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A rating system for potential exotic bird and mammal pests

K. Shawn Smallwood

Department of Agronomy and Range Science, University of California, Davis, California 95616, USA

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Terrell P. Salmon

Division of Agriculture and Natural Resources, Northern Region, University Research Park, University of California, Davis, California 95616, USA

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Natural areas, natural resources, and agricultural production systems have been damaged by introduced species, and are jeopardized by future invasions. A rating system was developed to prioritize research and control efforts for preventing species invasions and eradicating established exotic pests. Four rating criteria were the species potential (1) to be introduced; (2) to establish; (3) to cause damage; and (4) to be controlled. Each species was rated independently for each criterion, and these ratings summed to provide a total score. The rating system was developed with 24 exotic bird and mammal species with well-known invasion and pest histories. We then rated the 14 bird and mammal species on the California Department of Food and Agriculture most unwanted exotic species list, and 10 other species. The rating system provided surprising objectivity for assessing the threat of species invasion and pest status. Of the 14 'most unwanted species', four were rated as a low threat, and 13 of the 34 other rated species were recommended for this list. Certainly, this list should be lengthened. A quick-response apparatus was also developed to provide information on perceived exotic species threats. It consisted of a data base of expert contacts and citations on exotic pest species damage, biology, ecology, and control technology.

INTRODUCTION

Much of the recent literature on the ecology of invasions, including the Scientific Committee on Problems of the Environment (SCOPE) symposia (Groves & Burdon, 1986; Kornberg & Williamson, 1986; Macdonald *et al.*, 1986; Mooney & Drake, 1986), has been concerned with identifying where and how introduced species cause damage, and how we can better predict and prevent establishment of exotic pest species. Weir (1977) presented a model to predict pest status. Models or rating systems to screen species for invasion and pest potential were proposed by Arthington and Mitchell (1986) (no quantification used) and Ahmed *et al.* (1988) for fish, by Navarantham and Catley (1986) for plants, and by Schoulties *et al.* (1983) (no quantification) for plant pathogens. Shrum and Schein (1983) discussed the need for such models. Williamson and Brown (1986) surveyed the literature and taxonomic experts to determine whether knowledge of taxonomic patterns could improve the ability to predict invasion success and pest status. Usher (1986) and Fox and Fox (1986) sought to improve damage prediction in nature reserves by examining disturbances in relation to invasibility, or propensity to be invaded. Only Navarantham and Catley (1986) provided enough detail for model development and use, so that we may establish an exotic species list prioritized by concern for pest potential.

Much of the recent effort in describing environmental and wildlife damage by introduced species

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was perhaps precipitated by Simberloff's (1981) contention that investigators rarely provide evidence of biological invaders affecting the invaded systems. De Vos *et al.* (1956), Auld and Tisdell (1986), Breytenbach (1986), Usher (1986), Versfeld and van Wilgen (1986), Vitousek (1986), Macdonald *et al.* (1988), and Baker (1990) detailed many examples of exotic species causing environmental and wildlife damage in their invaded ranges. Moyle (1986) concluded that communities subject to invasion and disruption by exotic species exist in human-altered habitats. Pimm (1987) suggested that the impacts of exotic species on invaded systems should be most severe when (1) species are introduced into predator-free areas; (2) polyphagous species are introduced; and (3) species are introduced into relatively simple communities. Vitousek (1990) suggested that invaders can change ecosystems when they '(1) differ substantially from natives in resource acquisition or utilization; (2) alter the trophic structure of the invaded area; or (3) alter disturbance frequency and/or intensity'.

Besides the warranted concern for the integrity of natural areas, we need to be concerned for agricultural production systems, including forest resources. According to Pimentel (1986), 27% of insect pest species in US forests are exotics, 40% of major insect pests of US agriculture are exotics, and almost 40% of all 155 major vegetable pathogens have a worldwide distribution. According to our data, 11 (61%) of the exotic mammal species are pests in California, as are ≥5 (25%) of the exotic birds. Three exotic mammals (17%) and two exotic birds (10%) are serious agricultural pests, two mammals (11%) are serious pests to wildlife and habitat, and one bird is a serious urban pest. Thus, of exotic species in California, 28% of mammals and 15% of birds are recognized serious pests.

