APEX: Alaska Predator Ecosystem Experiment in Prince William Sound and the Gulf of Alaska

Project Number:	01163 A-T
Restoration Category:	Research
Proposer:	David Cameron Duffy, Project Leader, Paumanok Solutions.
Cooperating Agencies:	DOI, ADF&G, NOAA
Alaska SeaLife Center:	no
Duration:	Penultimate year of writing up of five-year project
Cost FY 01:	$199.6 K
Cost FY 02:	$ 100.0 K
Cost FY 03:	$ 20.0 K
Geographic Area:	Prince William Sound, Cook Inlet, Northern Gulf of Alaska
Injured Resource/Service:	Common Murre, Marbled Murrelet, Pacific Herring, Pigeon Guillemot.

ABSTRACT

This study uses seabirds as probes of the trophic (foraging) environment of Prince William Sound and Cook Inlet, comparing their reproductive and foraging biologies, including diet. These measurements are compared with hydroacoustic, aerial, and net sampling of fish to calibrate seabird performance with fish distribution and abundance. This will allow us to determine the extent to which food limits the recover of seabirds from the *Exxon Valdez* oil spill. We use historical data from a variety of sources to detect shifts in forage fish abundance and to test hypotheses explaining such shifts. This year represents production and publication of APEX results as scientific papers.

INTRODUCTION

The spill from the oil tanker *Exxon Valdez* resulted in significant mortality of several seabirds and in massive acute damage to Prince William Sound (PWS) and the Gulf of Alaska (GOA) (Piatt *et al.* 1990). A decade following the spill, several species have not recovered . This may be the result of lingering effects of the oil spill (toxicity of prey or sublethal effects of oil exposure to organisms). Other non-oil factors may also be involved, such as predation, climate-driven ecosystem changes, or even 'random' perturbations.

Both to aid in the recovery of injured resources and to safeguard the long-term health of Prince William Sound and the upper Gulf of Alaska, we need to understand the ecological processes that control the ecosystem. This project focuses on the trophic interactions of seabirds and the forage species they feed on. We chose food as the focus because: 1) much of seabird population theory and several empirical field tests have identified food as an important limiting factor (Ashmole 1963; Cairns 1989; Birt *et al.* 1987; Furness and Birkhead 1984); 2) seabird/fish researchers in the PWS/GOA complex have concluded that major changes in food have occurred during the period (Springer 1993; Anderson *et al.* 1994; Piatt and Anderson 1995); 3) other factors such as oil toxicity and climate change might express themselves through the food supply; and 4) knowledge of the forage prey base is critical for other apex predators, such as marine mammals and predatory fish (Pitcher 1980, 1981; Lowry *et al.* 1989), as well as for any larger effort to manage the marine resources of Prince William Sound, Cook Inlet and the Gulf of Alaska in a sustainable manner.

We studied the distribution and abundance of prey species through acoustic, aerial, and net sampling in relation to environmental conditions. Combined with historical analyses, this helped test hypotheses concerning the physical, behavioral and competitive factors that limit access to these forage species for seabirds. We examined the reproductive consequences of such limitations for pigeon guillemots (*Cepphus columba*), black-legged kittiwakes (*Rissa tridactyla*), tufted puffins (*Fratercula cirrhata*), common murres (*Uria aalge*) and cormorants (*Phalacrocorax* spp.).

By examining the diet and reproductive consequences for a surface-feeder (kittiwake), a benthic diver (pigeon guillemot), and two pelagic divers (puffin and murre), we built up a picture of the forage base for the entire seabird community, setting the stage for a long-term, low-cost monitoring program.

NEED FOR THE PROJECT

A. Statement of Problem

Numerous seabird species have declined between surveys in the 1970s and the 1990s in Prince William Sound: cormorants, kittiwake, glaucous-winged gull (*Larus glaucescens*), Arctic tern (*Sterna paradisaea*), Kittlitz's and marbled murrelets (*Brachyramphus brevirostris* and *B. marmoratus*), tufted and horned (*F. corniculata*) puffins, and pigeon guillemot (Agler *et al.* 1994 a,b; Klosiewski and Laing 1994). Colony trends for kittiwakes in Prince William Sound have been inconsistent, with colonies decreasing in the south and increasing in the north (Irons unpubl. data). The population of pigeon guillemots in PWS has decreased from about 15,000 in the 1970's to about 3,000 in 1993 (Isleib and Kessel 1973; Oakley and Kuletz 1996). Based on censuses taken around the Naked Island complex, pre-spill counts were roughly twice as high as post-spill counts (Oakley and Kuletz 1993). Pigeon guillemots are listed as "Not recovering" in the *Exxon Valdez* Oil Spill Restoration Plan.

