Tecnológico (Chile); 91-4502 from the National Geographic Society (U.S.A.); and from Fundación Andes/CONICYT (Chile), the Frank M. Chapman Memorial Fund (U.S.A.), the Lincoln Park Zoo Scott Neotropic Fund, and the program in Tropical Conservation and Development, University of Florida. Numerous people have contributed to the collection of data, foremost among them Christian Muñoz, Boris Saavedra, Enrique Silva, and Elier Tabilo. We also thank Sergio Castro, Carl Marti, Pablo Marquet, Enrique Silva, Sergio Silva, and Hugo Torres for data analysis. We owe special recognition to the Program of Sponsored Research in the System of Protected Wildlife Areas under auspices of Corporación Nacional Forestal (CONAF) of Chile, Juan Cerda of CONAF-IV Region and Jorge Silva of CONAF-Illapel kindly allowed us to work in Reserva Nacional Las Chinchillas and provided logistic support. Peter Meserve, John Wiens, and an anonymous reviewer greatly improved the clarity of our manuscript.

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