Invading species that become pests can be devastating. No reliable estimate is available of exotic vertebrate damage to California agriculture or forestry, but there are estimates for insect, plant, and disease pests. Pimentel (1986) estimated crop losses in the USA due to pests at 37%—13% due to insects, 12% to plant pathogens, and 12% to weeds. He estimated losses to US forests at 33%—21% due to plant pathogens, 9% to insects, and 3% to other animals. Diseases and insects cause 13% losses to livestock. Of course, many examples of damage described thus far cannot be expressed as dollars or percentage loss. The loss of genetic and community integrity creates a conservative bias in any model or rating system.

It is difficult to predict which exotic species will become pests following invasion because resources exploited in the new environment may differ from those exploited in the native range (Bateman, 1977). Such changes in resource use may result from interspecific interactions in the invaded community (Bateman, 1977) or from genetic changes among the invaders (Howard, 1965; Ehrlich, 1986; Mooney *et al.*, 1986).

A rating system is needed to help set priorities for research and control effort of invading bird and mammal pest species. For reasons of practicality and the immediate concerns of natural resource agencies, the system described herein expresses pest status in economic terms. In helping to set priorities for research and control effort, the rating system should be complemented by knowledge of other special factors. Following the Australians (Navarantham & Catley, 1986) and the California Department of Food and Agriculture (hereafter CDFA), we incorporated the rating system into the working steps of a quick-response strategy for evaluating and acting on the invasion of a potential exotic pest. We note that this study is developmental, and involves little hypothesis testing. A significant advantage is that the rating system presented in this paper can be adapted for use anywhere.

METHODS

The initial rating system evolved from our work with exotic bird and mammal pests, in which we developed empirical models to predict invasion success of birds and mammals in North America (Smallwood, 1990). Rating sheets (see Appendix I) were used to evaluate four criteria for exotic pests, including the potential (1) to be introduced; (2) to establish; (3) to cause damage; and (4) to be controlled. Each criterion was composed of two to five categories. For each species, a total score was arrived at by first rating the categories, then using the category ratings to index concern for each criterion, and finally summing the weighted concern values among criteria:

Category rating (rate 0–1)	'High' or 'Sum' Score/points
⇒ Criterion rating (0–1)	Average of category ratings
⇒ Concern (1–3)	Index of criterion rating
⇒ Total score (9–27)	Σ criteria weight × concern

Category ratings were ratios of High or Sum Scores relative to the score possible for that category (parentheses, Appendix I). A High Score applied when a single-category statement from a multiple choice described the investigated case, and a Sum Score applied when multiple statements described the case. Either way, the resulting ratio was entered into the appropriate workspace on the last page of Appendix I. Each criterion rating was the average of the corresponding category ratios. Thus, the final values ranged from 0 to 1 for each category and concern. This way, every category had equal potential of contribution to a criterion rating, and until they were weighted, all four criteria had equal potential to contribute to the total score. When a category did not apply to a species, it was skipped in rating that particular criterion. When information was poor, we sought to err on the conservative side, so we added a correction value of 0·05 to category ratings with questionable information, and 0·10 to ratings with poor or non-documented information.

Criteria were indexed for concern by ranking the species according to their ratings for each criterion. Logical cut-off values divided the species into groups that indexed concern: Low = 1; Moderate = 2; and High = 3. This indexing avoided inappropriate mathematical exactness in rating concern; a concern rating of 0·90 may not be different from 0·88. Based on our experience, we weighted the criteria according to their relative importance for defining the potential pest status of an exotic species: Introduction Potential = 1; Establishment Potential = 2; Damage Potential = 3; and Control Potential = 3. Finally, a total score for each species was calculated by summing criteria concern values multiplied by the criteria weightings.

We tested the sensitivity of the rating system with 12 randomly chosen species from our list of 144 birds and mammals introduced in North America (Smallwood, 1990). We also selected 12 species (not necessarily from the same list) that were easy to rate, and that we knew would vary greatly in their rating values. For each criterion, we sought to maximize the range of rating values within the limits 0 to 1, and obtain a mean near 0·5. This condition would maximize sensitivity of the rating system to discriminate the threat among potential exotic pests.