Common murres were among the species most damaged by the oil spill (Piatt et al. 1990), but most of the oiled birds nested outside PWS. Murres were also listed as "Not recovering" in the 1994 Exxon Valdez Oil Spill Restoration Plan, but have since been upgraded to "recovering" because productivity has been normal since 1993 (Roseneau *et al.* 1995, 1996). Marbled Murrelets are also listed as Recovering.

The best evidence for a shift in trophic resources for seabirds within Prince William Sound comes from pigeon guillemots. No long-term diet data sets exist for other species or, like black-legged kittiwakes, diet exhibits great year to year variability. In 1994, sand lance (*Ammodytes hexapterus*) accounted for only about 1% of prey items fed to guillemot chicks at Jackpot Island and about 8% at Naked Island ; in contrast, in 1979 the sand lance component at Naked Island was about 55% (Kuletz 1983; Oakley and Kuletz 1993). Gadids were much more prevalent in the diet of guillemot chicks on Naked Island in 1994 (ca. 30%) than they were in 1979-1981 (< 7%) (Kuletz 1983).

Pre-spill studies of pigeon guillemots breeding at Naked Island suggest that sand lance were preferred prey during chick-rearing (Kuletz 1983). Breeding pairs that specialize on sand lance tended to initiate nesting attempts earlier and produce chicks that grew faster and fledged at higher weights than did breeding pairs that preyed mostly upon blennies and sculpins, at least in years when sand lance were readily available. Consequently, the overall productivity of the guillemot population was higher when sand lance were available.

The decline in the prevalence of sand lance in the diet of guillemots breeding at Naked Island might be a key element in the failure of this species to recover from the oil spill. The schooling behavior of sand lance, coupled with their high lipid content relative to that of gadids and nearshore bottom fish, might make this species a particularly high-quality forage resource for PWS pigeon guillemots. This is consistent with the observation that other seabird species (e.g., puffins, murres, kittiwakes) experience enhanced reproductive success when sand lance are available (Pearson 1968; Harris and Hislop 1978; Vermeer 1979, 1980; Monaghan et al. 1993).

Major oceanographic shifts seen in the northern Gulf of Alaska and North Pacific (Springer 1993; Piatt and Anderson 1995) may have favored pollock (*Theragra chalcogramma*), also an important seabird food (Springer and Byrd 1989) which has become one of the most abundant forage fish species currently available to seabirds (Parks and Zenger 1979; Brodeur and Merati 1993). Pollock may be an important competitor or predator of other forage fish species and may have suppressed populations of these species. Similarly, other species pairs may overlap in diet, such as herring and sand lance (McGurk and Warburton 1992) or pink salmon (*Oncorhynchus gorbuscha*) and sand lance (Sturtevant 1995), raising the possibility that reductions in the trophic role of one species may "release" others from competition for food.

B. Rationale/Link to Restoration

Both scientific theory and common sense suggest that ecosystems change over time and that changes to one species or other component of the ecosystem may reverberate through the entire ecosystem (Pimm 1984; Wolfe and Kjerfve 1986). Such changes have occurred in the North Pacific and Gulf of Alaska (Hatch et al. 1993; Springer 1993; Piatt and Anderson 1995). Climate variations, fishing, or an oil spill may trigger changes that can take years to become apparent (Duffy 1993). Similarly, restoration efforts following the *Exxon Valdez* oil spill might increase injured species that are predators or competitors of other injured species, preventing their recovery several years after oil was removed as an immediate cause. By studying only the species level, we may miss such effects. An ecosystem approach, such as the APEX study of the upper-trophic level predators of Prince William Sound, is designed to look for such indirect links and to improve our understanding of the ecological context lacking from single-species work (Wheelwright 1994).

