TABLE OF CONTENTS

CHAPTER	One Introduction with Key Findings	1
ç	Science and the Watershed Assessment	2
ł	Key Findings	7
	Environmental History	7
	Air Quality	8
	Upland Water Quality and Lake Clarity	9
	Biological Integrity	14
	Social, Economic, and Institutional Conditions	17
CHAPTER	Two A Contextual Overview of Human Land Use and Environmental Conditions	23
I	ntroduction	23
F	Paleoclimate and Environmental History	24
	Environmental Change in the Tahoe Sierra	24
	Prehistoric Era (Prior to 1850s)	34
	Comstock Era (1850s to 1900)	47
	Post-Comstock Era (1900 to 1950s)	73
	Urbanization (1950s to Present)	84
1	Time Line of Paleoclimate and Environmental History in the Lake Tahoe Basin	92
٦	Time Line of Transportation and Community Development	95
	Time Line of Human Land Use and Environmental Conditions in Lake Tahoe Basin	99
	Time Line of Human Land Use and Environmental Conditions, Upper Truckee	
_	River/Trout/Saxon/Heavenly Valley Creeks Watersheds (Lake Valley) 112N/R18E	06
	I me Line of Human Use and Environmental Conditions, Emerald Bay/Cascade and Fallen	
-	Leaf Lakes/Taylor Creeks Watersheds	11
	Time Line of Human Land Use and Environmental Conditions, Meeks Creek Watershed/ Meeks and Rubicon Bays1	12
7	Time Line of Human Land Use and Environmental Conditions McKinney Creek Watershed (Homewood/Chambers/Sugar Pine PT)1	12
1	Time Line of Human Land Use and Environmental Conditions, Blackwood Creek Watershed 1	13
1	Time Line of Human Land Use and Environmental Conditions, Ward Creek Watershed1	14
٦	Time Line of Human Land Use and Environmental Conditions Truckee River (Tahoe City)1	14
٦	Time Line of Human Land Use and Environmental Conditions, Burton Creek Watershed	
	(Lake Forest) 1	15
1	Time Line of Human Land Use and Environmental Conditions Watson Creek Watershed	
	(Carnelian Bay) 1	15
	Time Line of Human Land Use and Environmental Conditions, Griff Creek Watershed	
_	(Tahoe Vista/Kings Beach/Brockway)1	16
	Time Line of Human Land Use and Environmental Conditions, First/Second/Third/Incline/ Mill Creeks Watersheds T16N/R18E1	17
7	Time Line of Human Land Use and Environmental Conditions, Marlette and Spooner	
	Lakes/Glenbrook, Logan House, and Lincoln Creeks Watersheds1	18
٦	Time Line of Human Land Use and Environmental Conditions, McFaul/Burke/Edgewood	
	Creeks Watersheds (Kingsbury) 1	21
F	References1	22

Page

CHAPTER THREE AIR QUALITY	131
Introduction	131
Historical Conditions	132
Current Status of and Trends in Air Quality at Lake Tahoe	133
Effects of Air Pollutants at Lake Tahoe	135
Link Between Science and Policy for the Benefit of Lake and Watershed Management	137
Watershed Assessment Focus	138
Issue 1: The Need to Collect Discontinuous Air Quality Data at Lake Tahoe into a Consistent	t
Form through the Development of a Heuristic Model	139
What is the model that was developed specifically for the Lake Tahoe basin, and	
what are the sources and reliability of data used for its development?	139
What are the scenarios that were developed for demonstration of the watershed	
models for the assessment, and what output is given by the LTAM?	178
Issue 2: The Need to Determine Spatial Location and Natural versus Anthropogenic Origin	
of Pollution that Degrades Air Quality in the Lake Tahoe Basin	184
What are the relative contributions of in-basin versus out-of-basin air pollution	
sources, especially sources in the Sacramento Valley and western slopes of the	
Sierra Nevada, that affect the Lake Tahoe basin?	184
What are the relative impacts of natural versus anthropogenic sources, especially	
the relative contribution of smoke from wildfires versus prescribed fires?	186
How has air quality changed from prehistoric to present times?	191
How does air quality degradation generated within the basin affect downwind	
recipient areas, such as the Carson Valley?	192
Issue 3: The Need to Determine the Adequacy of Existing Air Quality Standards to Protect	
the Tahoe Watershed's Terrestrial and Aquatic Resources through Existing Air Quality	
Control Programs	194
What is the present structure of air quality management in the Lake Tahoe basin,	
and what are the applicable air quality standards?	194
How is air quality regulated in the Lake Tahoe watershed?	196
Will air quality improve, degrade, or remain unchanged under the present	107
regulatory structure?	19/
How would the regulatory system respond to emission increases in the Tahoe basin?	198
Are the present standards and programs adequate to prevent adverse effects on	200
the scenic, terrestrial, and aquatic resources in the basin?	200
is take The Need to Assess the Relative impact of Air Quality Sources to Other Sources	202
In Lake Tanoe Basin Welfare	202
what are the relative impacts of transported versus local hitrogenous air pollutants	202
On take clarity:	202
pollutants on lake clarity?	202
How well known are the deposition rates of atmospheric pollutants to Lake Taboe?	203
What are the relative impacts of proceribed fire (low temperature) smaller and	204
wildfire (high temperature) smoke to lake clarity?	205
What is the nature of smoke from different types of wildfire (ground, passive	
crown active crown) and prescribed fire?	206
crowny active crowny and prescribed file?	

