EVOSTC FY19 CONTINUING PROJECT PROPOSAL SUMMARY PAGE

Project Number and Title

19110853
Pigeon Guillemot Restoration

Primary Investigator(s) and Affiliation(s)

Dr. Kathy Kuletz, U.S. Fish and Wildlife
Robert Kaler, U.S. Fish and Wildlife Service
Dr. David B. Irons, U.S. Fish and Wildlife Service (Retired)

Date Proposal Submitted

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Project Abstract

Historically, the Naked Island group had the largest breeding population of pigeon guillemot (*Cepphus columba*) in Prince William Sound (PWS), Alaska, but it declined over 90% after the 1989 *Exxon Valdez* Oil Spill. Following the effects of the oil spill, predation of adults and their nests by introduced American mink (*Neovison vison*) was the primary factor limiting population recovery. However, with the major changes in the ocean ecosystem in the Gulf of Alaska in the past few decades, sufficient food availability for nesting has also been a concern, as the guillemots in PWS overall have been gradually declining since the oil spill. Mink trapping in guillemot nesting areas was conducted 2014-2018 and mink were caught during the first three years (2014-2018; 76, 23, 7, 0, and 0 mink, respectively). In 2017, mink tracks were observed at one location, but no mink were caught. In 2018, no mink tracks were observed and no mink were captured. While trapping was restricted to pigeon guillemot nesting areas, which were placed along 70% of the shoreline throughout the islands, male mink were likely traveling greater distances in search of females, thereby increasing their exposure to traps. During this 5-year restoration study, counts of pigeon guillemots at Peak, Naked and Story islands has more than doubled from 2014-2018 (69 to 167 individuals) and numbers of nests increased more than four times (11 to 51 nests). Enough food has been available to allow good breeding success the last three years. Numbers of pigeon guillemots counted at control islands did not show a similar increase in population gain.

From a management perspective, it is important to determine if mink are absent from the islands, when or if they might return and at what numbers will they start having an effect on the pigeon guillemots again. We propose to continue to: (i) search for evidence of mink in guillemot breeding areas, (ii) monitor the recovery of pigeon guillemots, and (iii) monitor relative food availability, using black-legged kittiwakes (*Rissa tridactyla*) *as* indicators. While we expect no mink remain on the Naked Island group, we propose three additional years of winter/spring monitoring using bait stations, camera traps, and track surveys focused on 10 previously high-density mink areas to determine need for continued management of mink. To monitor continued population recovery of guillemots, we propose five years of annual guillemot population surveys. The surveys would be conducted, as they have been in the past, in spring at the Naked Island group and control islands (Fool, Seal, Smith and Little Smith islands). To monitor relative food availability, we will use black-legged kittiwakes as an indicator. We propose a cost efficient survey to follow productivity trends of black-legged kittiwake colonies in PWS to provide information on the relative availability of food for nesting. Together, these data will inform future management actions by determining if mink are absent from the islands, measure the rate of recovery of pigeon guillemots following the removal of mink, and provide an indicator for productivity patterns of ocean conditions to help interpret pigeon guillemot population trends.

EVOSTC Funding Requested* *(must include 9% GA)*

FY19	FY20	FY21	FY22	FY23	TOTAL
$69,514	$69,514	$69,514	$37,769	$37,769	$284,078

Non-EVOSTC Funds to be used, please include source and amount per source:					
FY19	**FY20**	**FY21**	**FY22**	**FY23**	**TOTAL**
$28,600	**$28,600**	**$28,600**	**$28,600**	**$28,600**	**$143,000**

**If the amount requested here does not match the amount on the budget form, the request on the budget form will considered to be correct.*

1. PROJECT EXECUTIVE SUMMARY

Provide a summary of the program including key hypotheses and overall goals, as submitted in your original proposal. Please include a summary and highlights since your last annual report: preliminary results with figures and tables. If there are no preliminary results to present, please explain why (i.e., lab analysis is still in progress). List any publications that have been submitted and/or accepted since you submitted your last proposal and other products in *Section 7*. Prior annual reports will be appended to remind reviewers of progress in previous years.