To test the utility of the rating system, we applied the cut-off values of concern established from the above 24 species to index concern for other species. We rated the 14 birds and mammals on CDFA's most unwanted species list and 10 others. Species with total scores of ≥24 were recommended for inclusion on CDFA's list, so long as they were not already well-established (beyond CDFA's eradication ability). Species with total scores of 20–22 were strongly considered for the list, and those with total scores of ≤19 were considered only if there were special circumstances, such as an unusual life-history strategy that suited invasion success and/or exploitation of a valuable resource. Also, the behaviors of criteria ratings among species groups were examined for bias that the rating system can help reduce when identifying potential exotic pests. Special attention was given to rating values that varied by method of species selection, and whether the species already occurred locally.

The vampire bat *Desmodus rotundus* was used to test a quick-response strategy that included Vertebrate Pest Control Contacts (VPCC) and a large reference collection, the Vertebrate Pest Control Library (VPCL). VPCC is a list of vertebrate pest-management experts who can provide pertinent information or expert contacts on pest species. Each of these individuals was contacted, and 108 names are on the current list and stored for use with the data management program SCIMATE. VPCL now contains >30 000 citations related to the ecology/biology, damage, and control technology for bird and mammal pests internationally; these are cataloged and stored in a SCIMATE data base that we refer to as BACKBONE. VPCC and VPCL are located at the Department of Wildlife and Fisheries Biology, University of California, Davis, and can be accessed by contacting Dr Terrell P. Salmon or Rex Marsh. Most of these citations were collected by Walter E. Howard, Professor Emeritus at the University of California, Davis, over his 43-year career. A trial of the quick-response procedure will be described in the Management Implications section.

RESULTS

We achieved our desired rating sensitivity. Ratings for introduction, establishment, and damage potential spanned the full range of 0 to 1, with a mean near 0·5. The control potential ratings were less variable, but with a similar mean (Tables 1 and 2). Furthermore, cut-off values for indexing concern were easy to choose because criteria ratings were clustered (Table 1).

Methods of species selection influenced rating values. Both total scores and individual criterion ratings (except control potential) were typically larger for species chosen intentionally rather than randomly (Tables 1 and 2). The original 24 species had a greater range of concern ratings (except control potential) than did either the 14 birds and mammals on CDFA's most unwanted list or the

Table 1. Ratings of 24 bird and mammal species that were used to develop the rating system

Species selected randomly (top 12) and intentionally (bottom 12)	Ratings of concern[a] for the potential to:				Total score
	Be introduced (× 1)	Establish[b] (× 2)	Cause damage (× 3)	Be controlled (× 3)	
Black grouse *Tetrao tetrix*	0·34 L	0·25 L	0·30 M	0·49 H	18
Brown-throated conure *Aratinga pertinax*	0·44 L	**0·50** M	0·57 H	0·38 M	22
Canary-winged parakeet *Brotogeris versicolorus*	0·96 H	**0·75** H	0·35 M	0·38 M	21
Cattle egret *Ardeola ibis*	0·61 H	**1·00** H	0·04 L	0·30 M	18
Chaffinch *Fringilla coelebs*	0·58 M	0·38 L	0·41 M	0·40 M	19
Common flamingo *Phoenicopterus ruber*	0·45 L	**0·50** M	0·10 L	0·13 L	11
Greenfinch *Carduelis chloris*	0·59 M	0·38 L	0·36 M	0·40 H	19
Nightingale *Luscinia megarhynchos*	0·54 M	0·00 L	0·20 L	0·46 H	16
Red deer *Cervus elaphus*	0·32 L	**0·63** M	0·31 M	0·19 L	14
Red-legged partridge *Alectoris rufa*	0·44 L	0·25 L	0·22 L	0·30 M	12
Tree sparrow *Passer montanus*	0·44 L	**0·88** H	0·55 H	0·46 H	25
White-winged dove *Zenaida asiatica*	0·54 M	**0·63** M	0·19 L	0·30 M	15
Burro *Equus asinus*	0·86 H	**0·75** H	0·46 M	0·30 M	23
Cockatoo *Cacatua galerita*	0·67 H	0·50 M	0·53 H	0·38 M	22
Common peafowl *Pavo cristatus*	0·79 H	**0·75** H	0·16 L	0·19 L	15
European rabbit *Oryctolagus cuniculus*	0·79 H	**0·88** H	0·77 H	0·24 L	21
Horse *Equus caballus*	0·75 H	**1·00** H	0·37 M	0·18 L	18
House crow *Corvus splendens*	0·50 M	0·50 M	0·74 H	0·25 L	18
House mouse *Mus musculus*	0·93 H	**1·00** H	0·84 H	0·41 H	27
House sparrow *Passer domesticus*	0·64 H	**1·00** H	0·66 H	0·41 H	27
Mouflon *Ovis orientalis*	0·57 M	**0·75** H	0·44 M	0·24 L	17
Penguin *Aptenodytes patagonica*	0·39 L	0·00 L	0·11 L	0·35 M	12
Pig *Sus scrofa*	0·82 H	**1·00** H	0·89 H	0·43 H	27
Starling *Sturnus vulgaris*	0·57 M	**1·00** H	0·81 H	0·41 H	26