Issue 5: The Need to Establish the Means by which Emissions Can Be Reduced to Levels Necessary to Avoid Deleterious Effects	206
Lake Clarity	206
Air Clarity	200
Forest Health	
Human Health	
Potential Mitigation Strategies for Reducing Airborne Inputs to Lake Tahoe	
References	209
CHAPTER FOUR AQUATIC RESOURCES, WATER QUALITY, AND LIMNOLOGY OF LAKE TAHOE AND ITS UPLAND WATERSHED	215
Issue 1: Upland Water Quality In The Tahoe Basin, With Emphasis On Sediment And	
Nutrient Discharge	220
What are the current sources and sinks of nutrients to Lake Tahoe? How do these	
compare to previous periods of disturbance and restoration since the mid-1850	s?220
What is the evidence linking tributary sediment and nutrient loading to land use	
and watershed geomorphologic characteristics?	252
What is the effect of nutrient cycling in the watershed on transportable carbon,	
nitrogen, and phosphorous? How does system hydrology interact with nutrient	
cycling to influence nutrient loading?	261
What are the major characteristics of sediment transport in tributary flow to Lake	074
Tanoe? What is known regarding the important sources of this material?	274
what is the water budget for Lake Tanoe and how might future regional warming	202
Scenarios allect precipitation and funor in the failoe basins	202 +
Practices Restoration and Other Management Techniques	284
What management/restoration approaches are currently being used in the Taboe	204
hasin?	284
What types of runoff treatment and erosion control techniques have been used in	
the Tahoe basin?	
What is the effect of large hydrologic events on BMP and restoration effectiveness?	
Can the expected reduction in sediment and nutrient loading to Lake Tahoe	
assuming varying restoration and implementation scenarios be quantified?	296
How will prescribed burning affect sediment and nutrient reservoirs in the	
watershed and the system hydrology and ultimately the loading of these	
materials to Lake Tahoe?	296
Are the available data from demonstration projects and other monitoring activities	
in the basin adequate for management decisions at the watershed scale? What	
are the concerns associated with managing restoration at both the project and	
watershed scales?	298
What are the primary characteristics of a potential project that should be used to	
rank its priority (e.g., distance from the lake, proximity to roadway, land slope,	
soil erodibility, and hydrologic connectedness to other disturbed areas)?	300
What are the implications for future monitoring?	301
Issue 3: Ecology, Biology and Biogeochemistry of Lake Tahoe, with Emphasis on Water Clar	ity.303
What has been the long-term trend for algal growth in Lake Tahoe? What are the	<i></i>
major factors regulating the phytoplankton primary productivity?	303
What is the long-term trend for water clarity in Lake Tahoe and how is clarity	
affected by phytoplankton and suspended mineral sediment?	310

 What has been the pattern of algal response to nutrient additions? Should management focus on reduction of a single nutrient? 320 Do the existing long-term biological chemical or physical characteristics of Lake Tahoe show significant trends for other parameters besides algal growth, clarity, and nutrients? 342 What is the magnitude of nutrient loss from Lake Tahoe and regarding the long-term behavior of these nutrients? 343 What is the magnitude of nutrient loss from Lake Tahoe and what is the importance of loss processes on mass balance and nutrient accumulation? 348 What has been the lake response during historical periods of disturbance and recovery? 351 How does predictive modeling of lake response allow better strategies for restoration and management efforts at Lake Tahoe? What is the scientific basis behind the proposed TRG Clarity Model to be selected? 352 What is the current status of macroflora (submerged aquatic plants) and macrofauna (benthic invertebrates, crayfish, zooplankton, and fish) in Lake Tahoe? References. 377 CHATTER FVE BIOLOGICAL INTEGENT 403 Introduction 403 Intoduction fibiological Integrity in the Basin 404 A Historical Context for Biological Integrity in the Basin 407 Issue 1: Define Desired Future Conditions for Old-Growth forest in the Lake Tahoe Basin. 408 What are the traits of modern relictual stands of old-growth forest compare with seral take flabe forests on the surgition? 409 How does the present condition of seral (non-old-growth forest on and walt are the reasons for that difference? 409 How does the disease incidence of modern old-growth forest on and what are the reasons for that difference? 411 Hase 1: he current Likelihood of Fire; the Relative Importance of Weather, Fuels, and Ignito		
management focus on reduction of a single nutrient?	What has been the pattern of algal response to nutrient additions? Should	
characteristics of Lake Tahoe show significant trends for other parameters besides algal growth, clarity, and nutrients?	management focus on reduction of a single nutrient? Do the existing long-term data for other biological chemical or physical	320