A 5-year pigeon guillemot restoration project (*Exxon Valdez* Oil Spill Trustee Council Project 19100853) aimed to restore the population of pigeon guillemots (*Cepphus columba*) at the Naked Island group in Prince William Sound (PWS), Alaska ends in 2018. Once the most important guillemot nesting site in PWS, the guillemot population had declined more than 90% since 1989 (Irons et al. 2000, Golet et al. 2002). Following the *Exxon Valdez* Oil Spill, predation on nests and adults by mink was the primary limiting factor for guillemot reproductive success and population recovery (Bixler et al. 2010). However, because of oceanic regime shifts in the Gulf of Alaska (Anderson and Piatt 1999) and population declines of many seabird species including the pigeon guillemots (Agler et al. 1999), food availability was also a concern for the recovery of the guillemots (Golet et al 2000, Litzow et al. 2002). Following the successful removal of mink from guillemot nesting areas, we propose a five-year study to: (i) search for evidence of mink in guillemot breeding areas, (ii) monitor the recovery of pigeon guillemots, and (iii) monitor relative food availability, using black-legged kittiwakes (*Rissa tridactyla*) as indicators.

During the first five years, we trapped mink during March-April, 2014-2018, and removed 76, 23, and 7 mink in the first three years, respectively. The fourth year (2017) we caught no mink but found tracks of a mink and the fifth year (2018) no mink were caught and no tracks were seen. From these data we infer no mink remain in pigeon guillemot nesting areas. We trapped only in the pigeon guillemot nesting areas, but throughout the project found that during the mating season (March-April) male mink traveled greater distances in search of females as the mink population was reduced, thereby exposing themselves to traps. It is possible and perhaps likely that no mink remain on the Naked Island group. If this is the case the pigeon guillemots should be safe from mink predation for the foreseeable future. However, we will not be sure of the status of mink or the status of pigeon guillemots unless monitoring continues. Numbers of pigeon guillemots at Peak, Naked and Story islands have more than doubled since 2014 (from 69 to 167 individuals in 2018, Table 1) and numbers of nests increased more than four times (from 11 to 51 nests)! From these data, we presume sufficient food was available to allow good breeding success the last three years. Numbers of pigeon guillemots counted at control islands did not show an increase. While the rapid increase in guillemots exceeded our expectations, ensuring continued population growth to the 1989 population size, adjusted for sound-wide changes since then, is the objective of this project.

We propose to continue monitoring the pigeon guillemot population at the Naked Island group and to monitor relative food availability for five years (2019-2023), and to search for evidence of mink for three years (2019-2021). Following standard methods (Irons et al. 1988, Oakley and Kuletz 1996, Bixler et al. 2010), guillemot monitoring would continue standardized annual pre-breeding guillemot surveys (conducted in late May or early June as birds congregate near colonies) to yield population counts of the Naked Island group and the control islands. Because monitoring pigeon guillemot productivity as a proxy for food availability is labor intensive and expensive (costing approximately $60,000 per year), we will use productivity trends of black-legged kittiwakes

(*Rissa tridactyla*) ($7,500 per year) to derive an index of relative food availability. This index would define each year as “good”, “moderate” or “poor” for potential guillemot food availability. To search for evidence of mink we propose to focus on 10 previously high density mink areas in winter and spring and deploy bait stations, camera traps, and conduct track surveys (when snow is present). Together, these data will inform future management actions: by determining if mink are present on the islands and if there is sufficient food for guillemot recovery; and by measuring the rate of recovery of pigeon guillemot populations following the removal of mink.

The population response of guillemots to mink eradication in the guillemot nesting areas at the Naked Island group is measurable through the comparison of historical and recent guillemot population surveys completed at the Naked Island group and the Smith Island group (latter are mink-free islands) using a Before–After–Control–Impact design. Although a precise prediction of the guillemot population response to mink eradication is not possible, because of the importance of food availability and other environmental factors, the time expected to population recovery can be estimated. If the expected increase in guillemot productivity from mink eradication is realized and model assumptions are correct, guillemot population at the Naked Island group will increase to 1000 birds 15 years after mink are removed (Figure 1).