In conjunction with the former Sound Ecology Assessment and Nearshore Vertebrate Predators projects, ecosystem projects funded by the Exxon Valdez Oil Spill Trustee Council, APEX attempted to give us a basic understanding of the ecological processes that may affect future changes in upper trophic levels that may in turn affect restoration efforts and also helps us to determine when we have finally restored a sustainable and healthy marine environment in the oil spill area.

C. Location

The project will use office-based locations for writing.

COMMUNITY INVOLVEMENT AND TRADITIONAL ECOLOGICAL KNOWLEDGE

None in this phase which draws only upon existing data and reports.

PROJECT DESIGN

A. Objectives

This fiscal year (FY 01) will be spent producing basic summary review papers on the results of APEX projects. FY 02 will see the production of a synthesis, based on the analysis from FY 00 – 01. FY 03 will see the production of a semipopular account of the APEX project.

B. Methods

FY 01
After discussions with project leaders, we selected certain projects for further funding, to produce terminal scientific publications, based on their annual reports and further analysis in FY 01. Different subprojects took very different approaches to producing these summary scientific papers. Some involve single projects, others involve multiple project "coalitions". Some projects are producing single, major papers containing their main results; others have broken their efforts into smaller units or have chosen to publish about separate aspects of their projects as individual papers. While there is some overlap, such cases involve a different focus or point of view. We will try to ensure that separate papers do not converge during preparation. In some cases, we may encourage copublication of complementary efforts, but there will be no sign common publication for the papers here.

The following papers are expected to result from FY 01 support. Subprojects are indicated below the list.

FISH
Long-term changes in Northern Gulf of Alaska forage fish. Anderson, Blackburn, Piatt *et al.* (Subproject L)

Dynamic structure and composition of marine fish communities in a large estuarine ecosystem. Robards, Abookire, Speckman *et al.* (nonparametric examination of fish community structure in relation to spatial and interannual variability in environment) (Subproject M)

Predation effects of scyphomedusae on zooplankton in Prince William Sound. Purcell (Subproject S)

Seasonal and interannual variability in forage fish distribution, abundance, availability as prey for seabirds, and environmental factors affecting that distribution in Prince William Sound, Alaska, 1995-1999. Brown, Coyle, Thedinga, Hurlbert *et al.* (This is a fish-based view of bird/fish interactions (Subprojects A, T)

Seabirds and forage fish of Prince William Sound: dynamics, selection and implications for recovery following the Exxon Valdez oil spill. Ostrand, Irons, Kuletz, Suryan and Thedinga (This is a bird's eye view of bird/fish interactions) (Subproject B, E, A, R)

BIRDS

Activity time-budgets of Common Murres at three colonies with differing food regimes. Shultz, Kettle, et al. (synthesis and summary of five years of study on chick-feeding rates). (Subproject M)

Individual strategies and local habitat characteristics dictate foraging site selection in Pigeon Guillemots. (pelagic vs benthic fish foraging) Golet, Litzow, Fischer, Howlin, Irons and Piatt. (Subprojects F, M)

Prey availability and other environmental controls of foraging and reproduction in the Black-legged Kittiwake: a multiyear, ecosystem study. Suryan, Irons *et al.* (Subproject E)

Breeding chronology and productivity of a non-colonial seabird in response to spatial and temporal variability in prey. Kuletz *et al.* (Subprojects R, A)

MODELS

Effects of diet quality on reproductive success of piscivorous seabirds in Alaska: testing the junk food hypothesis. Jodice, Roby, Irons, Golet, Suryan, Litzow, Piatt and Duffy (examining lipid content of forage fish vs. availability as affecting prey selection by kittiwakes and guillemots; lipid content vs. availability as factors influencing reproductive success; evidence of regime shifts influencing the relative availability of low and high lipid forage fishes) (Subprojects G, E, F, M, I)

The numerical response of seabirds to variation in food density. Piatt, Irons, Duffy, *et al.* (non-linear response of murres and kittiwakes to variations in food density) (Sub project M, E, I)

An integrated model of foraging behavior and demography for Black-legged Kittiwakes in Prince William Sound. Ainley and Ford (Subproject Q)

Marine and terrestrial factors that determine the distribution and productivity of marbled murrelets in Prince William Sound: Implications to monitoring and conservation efforts. Kuletz, DeVelice, *et al.* (GIS) (Subproject R)