[a] Rating values of 1 represent cases of greatest concern. Cut-off values for levels of concern were: H ≥ 0·60; M ≥ 0·50; L < 0·50; H ≥ 0·75; M ≥ 0·50; L < 0·50; H ≥ 0·50; M ≥ 0·30; L < 0·30; L ≥ 0·40; M ≥ 0·30; H < 0·30.
Concern was indexed *H*igh = 3, *M*oderate = 2, and *L*ow = 1. Indexed values were multiplied by the weightings in parentheses under each concern. The summed four products was the species total score, and could range from 9 to 27.
[b] Values in bold type denote species established in North America.

Table 2. The statistics used to validate the rating system for exotic species invasion and pest potential in California

	Ratings of concern for the potential to:				Total score
	Be introduced	Establish	Cause damage	Be controlled	
Randomly selected species					
Lo–Hi	0·32–0·96	0·00–1·00	0·04–0·57	0·13–0·49	12–25
Range	0·64	1·00	0·53	0·36	13
Mean	0·52	0·51	0·30	0·35	17·5
CV	32·10	55·58	54·10	31·38	23·6
Intentionally selected species					
Lo–Hi	0·39–0·93	0·00–1·00	0·11–0·89	0·18–0·43	12–27
Range	0·55	1·00	0·78	0·25	15
Mean	0·69	0·76	0·57	0·32	21·1
CV	23·32	39·94	46·52	29·47	24·3
All 24 species selected					
Lo–Hi	0·32–0·96	0·00–1·00	0·04–0·89	0·13–0·49	12–27
Range	0·64	1·00	0·85	0·36	15
Mean	0·61	0·64	0·43	0·33	19·3
CV	30·10	49·43	58·47	30·34	24·2

Table 3. Ratings of mammal and bird species on CDFA's most unwanted exotic species list, and of 10 other mammal and bird species

Species on CDFA list (top 14) and 10 others (bottom 10)	Ratings[a] of concern for the potential to:				Total score
	Be introduced (× 1)	Establish (× 2)	Cause damage (× 3)	Be controlled (× 3)	
Coati *Nasua nasua*	0·38 L	0·25 L	0·23 L	0·19 L	9
Crested mynah *Acridotheres cristatellus*	0·74 H	0·50 M	0·57 H	0·36 M	22
Common mynah *Acridotheres tristis*	0·71 H	0·38 L	0·57 H	0·36 M	19
European ferret *Mustela putoria*	0·86 H	0·63 M	0·69 H	0·60 H	25
Java sparrow *Padda oryzivora*	0·71 H	0·63 M	0·56 H	0·49 H	25
Kinkajou *Potos flavus*	0·52 M	0·25 L	0·27 L	0·29 L	10
Mongoose *Herpestes auropunctatus*	0·59 M	0·50 M	0·63 H	0·61 H	24
Mongolian gerbil *Meriones unguiculatus*	0·77 H	0·25 L	0·47 M	0·48 H	20
Monk parakeet *Myiopsitta monachus*	0·89 H	1·00 H	0·57 H	0·69 H	27
Nutria *Myocastor coypu*	0·69 H	1·00 H	0·71 H	0·18 L	21
Prairie dog *Cynomys ludovicianus*	0·60 H	0·25 L	0·60 H	0·38 M	20
Red-billed quelea *Quelea quelea*	0·37 L	0·25 L	0·72 H	0·84 H	21
Red-whiskered bulbul *Pycnonotus jocosus*	0·86 H	0·75 L	0·57 H	0·49 H	27
White-eye *Zosterops* spp.	0·88 H	0·75 H	0·41 M	0·65 H	24
Axis deer *Axis axis*	0·66 H	0·75 H	0·43 M	0·49 H	24
Capercaillie *Tetrao urogallus*	0·66 H	0·25 L	0·48 M	0·54 H	20
Common waxbill *Estrilda astrild*	0·77 H	0·88 H	0·43 M	0·35 M	21
Eastern fox squirrel *Sciurus niger*	0·86 H	0·75 H	0·41 M	0·30 M	21
Eastern gray squirrel *Sciurus carolinensis*	0·81 H	0·75 H	0·41 M	0·41 H	24
Red avadavet *Amandava amandava*	0·78 H	0·88 H	0·43 M	0·41 H	24
Rose-ringed parakeet *Psittacula krameri*	0·89 H	0·75 H	0·64 H	0·54 H	27
Song thrush *Turdus philomelos*	0·71 H	0·88 H	0·56 H	0·41 H	27
Spotted turtledove *Streptopelia chinensis*	0·89 H	0·75 H	0·58 H	0·43 H	27
Vampire bat *Desmodus rotundus*	0·55 M	0·63 M	0·40 M	0·60 H	21