Table 1. Results of Pigeon Guillemot Surveys at Naked Island group and Control Island group

YEAR	NAKED ISLAND GROUP				CONTROL ISLAND GROUP				
PIGU Survey Year	Naked Island	Peak Island	Storey Island	**Naked Island group Total**	Smith Island	Little Smith	Seal Island	Fool Island	**Control Island group Total**
2014	49	12	8	**69**	171	38	106	53	**368**
2015	59	18	18	**95**	178	27	54	56	**315**
2016	88	17	46	**151**	168	39	46	57	**310**
2017	101	11	57	**169**	189	32	47	57	**325**
2018	100	14	53	**167**	178	45	66	88	**377**

Pigeon Guillemot Population Model, developed by Dr. Joel Schmutz, USGS Alaska Science Center.

Justification of the model parameters:

The observed rate of population change of pigeon guillemots at the Naked Island group shown in Bixler et al. (2010; see Bixler et al. Figure 3.3) for 1989 to 2008, equates to approximately a 12.7% annual decline. This is the maximum rate of decrease in pigeon guillemot numbers we have noted. Conversely, an example of the a possible maximum rate of increase for guillemots was noted by Byrd (2001) in the western Aleutian Islands where they removed foxes from two islands and observed an average increase of 13.6% annually for six years. Numbers of pigeon guillemots on nearby islands where foxes were not removed were little changed. Collectively, these steep rates of decline and increase are a product of changes in nest survival, adult survival, and immigration/emigration of breeding pigeon guillemots. It is well documented in seabirds that in late summer they prospect for good breeding sites (i.e., ones where chicks are evident), resulting in subsequent immigration to productive colonies and emigration from nonproductive ones (Boulinier and Danchin 1997).

Our modeling strategy is to use the best data available on various demographic parameters to quantify a matrix population projection model. In our pigeon guillemot model (Figure 1), we have assumed a maximum average adult survival rate of 0.9 under optimal conditions. Although there are no empirical estimates of adult survival for this species, this seems reasonable when examining the plethora of adult survival data across a range of different seabird species (Schmutz 2009). Further, it is very similar to the rate of 0.89 estimated for black guillemots (Frederiksen and Petersen 1999). To emulate the decline depicted by Bixler et al. (2010), we used the mean nest survival rate (i.e., productivity) from the set of study years at Naked Island during this time trend - thus, the mean of 1989, 1990, and 1994-1998, which is 0.35. Bixler et al. (2010) also noted that adult guillemots were killed at up to 10% of nest sites. This rate could be an underestimate if mink carry an adult carcass away from the nest site, as it would then appear to investigators that the nest had failed and the adults simply dispersed. Nonetheless, we used a maximum predation rate of adults in the presence of mink of 10% (thus base adult survival [i.e., without mink] of 0.9 multiplied by 0.9 (the % that survive predation in the presence of mink) equals 0.81. This nest survival rate of 0.35, on average, and adult survival rate of 0.81, on average, produced a rate of decline less steep than depicted in Bixler et al. (2010; see Bixler et al. figure 3.3). We then added in an adult emigration rate that was sufficient to produce the trend shown by Bixler et al. (2010). This emigration rate was 15%. If this trend were to continue, from a population size of 100 pigeon guillemots, their population would descend to seven pigeon guillemots in 20 years. This model reflects the No Mink Removal model.

To model the potential response of pigeon guillemots at Naked Island to the eradication of mink, we assumed an adult survival rate of 0.9, and nest survival rate equal to the maximum noted in Golet et al. (2002) of 0.61, and an immigration rate that equated to the emigration rate needed to model the decline of pigeon guillemots at Naked Island in the presence of mink, as described in the previous paragraph. With this set of parameters for the Mink Eradication model, the average rate of annual increase of pigeon guillemots, over 20 years, was 17%, which is nearly identical to the value noted by Byrd (2001) for Simeonof Island. The starting point of this projection is when there is assumed to be no mink. Additional model simulations could be done to characterize pigeon guillemot response to mink eradication (or culling) that is gradual in nature. To emulate a significant culling of mink (i.e., remove 90% of them), rather than an eradication, we used nest survival and adult survival rates that were 90% of the maximum values used eradication model. For the Mink Culling model, the average rate of annual increase of pigeon guillemots, over 20 years, was 16%.