besides algal growth, clarity, and nutrients?	characteristics of Lake Tahoe show significant trends for other parameters	
 What is known regarding phosphorus and nitrogen in Lake Tahoe and regarding the long-term behavior of these nutrients?	besides algal growth, clarity, and nutrients?	326
the long-term behavior of these nutrients?	What is known regarding phosphorus and nitrogen in Lake Tahoe and regarding	
What is the magnitude of nutrient loss from Lake Taboe and what is the importance 348 What has been the lake response during historical periods of disturbance and 760 recovery? 351 How does predictive modeling of lake response allow better strategies for 751 How does predictive modeling of lake response allow better strategies for 752 What is the current status of macroflora (submerged aquatic plants) and macroflauna (benthic invertebrates, crayfish, zooplankton, and fish) in Lake Tahoe? 362 References 377 403 Introduction 403 Factors Influencing Biological Integrity in the Basin 404 A Historical Context for Biological Integrity in the Basin 403 Introduction 403 Issue 1: Define Desired Future Conditions for Old-Growth Forests in the Lake Tahoe Basin 404 What are the traits of macronunding matrix of more disturbed (seral) forest 409 How does the present condition of old-growth forest in the basin that make them unique from the surrounding matrix of more disturbed (seral) forest vegetation? 409 400 403 How does the disease incidence of modern old-growth forest in the basin that make them unique from the surrounding matrix of more disturbed (seral) forest	the long-term behavior of these nutrients?	342
of loss processes on mass balance and nutrient accumulation?	What is the magnitude of nutrient loss from Lake Tahoe and what is the importance	
What has been the lake response during historical periods of disturbance and 351 How does predictive modeling of lake response allow better strategies for 351 How does predictive modeling of lake response allow better strategies for 352 What is the current status of macroflora (submerged aquatic plants) and macrofauna (benthic invertebrates, crayfish, zooplankton, and fish) in Lake Tahoe? 362 References 377 CHAPTER FIVE BIOLOGICAL INTEGRITY 403 Introduction 403 Factors Influencing Biological Integrity in the Basin 404 A Historical Context for Biological Integrity in the Basin 405 Our Assessment of Biological Integrity in the Basin 406 Not are the traits of modern relictual stands of old-growth forest in the basin that 408 What are the reasons for that difference? 423 How does the present condition of old-growth forest in the basin? 409 How does the present condition of old-growth forests in the basin? 428 What is the present condition of seral (non-old-growth) forests in the basin? 428 What is the present condition of seral (non-old-growth) forests in the basin? 430 Issue 1: here furture? 428 What is the present condition of seral (non-old-growth) f	of loss processes on mass balance and nutrient accumulation?	348
recovery? 351 How does predictive modeling of lake response allow better strategies for restoration and management efforts at Lake Tahoe? What is the scientific basis behind the proposed TRG Clarity Model to be selected? 352 What is the current status of macroflora (submerged aquatic plants) and macrofauna (benthic invertebrates, crayfish, zooplankton, and fish) in Lake Tahoe? 362 References. 377 CHAPTER FIVE BIOLOCICAL INTECRITY 403 Introduction 403 Factors Influencing Biological Integrity in the Basin 404 A Historical Context for Biological Integrity 405 Our Assessment of Biological Integrity in the Basin 407 Issue 1: Define Desired Future Conditions for Old-Growth Forest in the Lake Tahoe Basin 407 Issue 1: Define Desired Future Condition of old-growth forest in the basin that make them unique from the surrounding matrix of more disturbed (seral) forest vegetation? 409 How does the present condition of old-growth forest not he basin? 428 What is the gisrabard incluse in SPM? 428 What is the distributional pattern of relictual old-growth forest not wand what should it be in the near future? What sustainable mix of seral and old-growth forests is possible? 431 Issue 2: The Current Likelihood of Fire; the Relative Importance of Weather, Fuels, and Ignitions in Contributing to the Likelihood of large fires in	What has been the lake response during historical periods of disturbance and	
How does predictive modeling of lake response allow better strategies for restoration and management efforts at Lake Tahoe? What is the scientific basis behind the proposed TRG Clarity Model to be selected?	recovery?	351
restoration and management efforts at Lake Tahoe? What is the scientific basis behind the proposed TRG Clarity Model to be selected?	How does predictive modeling of lake response allow better strategies for	