[a]See Table 1 for details of rating value calculations.

Table 4. The ranking by total scores of 48 bird and mammal species calculated with our rating system for invasion and pest potential in California

Species[a]	Total score	Species	Total score
House sparrow	27 *	**Canary-winged parakeet**	21 *
House mouse	27 *	Common waxbill	21
Pig	27 *	Eastern fox squirrel	21 *
Monk parakeet	27 *	European rabbit	21
Rose-ringed parakeet	27 *	***Mongolian gerbil***	20
Red-whiskered bulbul	27 *	*Prairie dog*	20
Song thrush	27	**Capercaillie**	20
Spotted turtledove	27 *	***Common mynah***	19
Starling	26 *	Chaffinch	19
Tree sparrow	25	Greenfinch	19
Java sparrow	25 *	Black grouse	18
European ferret	25	House crow	18
Axis deer	24 *	Cattle egret	18 *
Eastern gray squirrel	24 *	Horse	18 *
Mongoose	24	Nightingale	16
Red avadavet	24	Common peafowl	15 *
White-eye	24 *	White-winged dove	15
Burro	23 *	Mouflon	15
Crested mynah	22	*Coati*	15
Cockatoo	22	Red deer	14
Brown-throated conure	22	Red-legged partridge	12
Vampire bat	21	Penguin	12
Red-billed quelea	21	Common flamingo	11
Nutria	21	*Kinkajou*	10

[a]An * following the total score denotes species that occur in California. Italicized species are on CDFA's most unwanted exotic species list. Species in bold type were recommended for the list based on their ratings. Species in bold and italic are on CDFA's most unwanted pest list and it is recommended that they remain there.

10 other species (Table 3). Total scores were high among CDFA's most unwanted species, but highest for the 10 others ($\bar{x}$ = 21·0 and 23·9, respectively). However, total scores were unrelated with whether the species were listed as most unwanted by CDFA ($\chi^2 = 1{\cdot}66$, d.f. = 2, $p \gg 0{\cdot}05$) (Table 4). Indexed concern values of control potential were higher among CDFA's most unwanted species and the 10 others than among the original 24 species. We present in Table 4 the current list of most unwanted exotic pests, and a recommended new list based on our rating system. Finally, the rating system was sensitive to species occurrence at the location of concern. Total scores (grouped 10–18, 19–23, and 24–27) were positively related with whether species occur in California ($\chi^2 = 10{\cdot}54$, d.f. = 2, $p < 0{\cdot}05$).

DISCUSSION

The rating system can serve as a tool to help set priorities for research and control effort of potential exotic pests. This is because the rating system is general, validated with known exotic pests, sensitive to near the full range of potential rating values among criteria, and we understand some of the bias associated with the selection process of species to be rated. For instance, park and resource managers should be more concerned with our intentionally rather than randomly selected species. This makes sense, because we chose species based on their invasion and pest histories. The 14 species on CDFA's most unwanted list also averaged high total scores, although some had very low total scores. The listed species and the 10 others we selected were rated as being the most difficult to control. The high total scores for species already established in California served to validate the rating system.