The above model descriptions are deterministic, i.e., each model parameter has a singular value with no variation (e.g., if adult survival is 0.9, then it is maintained at that value throughout the 20 years of projection into the future). With these core model structures, we then ran stochastic models where we applied variability to the system. If biologically realistic values of variability in parameter values are used, then a stochastic model should be a more realistic representation of possible outcomes. For variability in nest survival (productivity), we used the data presented in Golet et al. 2002 for Naked Island. These data represent both ecologically real variability (i.e., 'process variation') and also variability due to the sampling process (e.g., the sampling error depicted by the reported Standard Error value). We used the variance decomposition procedures in Burnham et al. (1987) to extract an estimate of process variation in nest survival. Then assuming a normal distribution of this variability, we imposed this variability on the model by taking random draws from this distribution, and running the model 1000 times, where the 50^{th} and 950^{th} of the model runs, sorted by population growth estimates, reflect the confidence interval of this model projection. We also imposed stochastic variability on adult survival rates. This level of variability was taken by using the mean process variation in adult survival from 18 seabird populations listed in Schmutz (2009).

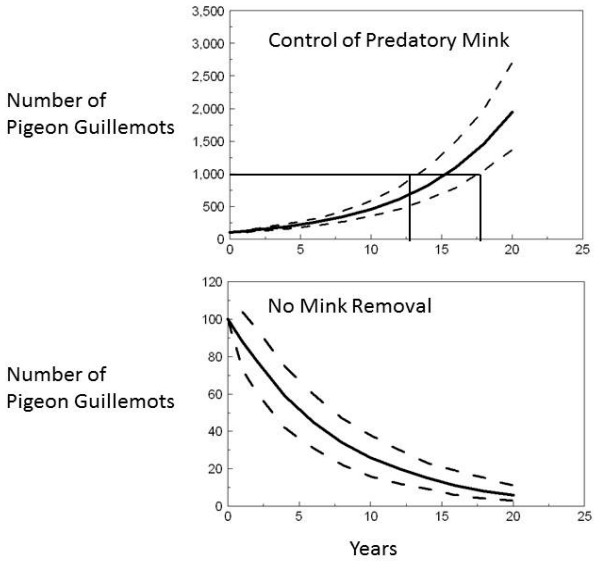

Figure 1. Population model with mink suppression (top) and no removal of mink (bottom) at the Naked Island group, Prince William Sound, Alaska.

2. PROJECT STATUS OF SCHEDULED ACCOMPLISHMENTS

A. Project Milestones and Tasks

Milestones are annual steps to meet overall project objectives. For each milestone listed, specify the status (completed, not completed) when each was completed and if they are on schedule, as submitted in your most current proposal.

Tasks are annual steps to meet milestones. Specify, by each quarter of each fiscal year, when critical tasks (for example, sample collection, data analysis, manuscript submittal, etc.) were and will be completed.

Please identify any substantive changes and the reason for the changes. *Reviewers will use this information in conjunction with annual program reports to assess whether the program is meeting its objectives and is suitable for continued funding.*

B. Explanation for not completing any planned milestones and tasks

Please identify any substantive changes and the reason for the changes. If tasks were not completed as scheduled or delayed, please explain why and the anticipated completion date.

C. Justification for new milestones and tasks

Please identify any new milestones and tasks and the reason why they have been added.

A. Project Milestones and Tasks

Project milestone and task progress by fiscal year and quarter, beginning February 1, 2019. C = completed, X = not completed or planned. Fiscal Year Quarters: 1= Feb. 1-April 30; 2= May 1-July 31; 3= Aug. 1-Oct. 31; 4= Nov. 1-Jan 31.