LESSONS

Management implications for a large ecosystem project: Why was APEX started? Spill, litigation; settlement cleared way for science. What did we know and assume at the start? Evidence of change in prey in North Pacific. Roles of El Nino and decadal change. Evolution of the project. Scientific and administrative constraints on a large science project. Links to restoration. Duffy (Subproject I)

FY 02

SYNTHESIS

This synthesis will be based on the final reports of FY 00 and the papers of FY 01. This is intended to be a book or special journal number. To have a successful synthesis, there has to be a common currency that

extends across topics and taxa; otherwise, there is a great risk of a topic-by-topic or taxon-by-taxon recapitulation of what has been learned. Possible common currencies include carbon, energy flux, variance, and scale. We have tentatively decided to use scale: how do organisms respond to different scales? Here, macroscale is roughly at the decadal and gulf level, mesoscale is at the month/year and sound/inlet scale (10 – 100 km) and microscale at the meter to kilometer and hour/day scale.

We hope to also include an element of complexity theory, examining how responses at one scale may be understandable biologically, but they produce effects at other scales that appear chaotic/random. Kittiwake foraging might be a good example of this: smart decisions at a decadal scale as to where to forage appear maladaptive at the scale of a particular year. Each chapter would hopefully address implications for the other scales.

Authors are tentative, as we would be offering only at most honoraria, so some participants of FY00 and FY01 may have taken other positions that do not allow them to participate.

1. Introduction.

Scale and Understanding of a Changing Marine Ecosystem—DUFFY & SCHNEIDER

2. Macroscale

A. Macroscale Changes in Prey Species and their Ecosystems in the Northern Gulf of Alaska-- ANDERSON, PIATT

B. Macroscale Changes in Seabird Species and their Ecologies in the Northern Gulf of Alaska--IRONS

3. Mesoscale

A. Mesoscale Distributions and Their Causes for Prey Species in the Northern Gulf of Alaska-- BROWN, SPECKMAN, & THEDINGA

B. Interactions of Prey and Seabird Colonies at the Mesoscale Level in the Northern Gulf of Alaska--PIATT

C. Mesoscale Foraging Decisions by Seabirds--SURYAN, GOLET, & LITZOW

4. Microscale

A. Microscale Distributions and Interactions of Prey Species. ROBARD, PURCELL, OSTRAND, BROWN, & STURTEVANT

B. Microscale Selection of Foraging Sites--KULETZ, GOLET, & LITZOW

C. Foraging at Microsites: Flocking, Conflict and Facilitation--OSTRAND

5. Understanding the System: Alternative Approaches

A. Patterns of Variability and Coherence between Prey and Bird Populations--FORD, AINLEY, & SCHNEIDER

B. It's Energetics and Nutrition: JODICE, ROBY, PIATT, & IRONS

C. Response Curves and Population Functions--PIATT

6. Afterword and Afterward:

Linking Birds to Prey and Monitoring and Managing the Northern Gulf of Alaska: Lessons from APEX—DUFFY AND WRIGHT

FY03

The project leader (Duffy) will be responsible for a semipopular synthesis and will solicit collaborations, but will if necessary proceed without them.

List of Subprojects

Project	PI	Short Title
a.	Thelinga/Hurlbert	Fish population sampling
b.	Ostrand	Seabird foraging
e.	Irons/Suryan	Kittiwake foraging and reproduction
f.	Golet	Guillemot foraging and reproduction
g.	Roby	Seabird reproduction and energetics
i.	Duffy	Project leader
j.	Roseneau	Barrens nesting study
k.	Roseneau	Predatory Fish Diets
l.	Piatt, Anderson & Blackburn	Historical analysis
m.	Piatt	Cook Inlet studies
o.	McDonald	Statistical support
q.	Ainley, Ford & Schneider	Modeling
r.	Kuletz	Marbled Murrelet
s.	Purcell	Jellyfish
t.	Brown/Norcross	Aerial Survey

Methods by Objective

All activities will involve analysis of data and samples and writing up of the material. Details of the original subprojects may be found in the previously-published, individual FY 00 Detailed Project Descriptions.