Given our rudimentary ability to predict invasion success and pest status, nearly all exotic birds and mammals should be of concern to resource agencies. Indeed, according to Williamson and Brown (1986), 'On our present knowledge, almost any sort of species might become a pest; however, knowing that the probability of its being so was low would be no consolation once it had become one'. Our present knowledge has improved, but because we cannot remain vigilant at all ports of entry, nor can we afford to, setting priorities is strongly justified. The California Department of Food and Agriculture's list of most unwanted exotic species serves a good purpose and should be retained. However, some species should be dropped from the list, and others added. For example, if we set a cutoff total score of ≥24 for inclusion on the list, six species would be retained, four dropped, and 13 more added. This does not mean that species dropped from the list would be of no concern.

Management implications

Imagine that a small propagule of vampire bats was accidentally released from a southern California zoo. We used this scenario to apply our rating system, and to test our data base on vertebrate pest control expertise. In less than 15 minutes, we obtained names and addresses from the VPCC system of 12 contacts, who are experts in vertebrate pest control in Mexico, and Central and South America. In less than 45 minutes, we searched all citations on BACKBONE (VPCL), and identified over 40 related to vampire bats. Of these citations, 25 pertained to ecology/biology, damage, and control techniques for this species. This citation search also added two more contacts to the original list of 12.

We quickly reviewed these citations and applied the information to our rating system. The vampire bat rated 21 out of 27 possible points. It ranked high on the list with known exotic vertebrate pests in North America, and equalled or surpassed seven of the 14 species on CDFA's most unwanted pest list. According to the rating system, the vampire bat warrants concern for its potential invasion and pest status in California.

Our rating system can be adapted elsewhere by modifying the multipliers in the category Damage Potential 'To Agriculture'. The models used to predict invasion success (Smallwood, 1990) were general because they were developed from most historical bird and mammal invasions in North America, and many of these species are frequent invaders internationally. For instance, species used to develop our rating system, such as the house sparrow *Passer domesticus*, starling *Sturnus vulgaris*, house mouse *Mus musculus*, and pig *Sus scrofa*, are found on most continents due to historical invasions. Others, such as the common peafowl *Pavo cristatus*, chaffinch *Fringilla coelebs*, tree sparrow *Passer montanus*, and burro *Equus asinus*, have been introduced to many international locations. Most modifications to our rating system would focus on location-specific concerns for natural areas, resources, agricultural production systems, and human health. To protect against negative impacts of future invasions, quick-response measures should be implemented now, and by many resource agencies.

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APPENDIX I

Exotic Vertebrate Pest Rating Sheet

Species name ______________________________

Investigator ______________________ Date ______________

INTRODUCTION POTENTIAL

Immigration (5 points possible)

Likely to survive importation trip if intentional	(1)
Found in imported cargo	(2)
Found in imported agricultural commodities	(3)
Experienced range expansion (natural or man-caused)	(4)
Found at location of concern	(5)
	High Score ____

Pet Trade (5 points possible)

Never known to be a pet	(0)
Information available about keeping in captivity	(1)
Kept in captivity, but difficult	(2)
Common pet outside local area	(3)
Known blackmarket trade in local area	(4)
Openly available in local area	(5)
	High Score ____

Desirability (4 points possible)

No introductions outside native range	(0)
Potential research animal	(1)
Common research animal (US research in last 10 years)	(2)
Known commercial value (hunted/fur/meat/byproducts)	(3)
Known introductions outside native range	(3)
Found in local zoos	(3)
Known past introductions in local area	(4)
Request (etc.) for importation in local area	(4)
	High Score ____

Detection/Observability (7 points possible)

Size ≤ 3 kg = 2, >3 and <15 kg = 1, ≥ 15 kg = 0	____
Activity period nocturnal = 1, diurnal = 0	____
Typical social group small = 2, medium = 1, large = 0	____
Detection techniques known well = 0, some = 1, little = 2	____
	Sum Scores ____

ESTABLISHMENT POTENTIAL

Worldwide (4 points possible)

Found only within native range	(0)
Original range expanding naturally	(1)
Successful in some introductions	(2)
Common invasions into many regions outside native range	(3)
Found in local area	(4)
	High Score ____

Discriminant Model Results (From Smallwood, 1990) (2 points possible)

