

# CONTENTS

Foreword	xv
Preface	xix
Acknowledgements	xxiii
Contributors	xxvii
I: STATUS, RESEARCH, AND MANAGEMENT NEEDS OF THE NATIVE HAWAIIAN BIOTA	1
1. An Assessment of the Current Status of Native Upland Habitats and Associated Endangered Species on the Island of Hawai'i <u>James D. Jacobi and J. Michael Scott</u>	3 22
Abstract	3
Introduction	4
Methods	6
Background on	
Hawai'i Forest Bird Survey	6
Vegetation Mapping	8
Assessment of	
Status of Native Vegetation	9
Analysis of Endangered Species Data	9
Results	10
Current Status of	
Major Native Vegetation Units	10
Summary of Endangered	
Species Found Within Study Area	16
Discussion	17
Factors Responsible for	
Degradation of Native Habitats	17
Recovery Potential for	
Damaged Native Ecosystems	18
Conservation Strategies	18
Acknowledgements	19
Literature Cited	20

2. Status of the Native Flowering Plants of the Hawaiian Islands <u>Warren L. Wagner,</u> <u>Derral R. Herbst, and Rylan S.N. Yee</u>	23-74
Abstract	23
Introduction	25
Taxonomic Problems	26
Rare and Endangered Species of Hawaiian Flowering Plants	27
Endangered Species Program	29
Distribution of Threatened and Endangered Plants	29
Ni'ihau	34
Kaua'i	39
O'ahu	39
Moloka'i and Lana'i	41
Maui and Hawai'i	42
1. Agriculture	43
2. Silviculture	43
3. Introduced species	44
4. Development	44
Kaho'olawe	44
Northwestern Hawaiian Islands	45
Status of Hawaiian Amaranthaceae, Fabaceae, and Malvaceae	45
History of the Flora of 'Ewa Plains	55
Setting and History	56
The Flora of 'Ewa Plains	57
Research and Management Needs	60
Acknowledgements	63
Literature Cited	65
3. Distribution and Abundance of Hawai'i's Endemic Land Birds: Conservation and Management Strategies <u>J. Michael Scott,</u> <u>Cameron B. Kepler, and John L. Sincock</u>	75-104
Abstract	75
Introduction	75
Species Accounts	78
Conservation Status	89
Specific Management Recommendations	95
Hawai'i	95
Hakalau Preserve	95
Ka'u-Kapapala corridor	96
Hualalai crow preserve	96
Control of ungulates	96
Banana poka	96
Maui	96
Axis deer	97
Moloka'i	97
Oloku'i	97
Kamakou Preserve	97

Kaho'olawe	97
Kaua'i	97
Acknowledgements	98
Literature Cited	99
 4. Conservation Status of Native Terrestrial Invertebrates in Hawai'i <u>Wayne C. Gagne and Carl C. Christensen</u>	 105
Abstract	105
Introduction	106
Endemicity and Vulnerability	107
Perturbations and Extinctions	109
The Pristine Environment	110
Prehistoric Human Impacts	111
Historic Impacts	112
Current Distribution and Diversity of Native Invertebrates	113
Conservation Status and Strategies	115
Taxon-Specific Actions	115
Site-Specific Actions	117
Restrictions on Importation of Alien Organisms	118
Selection and Design of Natural Preserves	118
Research Needs	119
Conclusions	120
Acknowledgements	120
Literature Cited	121
 5. Protection Status of the Native Hawaiian Biota <u>R. Alan Holt and Barrie Fox</u>	 127 - 141
Abstract	127
Introduction	127
Defining "Protection"	128
Protected Areas in Hawai'i	129
Ecosystem Protection	129
Rare Species Protection	135
Where Do We Go From Here?	136
Acknowledgements	137
Appendix	139
Literature Cited	141
 6. Status, Research, and Management Needs of the Native Hawaiian Biota: A Summary <u>Stephen Mountainspring</u>	 142 - 146
 II. STATUS, RESEARCH, AND MANAGEMENT NEEDS FOR ALIEN BIOTA	 147
 7. Impacts of Alien Land Arthropods and Mollusks on Native Plants and Animals in Hawai'i <u>Francis G. Howarth</u>	 149 - 177