 basis behind the proposed IRG Clarity Model to be selected?	restoration and management efforts at Lake Tahoe? What is the scientific	
What is the current status of macroflora (submerged aquatic plants) and macrofauna (benthic invertebrates, crayfish, zooplankton, and fish) in Lake Tahoe?	basis behind the proposed IRG Clarity Model to be selected?	352
(benthic invertebrates, craytish, zooplankton, and tish) in Lake Tahoef 362 References 377 CHAPTER Five BioLOCICAL INTEGRITY 403 Introduction 403 Factors Influencing Biological Integrity in the Basin 404 A Historical Context for Biological Integrity 405 Our Assessment of Biological Integrity in the Basin 407 Issue 1: Define Desired Future Conditions for Old-Growth Forests in the Lake Tahoe Basin 408 What are the traits of modern relictual stands of old-growth forest in the basin that 409 How does the present condition of old-growth forest differ from precontact time and what are the reasons for that difference? Allow does the disease incidence of modern old-growth forest not basin? 423 How does the present condition of seral (non-old-growth forest own and what should it be in the near future? What sustainable mix of seral and old-growth forests is possible? 430 What is the distributional pattern of relictual old-growth forest on a High Severity Fire 431 Issue 2: The Current Likelihood of Fire; the Relative Importance of Weather, Fuels, and 433 What is the likelihood of large fires in the Lake Tahoe basin under different weather 435 What is the likelihood of large fires in the Lake Tahoe basin under different wea	What is the current status of macroflora (submerged aquatic plants) and macrofauna	
Reterences. 377 CHAPTER FIVE BIOLOGICAL INTEGRITY 403 Introduction 403 Factors Influencing Biological Integrity in the Basin 404 A Historical Context for Biological Integrity in the Basin 407 Our Assessment of Biological Integrity in the Basin 407 Issue 1: Define Desired Future Conditions for Old-Growth Forests in the Lake Tahoe Basin 408 What are the traits of modern relictual stands of old-growth forest in the basin that make them unique from the surrounding matrix of more disturbed (seral) forest vegetation? 409 How does the present condition of old-growth forest differ from precontact time and what are the reasons for that difference? and what are the reasons for that difference? 423 How does the disease incidence of modern old-growth forests in the basin? 430 What is the present condition of seral (non-old-growth) forests in the basin? 430 What is the distributional pattern of relictual old-growth forest now and what should it be in the near future? What sustainable mix of seral and old-growth forests is possible? 431 Issue 2: The Current Likelihood of Fire; the Relative Importance of Weather, Fuels, and Ignitions in Contributing to the Likelihood of Fire; and Effects of a High Severity Fire on Urban Areas, Air Quality, Lake Clarity, and Biotic Health 433 <td< td=""><td>(benthic invertebrates, crayfish, zooplankton, and fish) in Lake Tahoe?</td><td> 362</td></td<>	(benthic invertebrates, crayfish, zooplankton, and fish) in Lake Tahoe?	362
CHAPTER FIVE BIOLOGICAL INTEGRITY 403 Introduction 403 Factors Influencing Biological Integrity in the Basin 404 A Historical Context for Biological Integrity 405 Our Assessment of Biological Integrity in the Basin 407 Issue 1: Define Desired Future Conditions for Old-Growth Forests in the Lake Tahoe Basin 408 What are the traits of modern relictual stands of old-growth forest in the basin that 409 How does the present condition of old-growth forest differ from precontact time 409 How does the present condition of old-growth forest in the basin? 423 How does the disease incidence of modern old-growth Tahoe forests compare with 428 What is the present condition of seral (non-old-growth) forests in the basin? 428 What is the distributional pattern of relictual old-growth forest now and what should 431 Issue 2: The Current Likelihood of Fire; the Relative Importance of Weather, Fuels, and 431 Ignitions in Contributing to the Likelihood of Fire; and Effects of a High Severity Fire 433 What is the likelihood of large fires in the Lake Tahoe basin under different weather 435 What is the likelihood of large fires in the Lake Tahoe basin under different weather 436 Ururent Likelihood of large fires in the Lake Tahoe bas	References	377
Introduction 403 Factors Influencing Biological Integrity in the Basin 404 A Historical Context for Biological Integrity 405 Our Assessment of Biological Integrity in the Basin 407 Issue 1: Define Desired Future Conditions for Old-Growth Forests in the Lake Tahoe Basin 408 What are the traits of modern relictual stands of old-growth forest in the basin that 408 What are the traits of modern relictual stands of old-growth forest in the basin that 409 How does the present condition of old-growth forest differ from precontact time 409 How does the disease incidence of modern old-growth Tahoe forests compare with 423 How does the disease incidence of modern old-growth Tahoe forests in the basin? 424 What is the present condition of seral (non-old-growth) forest now and what should 410 what is the distributional pattern of relictual old-growth forest now and what should 431 Issue 2: The Current Likelihood of Fire; the Relative Importance of Weather, Fuels, and 433 What is the likelihood of Fire; the Relative Importance of Weather, Fuels, and 433 What is the likelihood of Fire; the Relative Importance of Weather, Fuels, and 435 What is the likelihood of Fire; the Relative Importance of Weather, Fuels, and 436 Urban Ar	CHAPTER FIVE BIOLOGICAL INTEGRITY	403