C. Cooperating Agencies, Contracts, and other Agency Assistance

Details of the responsibility of each agency and contracts with the private sector and with other government agencies can be found in the appendices describing individual subprojects in the FY 00 Detailed Project Descriptions.

SCHEDULE

A. Measurable Project Tasks for FY 01

2001
Sept. Final Manuscripts Due for papers

B. Project Milestones and Endpoints
2001 Final manuscripts completed.
2002 Synthesis manuscripts completed
2003 Popular account completed

C. Completion Date
December 31, 2002

PUBLICATIONS AND REPORTS

See methods and schedule above for publications.

PROFESSIONAL CONFERENCES

None budgeted

NORMAL AGENCY MANAGEMENT

99163 A
Not applicable

99163 B
See explanation under 99163 E

99163 E
The need for the APEX synthesis would not exist if the oil spill and resulting research had not occurred.

99163 F
See explanation under 99163 E

99163 G
Not applicable

99163 I
Not applicable

99163 J
The need for the APEX synthesis would not exist if the oil spill and resulting research had not occurred.

99163 K
Not applicable

99163 L
The need for the APEX synthesis would not exist if the oil spill and resulting research had not occurred.

99163 M
See explanation under 99163 L.

99163 O
Not applicable

99163 Q
Not applicable

99163 R
See explanation under 99163 E.

99163 S
Not applicable

99163 T
Not applicable

COORDINATION AND INTEGRATION OF RESTORATION EFFORT

This project is an integration of the APEX project, designed to provide an accessible synthesis of its results for the public and managers.

EXPLANATION OF CHANGES IN CONTINUING PROJECTS

NA

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2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FFY 2000	Proposed FFY 2001	PROPOSED FFY 2001 TRUSTEE AGENCIES TOTALS					
			ADEC	ADF&G	ADNR	USFS	DOI	
			$0.0	$0.0	$0.0	$0.0	$76.0	
Personnel	$626.2	$48.6						
Travel	$7.0	$0.0						
Contractual	$470.2	$134.3						
Commodities	$0.0	$0.0						
Equipment	$0.0	$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal	$1,103.4	$182.9	Estimated	Estimated	Estimated	Estimated	Estimated	Es
General Administration	$126.7	$16.7	FFY 2002	FFY 2003	FFY 2004	FFY 2005	FFY 2006	Fl
Project Total	$1,230.1	$199.6	$100.0	$20.0	$0.0	$0.0	$0.0	
Full-time Equivalents (FTE)	12.8	0.7						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments: The primary objective of the 1994 Forage Fish Study was to test techniques and collect data in PWS to aid in designing sampling methods for subsequent years. In 1995 the Apex Predator Ecosystem Experiment (APEX) conducted simultaneous seabird and hydroacoustic surveys in conjunction with collections of seabird productivity and energetics data. The 1996 APEX project included related monitoring and research of seabirds and their forage fish prey. Additional components of APEX incorporated analysis of historic Gulf of Alaska trawl data, ecosystem modeling, and investigating of sand lance exposure to Exxon Valdez oil. The FY97 APEX study incorporated marbled murrelet (163R) investigations. The FY98 APEX study incorporated jellyfish (163S) investigations, and aerial surveys (163T) investigations. The last field year for APEX was FY99. The 163D, Puffins as Samplers, was closed out in FY96, 97163H PI withdrew from the project, and 163C and 163N were closed out in FY98. FY00 is dedicated to sample and data analysis, and write up of final report and manuscripts for publication. FY01 and FY02 is dedicated to write up of syntheses papers.

2001

Project Number: 01163
Project Title: APEX Synthesis
Lead Agency: NOAA

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET

October 1, 2000 - September 30, 2001

Budget Category:	Authorized FFY 2000	Proposed FFY 2001						
Personnel		$15.1						
Travel		$0.0						
Contractual		$99.3						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal		$114.4	Estimated FFY 2002	Estimated FFY 2003				
General Administration		$9.2						
Project Total		$123.6	$80.0	$20.0				
Full-time Equivalents (FTE)		0.2						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments: This project was first funded as the Forage Fish/Seabird Study (94163) then as the Apex Predator Ecosystem Experiment (APEX) project (95163 , 96163, 97163, 98163, 99163, 00163). For FY01 the NOAA component contains several contracts for many of the continuing APEX components (01163G, 01163I, 01163S, 01163Q, and 01163T), as well as direct funding for the PIs of APEX components 01163A and 01163L). FY 00 is dedicated to sample and data analysis, and write up of the final report and manuscripts for publication. FY01 and FY02 is dedicated to write up of syntheses papers.