	FY19				FY20				FY21				FY22				FY23			
Milestone/Task	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Milestone /Task																				
Survey pigeon guillemots		X				X				X				X				X		
Collect Data on Relative Food Availability		X	X			X	X			X	X			X	X			X	X	
Set up and Retrieve Mink Bait Stations and Camera Traps	X	X			X	X			X	X										
Mink Track Surveys	X	X			X	X			X	X										
Analyze Data				X				X				X				X				X
Reporting																				
Annual reports	X				X				X				X				X			
Annual PI meeting				X				X				X				X				X
FY work plan (DPD)			X				X				X				X				X	

B. Explanation for not completing any planned milestones and tasks

Not applicable

C. Justification for new milestones and tasks

We are proposing continued monitoring of pigeon guillemot recovery and to search for evidence of mink. The original 5-year project aimed to eradicate mink from the Naked Island group, but the Alaska Department of Fish and Game would only permit mink removal from the 70% of the shoreline where pigeon guillemots nested or currently nest. However, given that we have not caught a mink in the pigeon guillemot nesting habitat for two years we suspect that all mink that normally come into the guillemot nesting areas, and perhaps from the entire island, are gone. Targeted follow-up to search for evidence of mink and conduct shoreline surveys of guillemots is a low-cost way to ensure timely management actions could be carried out, should numbers of guillemot decline. Furthermore, shoreline guillemot (marine bird) surveys would provide baseline data on recovery following mink removal for other populations of marine birds that have been impacted by mink, including tufted and horned puffins (*Fratercula cirrhata, F. corniculata*), parakeet auklets (*Aethia psittacula*), and Arctic terns (*Sterna paradisaea*).

3. PROJECT COORDINATION AND COLLABORATION

A. Within an EVOTC-Funded Program

Provide a list and clearly describe the functional and operational relationships with any EVOSTC-funded Program (Herring Research and Monitoring, Long-Term Research and Monitoring or Data Management Programs). This includes any coordination that has taken or will take place and what form the coordination will take (shared field sites or researchers, research platforms, sample collection, data management, equipment purchases, etc.).

B. With Other EVOSTC-funded Projects

Indicate how your proposed project relates to, complements or includes collaborative efforts with other proposed or existing projects funded by the EVOSTC that are not part of a EVOSTC-funded program.

C. With Trustee or Management Agencies

Please discuss if there are any areas which may support EVOSTC trust or other agency work or which have received EVOSTC trust or other agency feedback or direction, including the contact name of the agency staff. Please include specific information as to how the subject area may assist EVOSTC trust or other agency work. If the proposed project requires or includes collaboration with other agencies, organizations or scientists to accomplish the work, such arrangements should be fully explained and the names of agency or organization representatives involved in the project should be provided. If your proposal is in conflict with another project, note this and explain why.

A. The proposed project will collaborate closely with the Gulf Watch Alaska program. Specifically, Continuing the Legacy: Prince William Sound Marine Bird Population Trends Project (Kaler and Kuletz; 19120114-M) produces a sound-wide estimate for pigeon guillemots, which will be used to monitor the population recovery at the sound-wide scale. Where possible, the two projects will share field equipment, personnel, survey computers, and binoculars. Additionally, the forage fish project (Arimitsu and Piatt; 19120114-C) and Middleton Island seabird research led by Dr. Scott Hatch (Institute for Seabird Research and Conservation) will provide background on forage fish availability in the northern Gulf of Alaska and PWS region.

B. Our data are available to all other EVOSTC-funded projects.

C. Implementation of this plan requires coordination with state and federal agencies with authority and responsibility of the Naked Island group and pigeon guillemots (see below). Monitoring of pigeon guillemots is being conducted by the U.S. Fish and Wildlife Service. Permits for working at the Naked Island group are being obtained from the U.S. Department of Agriculture – Forest Service.

Authority and Responsibility

U. S. Fish and Wildlife Service

The U.S. Fish and Wildlife Service mission is “to work with others to conserve, protect and enhance fish, wildlife and plants and their habitats for the continuing benefit of the American people.” Along with other Federal, State, Tribal, local, and private entities, the Service protects migratory birds, endangered species, certain fish species, and wildlife habitat. The Service is the primary agency responsible for the conservation of the pigeon guillemot and its habitat as authorized by the Migratory Bird Treaty Act. The U.S. Fish and Wildlife Service is responsible for seabirds in Alaska. They have a monitoring program to assess the status and trends of seabirds. They have also spent more than 30 years eradicating introduced predators from seabird islands in the Aleutian Islands and other places. Much of their work has taken place on lands they manage and little USFWS money has gone to PWS, although they have supported the EVOSTC work in PWS since the oil spill. The contact person is Dr. Kathy Kuletz (Alaska Region Seabird Coordinator), a Principle Investigator on this proposed project.