Factors Influencing Biological Integrity in the Basin 404 A Historical Context for Biological Integrity 405 Our Assessment of Biological Integrity in the Basin 407 Issue 1: Define Desired Future Conditions for Old-Growth Forests in the Lake Tahoe Basin 408 What are the traits of modern relictual stands of old-growth forest in the basin that 408 What are the traits of modern relictual stands of old-growth forest in the basin that 409 How does the present condition of old-growth forest differ from precontact time 423 How does the disease incidence of modern old-growth Tahoe forests compare with 428 What is the distributional pattern of relictual old-growth forest in the basin? 430 What is the present condition of seral (non-old-growth) forests in the basin? 431 Use 1: The Current Likelihood of Fire; the Relative Importance of Weather, Fuels, and Ignitions in Contributing to the Likelihood of Fire; and Effects of a High Severity Fire on Urban Areas, Air Quality, Lake Clarity, and Biotic Health 433 What is the likelihood of large fires in the Lake Tahoe basin under different weather 431 Urban Areas, Air Quality, Lake Clarity, and Biotic Health 433 What is the likelihood of large fires in the Lake Tahoe basin under different weather 435 What are the likely weather	Introduction	403
A Historical Context for Biological Integrity	Factors Influencing Biological Integrity in the Basin	404
Our Assessment of Biological Integrity in the Basin 407 Issue 1: Define Desired Future Conditions for Old-Growth Forests in the Lake Tahoe Basin 408 What are the traits of modern relictual stands of old-growth forest in the basin that make them unique from the surrounding matrix of more disturbed (seral) forest vegetation? 409 How does the present condition of old-growth forest differ from precontact time and what are the reasons for that difference? 423 How does the disease incidence of modern old-growth Tahoe forests compare with seral Tahoe forests and those in SPM? 428 What is the present condition of seral (non-old-growth) forests in the basin? 430 What is the present condition of seral (non-old-growth) forest now and what should it be in the near future? What sustainable mix of seral and old-growth forests is possible? 431 Issue 2: The Current Likelihood of Fire; the Relative Importance of Weather, Fuels, and Ignitions in Contributing to the Likelihood of Fire; and Effects of a High Severity Fire on Urban Areas, Air Quality, Lake Clarity, and Biotic Health 433 What is the likelihood of large fires in the Lake Tahoe basin under different weather conditions? 441 What is the relative importance of fuels, weather, and ignitions in contributing to the likelihood of large or high severity fires? 444 What is the relative importance of fuels, weather, and ignitions in contributing to the likelihood of large or high severity fires? 444 What is the likely	A Historical Context for Biological Integrity	405
Issue 1: Define Desired Future Conditions for Old-Growth Forests in the Lake Tahoe Basin408 What are the traits of modern relictual stands of old-growth forest in the basin that make them unique from the surrounding matrix of more disturbed (seral) forest vegetation?	Our Assessment of Biological Integrity in the Basin	407
What are the traits of modern relictual stands of old-growth forest in the basin that make them unique from the surrounding matrix of more disturbed (seral) forest vegetation? 409 How does the present condition of old-growth forest differ from precontact time and what are the reasons for that difference? 423 How does the disease incidence of modern old-growth Tahoe forests compare with seral Tahoe forests and those in SPM? 428 What is the present condition of seral (non-old-growth) forest in the basin? 430 What is the distributional pattern of relictual old-growth forest now and what should it be in the near future? What sustainable mix of seral and old-growth forests is possible? 431 Issue 2: The Current Likelihood of Fire; the Relative Importance of Weather, Fuels, and Ignitions in Contributing to the Likelihood of Fire; and Effects of a High Severity Fire on Urban Areas, Air Quality, Lake Clarity, and Biotic Health what is the likelihood of large fires in the Lake Tahoe basin under different weather conditions? 435 What are the likely weather conditions associated with a high severity fire or a large fire? 441 What is the relative importance of fuels, weather, and ignitions in cont	Issue 1: Define Desired Future Conditions for Old-Growth Forests in the Lake Tahoe Basin	408