Abstract	149
Introduction	150
Characteristics of Colonizing Species	151
Impacts of Alien Invertebrates	152
Direct Consumption of Native Plants	152
Interference with	
Native Plant Reproduction	155
Predation and	
Parasitism of Native Animals	157
Transmission of Disease	
Organisms among Native Biota	161
Synergistic Effects among Aliens	163
Alteration in	
Soil Formation and Structure	164
Hybridization with	
Related Native Forms	165
Effects of Alien Pest Control	165
Solutions	165
Quarantines	166
Research Needs	168
Management	169
Biocontrol	170
Education	173
Acknowledgements	173
Literature Cited	174
 8. Impact of Alien Plants on Hawai'i's Native Biota	
<u>Clifford W. Smith</u>	180 250
Abstract	180
Introduction	181
Terminology	182
Plant Pests of	
Hawaiian Native Ecosystems	183
Problem Weeds in Hawai'i by Island	206
Problem Weeds in Hawai'i	
by Vegetation Zone	217
Impact of Weeds on Hawaiian Ecosystems	227
Formation of Monotypic Stands	227
Changing Fire Characteristics	228
Changing Soil-Water Regimes	229
Changing Nutrient Status	230
Mutually Beneficial Interaction	
Between Alien Plants and Animals	230
Impacts of Weeds on	
Other Tropical and Subtropical Islands	231
Atlantic Ocean and Caribbean Sea	231
Indian Ocean	232
Pacific Ocean	233
What Needs to be Done	233
Prevent Further Introductions	233
Stop Disturbance of Ecosystems	235
Develop Strategies to Encourage	
Native Species Reestablishment	236

Conclusions	239
Acknowledgements	242
Literature Cited	243
9. Alien Animals in Hawai'i's Native Ecosystems: Toward Controlling the Adverse Effects of Introduced Vertebrates	
<u>Charles P. Stone</u>	251
Abstract	251
Introduction	252
Polynesian Impacts (400 A.D.--1778 A.D.)	253
Effects on Islands and Ecosystems	255
Depredation	256
Domestic and feral cattle	256
Feral sheep	260
Mouflon	261
Feral goats	261
Black-tailed and axis deer	261
Feral pigs	262
Black and Polynesian rats	264
House mice	265
Predation	265
Small Indian mongooses	265
Feral cats	266
Black and Polynesian rats	267
Interspecific Competition	268
Native and alien birds	268
Native birds and rats	270
Habitat Degradation	270
Indirect Effects	272
Impacts on other aliens	272
Nutrient cycling	274
Reduction of Alien Impacts	275
Complexities of Damage Control	275
Depredations	278
Predation	281
Interspecific Competition	282
Management-Research Coordination	284
Multiple Approaches and Persistence	285
Toward Cooperative Efforts	286
Acknowledgements	287
Literature Cited	288
10. A Summary of Known Parasites and Diseases Recorded from the Avifauna of the Hawaiian Islands	
<u>Sandra G. van Riper and Charles van Riper III</u>	298
Abstract	298
Introduction	298
Classification of	
Parasites Reported from Hawaiian Birds	300
Endoparasites	306
Protozoa	306

Nematoda	311
Acanthocephala	318
Cestoda	318
Trematoda	321
Ectoparasites	323
Acari	323
Insecta	326
Viral, Bacterial, and Fungal Infections	329
Viral Diseases	329
Bacterial Diseases	331
Fungal Diseases	332
Discussion	333
Acknowledgements	337
Appendix	338
Literature Cited	357
11. Status, Research and Management Needs for Alien Biota: A Summary <u>Ronald L. Walker</u>	372
III. ECOSYSTEM MONITORING, RESTORATION, AND MANAGEMENT IN HAWAI'I	375
12. Vegetation Response within Exclosures in Hawai'i: A Review <u>Lloyd L. Loope and Paul G. Scowcroft</u>	377 - 402
Abstract	377
Introduction	377
Inventory of Hawaiian Exclosures	378
Exclosure Objectives and Their Accomplishments	378
Demonstrate Impacts of Alien Vertebrate Herbivores	378
Study Recovery Potential of Animal-damaged Ecosystems	378
Provide Ungulate-free Areas for Biological Experiments	390
Preserve Populations of One or More Rare Plant Species or Small Tracts of a Rare Plant Community Which Would Otherwise be Lost through Animal Damage	390
Assessing Vegetation Change	390
Cover	390
Density	391
Survival and Growth	392
Statistical Analysis	392
Sampling Frequency	392
Adequacy of Methods	392
Summary of Vegetation Response in Hawaiian Exclosures	393
Leeward Low/Middle Elevation Shrubland/Grassland	393
Leeward Low/Middle Elevation Forest	393

<u>Acacia koa</u> Forest	394
<u>Metrosideros</u> Rainforest	395
Subalpine Forest/Shrubland	395
Subalpine Grassland	396
Montane Bogs	396
"Natural Exclosures"	
and their Implications	397
Needs for the Future	397
Acknowledgements	399
Literature Cited	400
 13. 'Ohi'a Dieback and Protection Management of the Hawaiian Rain Forest	
<u>Dieter Mueller-Dombois</u>	403 - 421
Abstract	403
Introduction	404
Five Facts from Vegetation Research	404
'Ohi'a Dieback Shows Different	
Patterns and Site Relationships	405
Alternate Cause Hypotheses	406
Putting the Facts Together	407
Climatic Instability Factors	407
Soil Factors	408
Stand Factors	408
Application to Management	410
A New Viewpoint	410
Design of Preserves	410
Rare Endemic and Introduced Species	412
Soil Fertility	413
Forest Hydrology	413
Conclusions	415
Acknowledgements	416
Literature Cited	417
 14. Restoration of Native Ecosystems	
<u>Charles H. Lamoureux</u>	422 - 431
Abstract	422
Introduction	422
Various Concepts of	
Ecosystem Restoration	423
Problems in	
Adequately Characterizing Ecosystems	423
Goals and Objectives	
of Ecosystem Restoration	424
Efforts at	
Ecosystems Restoration in Hawaii	425
Costs of Ecosystems Restoration	427
Conclusions	427
Literature Cited	429
 15. Genetics, Minimum Population Size, and the Island Preserve	
<u>Christine Schonewald-Cox</u>	432 - 432