U.S. Department of Agriculture Forest Service

The mission of the Forest Service is "to sustain the health, diversity, and productivity of the Nation's forests and grasslands to meet the needs of present and future generations." The Forest Service is responsible for the management of the 5.4 million acre Chugach National Forest that includes the Naked Island group, along with most of the rest of the land area of Prince William Sound.

4. PROJECT DESIGN

A. Overall Project Objectives

Identify the overall project objectives for your project as submitted in your original proposal.

B. Changes to Project Design and Objectives

If the project design and objectives have changed from your original proposal, please identify any substantive changes and the reason for the changes. Please include the revised objectives in this section. Include any information on problems encountered with the research or methods, if any. This may include logistic or weather challenges, budget problems, personnel issues, etc. Please also include information as to how any problem has been or will be resolved. This may also include new insights or hypotheses that develop and prompt adjustment to the project.

A.

Objective 1. Remove mink from pigeon guillemot nesting areas on Naked, Storey and Peak Islands.
Objective 2. Monitor guillemot population response to mink removal on the Naked Island group.

B.

Objective 1. Search for evidence of mink in pigeon guillemot nesting areas on the Naked Island group.
Objective 2. Monitor pigeon guillemot recovery on the Naked Island group.
Objective 3. Monitor relative food availability, using kittiwakes as indicators.

The first five years of this project focused on (i) removal of mink from the pigeon guillemot nesting areas on the Naked Island group and (ii) monitoring the recovery of pigeon guillemots. Recent data demonstrate that there are no mink in pigeon guillemot nesting areas. The last young mink were caught in 2016, and since young of the year are relatively easy to trap, we believe that the last year mink reproduced was in 2015. We trapped only in the pigeon guillemot nesting areas, but throughout the project we found that male mink traveled greater distances in search of females during the mating season as they became rare. It is possible that no mink remain on the Naked Island group. If this is the case the pigeon guillemots should be safe from mink predation for the foreseeable future. However, we will not be sure of the status of mink or the status of pigeon guillemots unless monitoring continues at least another five years. We propose monitoring pigeon guillemots, relative food availability and searching for mink.

The guillemot monitoring would entail continuing the annual survey that has been done throughout earlier studies, to give us population counts of the Naked Island group and the mink-free islands used as a control; Smith Islands, Seal Island, and Fool Island. The boat-based survey is done in late May or early June and parallels the shoreline 100m offshore. All pigeon guillemots are recorded.

Food availability will be measured indirectly, using PWS black-legged kittiwake nest and chick counts. Because monitoring pigeon guillemot diets and productivity is labor intensive and expensive, we will use black-legged kittiwakes as a surrogate as they are much cheaper to monitor. Kittiwakes have been monitored in PWS for 35 years (D. Irons, unpublished data) and provide long-term baseline data to classify "good", "moderate", and

"poor" years regarding food availability for seabirds in PWS, which will help determine if there is sufficient food for pigeon guillemot recovery. Kittiwakes in PWS rely on sandlance, herring, and capelin (Suryan et al. 2000, Suryan et al. 2001) and Golet et al. (2000) and Litzow et al. (2002) demonstrated that pigeon guillemots have higher nest success when there are forage fish such as sand lance, herring, and capelin available. Seabirds are regularly monitored to provide information on the status of forage in the oceans around the world (Piatt et al. 2007, Einoder 2009, Sydeman et al. 2017) and kittiwakes are known to be sensitive to changes in food availability (Suryan et al. 2002, Frank et al. 2006). Kittiwates are also one of the primary species monitored within their circumpolar range, partly because they are good ecosystem indicators (Irons et al. 2015).