make them unique from the surrounding matrix of more disturbed (seral) forest vegetation?	What are the traits of modern relictual stands of old-growth forest in the basin that	
vegetation? 409 How does the present condition of old-growth forest differ from precontact time 423 How does the disease incidence of modern old-growth Tahoe forests compare with 423 How does the disease incidence of modern old-growth Tahoe forests compare with 428 What is the present condition of seral (non-old-growth) forests in the basin? 420 What is the distributional pattern of relictual old-growth forest now and what should 420 it be in the near future? What sustainable mix of seral and old-growth forests is 430 What is the distributional pattern of relictual old-growth forest now and what should 431 Issue 2: The Current Likelihood of Fire; the Relative Importance of Weather, Fuels, and 431 Ignitions in Contributing to the Likelihood of Fire; and Effects of a High Severity Fire 433 What is the likelihood of large fires in the Lake Tahoe basin under different weather 435 What is the likely weather conditions associated with a high severity fire or a 441 What is the relative importance of fuels, weather, and ignitions in contributing to 444 What are the likely effects of a high severity or large unplanned fire on soil erosion, 449 How will susceptibility to fire change in the future when snags fall to the ground? 458 What are the key areas to restore or ma	make them unique from the surrounding matrix of more disturbed (seral) forest	
How does the present condition of old-growth forest differ from precontact time 423 How does the disease incidence of modern old-growth Tahoe forests compare with 423 How does the disease incidence of modern old-growth Tahoe forests compare with 428 What is the present condition of seral (non-old-growth) forests in the basin?	vegetation?	409
and what are the reasons for that difference?	How does the present condition of old-growth forest differ from precontact time	
How does the disease incidence of modern old-growth Tahoe forests compare with seral Tahoe forests and those in SPM? 428 What is the present condition of seral (non-old-growth) forests in the basin? 430 What is the distributional pattern of relictual old-growth forest now and what should it be in the near future? What sustainable mix of seral and old-growth forests is possible? 431 Issue 2: The Current Likelihood of Fire; the Relative Importance of Weather, Fuels, and Ignitions in Contributing to the Likelihood of Fire; and Effects of a High Severity Fire on Urban Areas, Air Quality, Lake Clarity, and Biotic Health 433 What is the likelihood of large fires in the Lake Tahoe basin under different weather conditions? 435 What is the relative importance of fuels, weather, and ignitions in contributing to the Likelihood of fire? 441 What is the likely weather conditions associated with a high severity fire or a large fire? 441 What is the relative importance of fuels, weather, and ignitions in contributing to the likelihood of large or high severity or large unplanned fire on soil erosion, air quality, lake clarity, biotic health, old growth, and urban areas? 444 What are the likely effects of a high severity or large unplanned fire on soil erosion, air quality, lake clarity, biotic health, old growth, and urban areas? 449 How will susceptibility to fire change in the future when snags fall to the ground? 458 Where are the key areas to restore or manage to reduce the likelihood of unplanned, large, or se	and what are the reasons for that difference?	423
 seral Tahoe forests and those in SPM?	How does the disease incidence of modern old-growth Tahoe forests compare with	
What is the present condition of seral (non-old-growth) forests in the basin?	seral Tahoe forests and those in SPM?	428
What is the distributional pattern of relictual old-growth forest now and what should it be in the near future? What sustainable mix of seral and old-growth forests is possible? 431 Issue 2: The Current Likelihood of Fire; the Relative Importance of Weather, Fuels, and Ignitions in Contributing to the Likelihood of Fire; and Effects of a High Severity Fire on Urban Areas, Air Quality, Lake Clarity, and Biotic Health 433 What is the likelihood of large fires in the Lake Tahoe basin under different weather conditions? 435 What are the likely weather conditions associated with a high severity fire or a large fire? 441 What is the relative importance of fuels, weather, and ignitions in contributing to the likelihood of large or high severity fires? 444 What are the likely effects of a high severity or large unplanned fire on soil erosion, air quality, lake clarity, biotic health, old growth, and urban areas? 449 How will susceptibility to fire change in the future when snags fall to the ground? 458	What is the present condition of seral (non-old-growth) forests in the basin?	430