Abstract	432
Introduction	433
Why Do Populations Become Small?	434
Smallness and Survival	434
What is a Small Population?	435
Effective Population Size	435
Minimum Viable Population	436
The Evolutionary	
Potential of Small Populations	436
Typically Out-Breeding	
Diploid Species	437
Polyploid and Typically Inbreeding	
and Self-Fertilizing Species	438
Difference Between Small Populations	
Now and At Initial Colonization	438
Disequilibrium -- Adaptation	438
Disequilibrium -- Species Turnover	439
Assessing and Improving	
a Small Population's Condition	439
Populations ex situ	440
Populations in situ	441
Condition of Hawaiian Endemics	443
Surviving Colonization	443
Historical Influences on Survival	443
Modern Prospects for Survival	444
Inbreeding and	
Hawaiian Endemic Diploid Species	444
Restoring Small Population	
Remnants of Diploid Species	
with Inbreeding: a Case Example	446
Adapting to One's Genome	446
Adapting to Inbreeding	446
Two Notes on the Method	448
Small Populations of	
Self-Fertilizing and Polyploid Species	449
A Thought on Essentially Extinct Species	450
Conclusions: Genetics, Minimum	
Population Size, and	
the Prospect for Hawaiian Species	452
Acknowledgements	453
Literature Cited	454
 16. Design of Natural Area Preserves in Hawai'i	
<u>Jerry F. Franklin</u>	459-474
Abstract	459
Introduction	459
Principles in Preserve Design	460
Definition of Preserve Objectives	460
Determination of Minimal Area	461
Management Programs	464
Special Problems in Preserve Design	465
Large and Migratory Animals	465
Aquatic Ecosystems	466
Succession	466



Life Expectancies and Risk-Spreading	467
Preserve Design in Hawai'i	468
Conservation Triage	469
Acquisition and Intensive Management	470
Conclusions	472
Literature Cited	474
 17. Ecosystem Monitoring, Restoration, and Management in Hawai'i: A Summary <u>Sheila Conant</u>	 475-482
Monitoring with Exclosures	475
'Ohi'a Dieback	476
Ecosystem Restoration	477
Preserve Design:	
Genetics and Population Size	478
Preserve Design:	
Size, Shape, and Distribution	479
 IV. ROLES OF RESPONSIBLE GROUPS	 481
 18. Current and Future Roles of Agencies, Conservation Groups, Legislature, and the Public in Preserving and Managing Hawaiian Ecosystems: A Summary <u>Cameron B. Kepler</u>	 483-493
The U.S. Fish and Wildlife Service	483
The Nature Conservancy	484
National Park Service	485
State Department of Land and Natural Resources	486
Conservation Groups	487
Political Representatives	488
Private Landowners	488
Biologists	489
Hawaiian People	490
Group Interaction on Behalf of Hawaiian Ecosystems	490
Literature Cited	492
 V. CONCLUSION	 493
 19. Hawai'i's Native Ecosystems: Importance, Conflicts, and Suggestions for the Future <u>Charles P. Stone and J. Michael Scott</u>	 495-534
Reasons for Preserving Native Ecosystems	495
Aesthetic and Recreational Values	496
Hawaiian Cultural Uses	497
The Need to Preserve Genetic Diversity	498

The Need to Preserve Natural	
Processes and Gene Pools	499
The Need for Environmental Base-	
lines, for Research and Education	
Areas, and for Improving Land-	
Use Decisions	500
Watershed and Climatic Values	500
Ethical Considerations	501
Constitutional, Statutory, and	
Planning Mandates	502
Constitution of the State of	
Hawai'i, Hawai'i State Plan,	
and County General Plans	502
Hawai'i Revised Statutes (HRS)	503
Hawai'i Wildlife Plan	503
Hawai'i's Renewable Resources	
Research Plan for the 80's	503
Endangered Species	
Recovery Plans	504
DLNR Regulation No. 4	505
Conflicts with Other Land Uses	506
Private Lands	506
Public Lands	508
Suggestions for the Future	509
Acknowledgements	516
Appendix 1	517
Appendix 2	518
Appendix 3	527
Appendix 4	528
Literature Cited	530
Indexes	535
Geographic Index	537
Taxonomic Index	543
Subject Index	571