Unsuccessful	(0)
Locally successful	(1)
Regionally successful	(2)
	High Score ____

DAMAGE POTENTIAL

In Native Range (Agricultural commodities only) (5 points possible)

Rare/never reported	(0)
Not reported but possible	(1)
Infrequent (one/few commodities)	(2)
Infrequent (many commodities)	(3)
Common (one/few commodities)	(4)
Common (many commodities)	(5)
	High Score ____

In Introduced Range (Agricultural commodities only) (5 points possible)

Rare/never reported	(0)
Not reported but possible	(1)
Infrequent (one/few commodities)	(2)
Infrequent (many commodities)	(3)
Common (one/few commodities)	(4)
Common (many commodities)	(5)
	High Score ____

To Agriculture (42 points possible for California)

Fill in the first column of blanks with the following damage scores: High = 2, low = 1, none = 0. The multipliers were calculated to represent the relative value of each local (California) commodity group in billions (10^9) of dollars. Multipliers for aquaculture, landscape, and structural commodities were best guesses. All multipliers should be adjusted for relative values of commodities at different locations.

	California multiplier	
Annual crops	____ × 5·1 = ____	
Perennial crops	____ × 6·6 = ____	
Livestock	____ × 4·0 = ____	
Ornamental	____ × 1·2 = ____	
Rangelands	____ × 1·0 = ____	
Aquaculture	____ × 0·1 = ____	
Landscape	____ × 1·0 = ____	
Structural	____ × 1·0 = ____	
Other	____ × __ = ____	
		Sum Scores ____

To Natural Resources (4 points possible) (yes = 1, no = 0)

Endangered species	____
Wildlife—impact on species similar to local species	____
Erosion/water flow	____
Wildlife habitat destruction	____
	Sum Scores ____

To Commensal/Public Health (4 points possible) (yes = 1, no = 0)

Life history/ecology suggests commensalism (known habitat in/around buildings)	____
Known/suspected vector/reservoir of human disease(s)	____
Known/suspected vector/reservoir of livestock disease(s)	____
Known/suspected aggressiveness toward humans	____
	Sum Scores

CONTROL POTENTIAL

Detection (5 points possible) (yes = 1, no = 0)

No system published/available	____
No system published/available for similar species	____
Animal difficult to see	____
Sign difficult to see	____
Size of detection area expected >8 km^2	____
Sum Scores	____

Current Range (4 points possible)
Are the following control measures reported to be effective? Check appropriate measures and assign score at bottom of both goals for control: yes = 0, some = 1, no = 2 (2 points possible for each goal).

	Eradicate	Prevent damage
Cultural control	____	____
Toxicants	____	____
Traps/shooting	____	____
Exclusion	____	____
Repellents/frightening	____	____
	Score ____	Score ____

Sum Score ____

Usefulness in Local Area (2 points possible) (Usually 'yes')
Could the above control measures be effective locally? (yes = 0, some = 1, no = 2)

Score ____

Eradication Potential (4 points possible)
The species can be eradicated:

if animals spread statewide	(1)
if animals present regionally	(2)
only if animals present locally	(3)
only if 1 or a few animals present	(4)
High Score	____

WORK SHEET

INTRODUCTION POTENTIAL

Immigration	High score ____/5 = ____
Pet Trade	High score ____/5 = ____
Desirability	High score ____/4 = ____
Detection	Sum scores ____/7 = ____
	Sum ratios ____/no. categories ____ = ____

ESTABLISHMENT POTENTIAL

Worldwide	High score ____/4 = ____
Model Results	High score ____/2 = ____
	Sum ratios ____/no. categories ____ = ____

DAMAGE POTENTIAL

In Native Range	High score ____/5 = ____
In Introduced Range	High score ____/5 = ____
To Agriculture	Sum scores ____/42 = ____
To Natural Resources	Sum scores ____/4 = ____
To Commensal/Public Health	Sum scores ____/4 = ____
	Sum ratios ____/no. categories ____ = ____

CONTROL POTENTIAL

Detection	Sum scores	____/5	=	____
Current Range	Sum scores	____/4	=	____
Usefulness in Local Area	High score	____/2	=	____
Eradication Potential	High score	____/4	=	____
	Sum ratios ____	/no. categories ____	=	____