It be in the near future? What sustainable mix of seral and old-growth forests is possible? 431 Issue 2: The Current Likelihood of Fire; the Relative Importance of Weather, Fuels, and Ignitions in Contributing to the Likelihood of Fire; and Effects of a High Severity Fire on Urban Areas, Air Quality, Lake Clarity, and Biotic Health 433 What is the likelihood of large fires in the Lake Tahoe basin under different weather conditions? 435 What are the likely weather conditions associated with a high severity fire or a large fire? 441 What is the relative importance of fuels, weather, and ignitions in contributing to the likelihood of large or high severity fires? 444 What are the likely effects of a high severity or large unplanned fire on soil erosion, air quality, lake clarity, biotic health, old growth, and urban areas? 449 How will susceptibility to fire change in the future when snags fall to the ground? 458	What is the distributional pattern of relictual old-growth forest now and what should	
possible? 431 Issue 2: The Current Likelihood of Fire; the Relative Importance of Weather, Fuels, and Ignitions in Contributing to the Likelihood of Fire; and Effects of a High Severity Fire on Urban Areas, Air Quality, Lake Clarity, and Biotic Health 433 What is the likelihood of large fires in the Lake Tahoe basin under different weather conditions? 435 What are the likely weather conditions associated with a high severity fire or a large fire? 441 What is the relative importance of fuels, weather, and ignitions in contributing to the likelihood of large or high severity fires? 444 What are the likely effects of a high severity or large unplanned fire on soil erosion, air quality, lake clarity, biotic health, old growth, and urban areas? 449 How will susceptibility to fire change in the future when snags fall to the ground? 458 Where are the key areas to restore or manage to reduce the likelihood of unplanned, large, or severe fires? 458	It be in the near future? What sustainable mix of seral and old-growth forests is	101
Issue 2: The Current Likelihood of Fire; the Relative Importance of Weather, Fuels, and Ignitions in Contributing to the Likelihood of Fire; and Effects of a High Severity Fire on Urban Areas, Air Quality, Lake Clarity, and Biotic Health		431
 Ignitions in Contributing to the Likelihood of Fire; and Effects of a High Severity Fire on Urban Areas, Air Quality, Lake Clarity, and Biotic Health	Issue 2: The Current Likelinood of Fire; the Relative Importance of Weather, Fuels, and	
On Orban Areas, Air Quality, Lake Clarity, and Blotic Health	Ignitions in Contributing to the Likelinood of Fire; and Effects of a High Severity Fire	422
 What is the likelihood of large lifes in the Lake Table basin under different weather conditions?	on Urban Areas, Air Quality, Lake Clarity, and Blotic Health	433
What are the likely weather conditions associated with a high severity fire or a large fire?	what is the likelihood of large lifes in the Lake Tanoe basin under different weather	42 E
What are the likely weather conditions associated with a high seventy file of a large fire? 441 What is the relative importance of fuels, weather, and ignitions in contributing to the likelihood of large or high severity fires? 444 What are the likely effects of a high severity or large unplanned fire on soil erosion, air quality, lake clarity, biotic health, old growth, and urban areas? 449 How will susceptibility to fire change in the future when snags fall to the ground? 458 Where are the key areas to restore or manage to reduce the likelihood of unplanned, large, or severe fires? 458	Conditions:	435
What is the relative importance of fuels, weather, and ignitions in contributing to the likelihood of large or high severity fires?	large fire?	4.4.1
 What is the relative importance of iders, weather, and ignitions in contributing to the likelihood of large or high severity fires?	Idige IIIes	44 I
What are the likely effects of a high severity or large unplanned fire on soil erosion, air quality, lake clarity, biotic health, old growth, and urban areas?	the likelihood of large or high severity fires?	111
air quality, lake clarity, biotic health, old growth, and urban areas?	What are the likely effects of a high severity or large upplanned fire on soil erosion	444
How will susceptibility to fire change in the future when snags fall to the ground?	air quality lake clarity biotic bealth old growth and urban areas?	440
Where are the key areas to restore or manage to reduce the likelihood of unplanned, large, or severe fires?	an quanty, lake clarity, blotte fieduti, blu glowith, and urban aleast How will suscentibility to fire change in the future when snags fall to the ground?	458
large, or severe fires?	Where are the key areas to restore or manage to reduce the likelihood of upplanned	
	large, or severe fires?	