To search for evidence of mink we propose to focus on 10 previously high density areas where mink were trapped. Sixty-seven of the 106 mink trapped were in these relatively small areas (less than 2 km of shoreline), each had 5-9 mink trapped over the course of this project. During winter and spring, bait stations, camera traps, and track surveys will be carried out at these 10 areas. Bait stations and camera traps will be set up as we did in 2012 while investigating the distribution of mink. At each site, we will use one trail camera and one bait container with herring. In 2012, multiple individual mink (identified by variations in pelage color) visited a single bait station dozens of times in a week and we are confident that if mink are present they will find the bait stations. Track surveys will be conducted as we have done for the past five years. We found that the mink use game trails parallel to the shoreline, along with river otters and deer. These game trails will be checked for mink tracks in each of the 10 focus areas.

5. PROJECT PERSONNEL – CHANGES AND UPDATES

If there are any staffing changes to Primary Investigators or other senior personnel please provide CV's for any new personnel and describe their role on the project.

Dr. Kathy Kuletz will oversee and advise on the project. Dr. Kuletz is a Co-PI on Gulf Watch Alaska Project 19120114-M (Prince William Sound Marine Bird Survey)

6. PROJECT BUDGET FOR FY19

A. Budget Forms (Attached)

Provide completed budget forms.

B. Changes from Original Proposal

C. Sources of Additional Funding

Identify non-EVOSTC funds or in-kind contributions used as cost-share for the work in this proposal. List the amount of funds, the source of funds, and the purpose for which the funds will be used. Do not include funds that are not directly and specifically related to the work being proposed in this proposal.

A. See attached Budget forms

B. Originally the project was scheduled to conclude in 2018. We are now requesting funding for a five year monitoring program to record the recovery of pigeon guillemots and a three year program to search for mink on the islands.

C. Annual In-kind Contributions

Kathy Kuletz Salary 2 weeks	$5500
Robb Kaler Salary 5 Weeks	$9400
Liz Labunski Salary 3 weeks	$4700
Computer, GPS, Binoculars and Misc. equipment	$5000
Truck	$2000
Warehouse space	$2000

Total	**$28600**

7. FY18 PUBLICATIONS AND PRODUCTS

Products include publications (include *in prep* and *in review*), published and updated datasets, presentations, and outreach during FY18.

Publications in Preparation

Stark, S., D.D. Roby, and D.B. Irons (in prep) Removal of introduced predators and recovery of seabirds on the Naked Island group, Prince William Sound, Alaska.

Stark, S., D.D. Roby, and D.B. Irons (in prep) The role of social attraction in the recovery of seabirds on the Naked Island group, Prince William Sound, Alaska.

Outreach and Presentations

Sam Stark (Graduate Student, Oregon State University) gave an invited presentation on the pigeon guillemot study to the Prince William Sound Regional Citizen's Advisory Council in Anchorage, AK, November 2017.

Literature Cited

Agler, B. A., Kendall, S .J., D. B. Irons, and S. P. Klosiewski. 1999. Declines in Marine Bird Populations in Prince William Sound, Alaska Coincident with a Climatic regime Shift. Waterbirds 22:98-103.

Anderson P. J., J .F. Piatt. 1999. Community reorganization in the Gulf of Alaska following ocean climate regime shift. Marine Ecology Progress Series 189:117-123

Bixler, K. S., D. D. Roby, D. B. Irons, M. A. Fleming, and J. A. Cook. 2010. Pigeon Guillemot restoration research in Prince William Sound, Alaska. Exxon Valdez Oil Spill Restoration Project Final Report, 267 pp.

Boulinier, T., and E. Danchin. 1997. The use of conspecific reproductive success for breeding patch selection in terrestrial migratory species. Evolutionary Ecology 11:505-517.

Burnham, K. P., D. R. Anderson, G. C. White, C. Brownie, and K. H. Pollock. 1987. Design and analysis methods for fish survival experiments based on release-recapture. American Fisheries Society Monograph 5.

Byrd, G. V. 2001. Wildlife surveys at Simeonof, Chernabura and nearby islands in the Outer Shumagin Islands in July 2001. U.S. Fish and Wildlife Service report, Alaska Maritime National Wildlife Refuge, Homer, Alaska.