2001

Project Number: 01163
Project Title: APEX Synthesis
Agency: NOAA

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2000 - September 30, 2001

Personnel Costs:			GS/Range/ Step	Months Budgeted	Monthly Costs	Overtime	P Fl
	Name	Position Description					
	J. Thedinga	PI for 00163A	GS12	1.0	7,000		
	P. Anderson	PI for 00163	GS12	1.1	7,400		
		Subtotal		2.1	14,400	0	
							Personnel Total

Travel Costs:		Ticket Price	Round Trips	Total Days	Daily Per Diem	P Fl
	Description					
						Travel Total

2001

Project Number: 01163
Project Title: APEX Synthesis
Agency: NOAA

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2000 - September 30, 2001

Contractual Costs:	P Fl
Description	
Oregon State University contract (00163 G Energetics/Roby/Jodice) Paumanok contract (00163 I/Duffy) subcontract to UAF/00163T/Brown for $9.3K University of Maryland contract (00163 S Jellyfish/Purcell) H.T. Harvey and Associates contract (00163 Q Modeling/Ainley/Ford) University of Alaska contract (00163T/Brown)	
Contractual Total	

Commodities Costs:	P Fl
Description	
Commodities Total	

2001

Project Number: 01163
Project Title: APEX Synthesis
Agency: NOAA

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2000 - September 30, 2001

New Equipment Purchases:	Number of Units	Unit Price	P Fl
Description			
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	

Existing Equipment Usage:	Number of Units	In
Description		

2001

Project Number: 01163
Project Title: APEX Synthesis
Agency: NOAA

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2000 - September 30, 2001

Budget Category:	Authorized FFY 2000	Proposed FFY 2001						
Personnel		$33.5						
Travel		$0.0						
Contractual		$35.0						
Commodities		$0.0						
Equipment		$0.0	LONG RANGE FUNDING REQUIREMENTS					
Subtotal		$68.5	Estimated FFY 2002	Estimated FFY 2003	Estimated FFY 2004	Estimated FFY 2005	Estimated FFY 2006	
General Administration		$7.5						
Project Total		$76.0	$20.0	$0.0				
Full-time Equivalents (FTE)		0.5						
	Dollar amounts are shown in thousands of dollars.							
Other Resources								

Comments: FY 00 is dedicated to sample and data analysis, and write up of the final report and manuscripts for publication. FY01 and FY02 is dedicated to write up of syntheses papers.

2001

Project Number: 01163
Project Title: APEX Synthesis
Agency: DOI

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2000 - September 30, 2001

Personnel Costs:			GS/Range/ Step	Months Budgeted	Monthly Costs	Overtime	P Fl
	Name	Position Description					
	B. Ostrand	PI for 00163 B	GS11-4	3.0	5,367		
	R. Suryan	PI for 00163 E	GS11-4	3.0	5,800		
		Subtotal		6.0	11,167	0	
						Personnel Total	

Travel Costs:		Ticket Price	Round Trips	Total Days	Daily Per Diem	P Fl
	Description					
					Travel Total	

2001

Project Number: 01163
Project Title: APEX Synthesis
Agency: DOI

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2000 - September 30, 2001

Contractual Costs:	Pr
Description	FF
S. Speckman (00163 M/Piatt) M. Robards (00163 M/Piatt)	
Contractual Total	

Commodities Costs:	P
Description	Fl
Commodities Total	

2001

Project Number: 01163
Project Title: APEX Synthesis
Agency: DOI

2001 EXXON VALDEZ TRUSTEE COUNCIL PROJECT BUDGET
October 1, 2000 - September 30, 2001

New Equipment Purchases:	Number of Units	Unit Price	P Fl
Description			
Those purchases associated with replacement equipment should be indicated by placement of an R.		**New Equipment Total**	

Existing Equipment Usage:	Number of Units	In
Description		

2001

Project Number: 01163
Project Title: APEX Synthesis
Agency: DOI