Page

P	a	g	е
	а	ົ	L

Issue 3: The Need to Determine the Extent to which Prescribed Burning Reduces Fire Risk,	
Affects Wildlife Habitat, and Mimics the Process of Historic Fire	465
What were the historic fire regimes in the Lake Tahoe basin?	465
What is the state of knowledge of fire in the ecosystem in the Lake Tahoe basin?	472
What is the effectiveness of current prescribed burning and other treatments in	. = 0
reducing fire hazard and risk, and mimicking the process of historic fire?	472
Issue 4: The Need to Develop a Conceptual Model of Forest Vegetation and Function as a	470
Basis for Identifying Attributes of Integrity	4/3
What are the key ecosystem processes and stressors?	4/4
What are the potential attributes of integrity that are useful for monitoring?	4/4
Issue 5: The Condition of Aquatic Ecosystems in the Basin	4//
What aquatic ecosystems currently occur in the basin?	4//
How have aquatic ecosystems changed from historic times to the present?	4/9
which aquatic ecosystems are potentially imperiled or vulnerable to future	
imperiment in the basin, and what is the state of knowledge about these	400
ecosystems:	403
What can approximation manitaring and research activities are most empropriate for	490
the focal equation accounting, and research activities are most appropriate for	400
Ine local aqualic ecosystems identities and Condition of Ecologically Significant Areas	
in the Resin	, 406
What are some of the most ecologically unique and biologically intact environment	
and areas in the basin, and what is the state of knowledge about these areas?	.5
What data gaps were revealed in the process of assessing ecologically significant	
areas?	522
What monitoring conservation and research activities are most appropriate for the	
ecologically significant areas identified?	522
Issue 7: The Need to Understand the Condition of Species and Populations in the Basin	
What species currently occur in the basin?	
How has species composition changed from historic times to the present?	
Which species should be of special focus within in the basin based on ecological	
and cultural criteria?	538
What is the status of our knowledge about select focal species of greatest interest	
to local agencies and organizations ?	566
What data gaps were revealed in the process of assessing species and populations?.	570
What monitoring, conservation, and research activities are most appropriate for	
the focal species identified?	574
Concluding Remarks	581
References	581
CHAPTER SIX SOCIAL ECONOMIC AND INSTITUTIONAL ASSESSMENT	
Employment and Income	602
Population and Demography	607
Housing	610
Socioeconomic Well-being and Community Capacity	611
Issue 1: Determining Appropriate Indicators and Geographic Scales for Measuring Social	<i>с</i>
vveil-being and Economic Health as They Kelate to Environmental Quality	614
issue 2: Understanding Patterns of Recreation and Tourism as They Affect Environmental	60F
Quality, Social Well-being, and Economic Health	635

	Page
Issue 3: Understanding How Land Use Trends Affect the Basin's Environment and	
Socioeconomic Dynamics	645
Issue 4: Determining Appropriate Institutional and Organizational Aspects of Adaptive	
Management in the Lake Tahoe Basin Context	661
References	679
CHAPTER SEVEN ELEMENTS OF AN ADAPTIVE MANAGEMENT STRATEGY FOR THE LAKE TAHOE BASIN	
Introduction	
The Role of Science and Research in Adaptive Management	
Development of New Information	
Integrated Research	
Packaging Scientific Information	
The Role of Monitoring in Adaptive Management	
Monitoring Goals, Objectives, and Questions	
The Use of Conceptual Models for Indicator Selection	
Selecting and Interpreting Indicators for Monitoring	
Considerations in Data Collection	
Interpreting the Ecological and Management Significance of Indicator Values	
The Role of Modeling in Adaptive Management	
Types of Models and Their Applications	
Taking a Systems Approach	
Criteria for Evaluating Model Utility	
Integration through Modeling	704
Decision Support Tools	

Research Needs......709 The Status of Modeling......714

Collaborative Structures for Adaptive Management727 Next Steps for the Adaptive Management Cycle730

LIST OF APPENDICES (VOLUME II)

Appendix A	Wildland Fire Susceptibility Analysis
Appendix B	Aquatic Ecosystem Ratings for the Sierra Nevada and the Lake Tahoe Basin, based on the System of Moyle (1996)
Appendix C	Accounts of Focal Aquatic Ecosystems and Ecologically Significant Areas
Appendix D	Details of Models of Riparian Biodiversity and Community Diversity
Appendix E	Vascular Plants of the Lake Tahoe Basin
Appendix F	Nonvascular Plants of the Lake Tahoe Basin
Appendix G	Vertebrate Species of the Lake Tahoe Basin
Appendix H	Invertebrates of the Lake Tahoe Basin
Appendix I	Fungi of the Lake Tahoe Basin
Appendix J	Historical Changes in Vertebrate Species Composition
Appendix K	Focal Vascular Plant Species of the Lake Tahoe Basin
Appendix L	Designation of Focal Vertebrate Species for the Lake Tahoe Basin
Appendix M	Imperilment and Vulnerability of Lake Tahoe Basin Terrestrial Vertebrates
Appendix N	Focal Vertebrates of the Lake Tahoe Basin
Appendix O	Species Accounts for Select Focal Species
Appendix P	Biologists Queried in Determining Select Focal Species
Appendix Q	Recommended Conservation for Focal Species
Appendix R	Recommended Monitoring for Focal Species
Appendix S	Draft List of Key Indicators Identified by the Socioeconomic and Institutional Working Group