Einoder, L. D. 2009. A review of the use of seabirds as indicators in fisheries and ecosystem management. Fisheries Research 95:6-13.

Frank, K. T., B. Petrie, N. L. Shackell, and J. S. Choi (2006). Reconciling differences in trophic control in mid-latitude marine ecosystems. Ecology Letters 9:1096–1105.Frederiksen, M. and A. Petersen. 1999. Adult survival of the black guillemot in Iceland. Condor 101: 589-597.

Golet, G. H., K. J. Kuletz, D. D. Roby, D. B. Irons. 2000. Adult prey choice affects chick growth and reproductive success of Pigeon Guillemots. The Auk 117:82-91.

Golet, G. H., P. E. Seiser, A. D. McGuire, D. D. Roby, J. B. Fischer, K. J. Kuletz, D. B. Irons, T. A. Dean, S. C. Jewett, and S. H. Newman. 2002. Long-term direct and indirect effects of the 'Exxon Valdez' oil spill on Pigeon Guillemots in Prince William Sound, Alaska. Marine Ecology Progress Series 241:287-304.

Irons, D.B., S.J. Kendall, W.P. Erickson, L.L. McDonald, B.K. Lance. 2000. Nine years after the Exxon Valdez oil spill: effects on marine birds in Prince William Sound, Alaska. Condor 102:723-737.

Irons, D.B., D.R. Nysewander, and J.L. Trapp. 1988. Prince William Sound waterbird distribution in relation to habitat type. U.S. Fish and Wildlife Service, Anchorage, AK.

Irons D. B, A. Petersen, T. Anker--Nilssen, Y. Artukhin, R. Barrett, D. Boertmann, M. V. Gavrilo, G. Gilchrist, E. S. Hansen, M. Hario, K. Kuletz, M. J. Mallory, F. Merkel, A. Mosbech, A. L. Labansen, B. Olsen, H. Österblom, J. Reid, G. Robertson, M. Rönkä, and H. Strøm. 2015. Circumpolar Seabird Monitoring Plan. CAFF Monitoring Report No.17. CAFF International Secretariat, Akureyri, Iceland. ISBN: 978-9935-431-47-9

Litzow, M. A., J. F. Piatt, A. K. Prichard, D. D. Roby 2002. Response of pigeon guillemots to variable abundance of high-lipid and low-lipid prey. Oecologia, 132: 286-295.

Oakley K. L., K. J. Kuletz 1996. Population, reproduction, and foraging of pigeon guillemots at Naked Island, Alaska, before and after the Exxon Valdez oil spill. *In* Rice S. D., R. B. Spies, D. A. Wolfe, B. A. Wright 1996. Proc Exxon Valdez Oil Spill Symp. Am Fish Soc Symp 18:759-769

Piatt, J. F., W. J. Sydeman, and F. Wiese. 2007. "Introduction: A Modern Role for Seabirds as Indicators." Marine Ecology Progress Series 352: 2007: 199-204.

Schmutz, J. 2009. Stochastic variation in avian survival rates: Life-history predictions, population consequences, and the potential response to human perturbations and climate change *In* Thomson, D., E. Cooch, and M. Conroy. 2009. Modeling demographic processes in marked populations. Springer Publishing.

Suryan, R. M., D. B. Irons, and J. Benson. 2000. Inter-annual variation in diet and foraging effort of kittiwakes in relation to prey abundance. Condor 102:374-384.

Suryan, R. M., D. B. Irons, M. Kaufman, J. Benson, P.G.R. Jodice, D.D. Roby, E.D. Brown. 2002. Short-term fluctuations in forage fish availability and the effect on prey selection and brood-rearing in the black-legged kittiwake *Rissa tridactyla*. Marine Ecology Progress Series 236:273-287.

Sydeman, W. J., S. A. Thompson, J. F. Piatt, M. Garc´ıa-Reyes, S. Zador, J. C. Williams, M. Romano, and H. M. Renner. 2017. Regionalizing indicators for marine ecosystems: Bering Sea– Aleutian Island seabirds, climate, and competitors. Ecological Indicators 78:458–469.