Exxon Valdez Oil Spill
Restoration Project Final Report

East Amatuli Island Remote Video Link Project

Restoration Project 99434
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<u>Study History</u>: Restoration Project 99434 was an outgrowth of experience gained by the Pratt Museum and Broadcast Services of Alaska (now SeeMore Wildlife Systems) in development and testing of a prototype remote video camera installation on Gull Island in Kachemak Bay. Between April and September 1998, a suite of cameras transmitted real-time images approximately 8 miles from the island to the museum. Fully controllable camera movement allowed close observation of nesting seabirds by museum staff and visitors. An informal relationship with the U.S. Geological Survey Biological Resources Division Gull Island field research team enhanced educational use of the cameras and incubated the idea of using remote cameras to supplement field observations of seabird nest attendance and productivity. During the winter of 1998/99 Dave Roseneau and Arthur Kettle, U.S. Fish and Wildlife Service Alaska Maritime National Wildlife Refuge, agreed to supervise the testing of remote video technology on East Amatuli Island in conjunction with Alaska Predator Ecosystem Experiment Project 99163J.

<u>Abstract</u>: Two remotely operated video cameras were installed near common murre (*Uria aalge*) field observation posts at E. Amatuli Island on 22 May. Live images were transmitted to Homer by microwave via a repeater atop Mt. Bede, on the southwestern Kenai Peninsula. Between 23 June and 4 September Pratt Museum and U.S. Fish and Wildlife Service staff worked in the museum with the cameras as public interpreters and data collectors. They helped teach nearly 15,000 visitors about seabirds, predator-prey relationships, habitat, and scientific research. Productivity data for a selected study plot was collected by camera at the museum and by observers in the field using binoculars and telescopes. Comparison of data sets revealed variations between data from camera and field observations. With camera observation fewer murres were counted, adult postures more frequently misidentified, eggs and chicks less frequently seen, and different hatch dates recorded. Calculated results for measures of productivity were similar between the two methods, however. Public interaction with interpreter/data collectors greatly enhanced education and outreach but may have been one factor responsible for variation between camera-derived and field-derived data. Electronic interference, problems of hardware/software design, and delayed field maintenance were among other factors influencing camera effectiveness.

<u>Key Words</u>: Barren Islands, common murre, East Amatuli Island, education, interpreter, microwave, monitoring, public outreach, reproductive success, seabird, *Uria aalge*

<u>Project Data</u>: The project differed somewhat from the majority of those sponsored by the *Exxon Valdez* Oil Spill Trustee Council because it had 2 purposes: (1) use of remote video technology to increase public access to *Exxon Valdez* Trustee council supported research; and (2) for collecting supplementary data on breeding parameters for common murres (*Uria aalge*). Hence, an education/outreach component functioned jointly with a research component.

Public outreach/education – At least 14,696 people participated in the project's student programs and public outreach activities at the museum between 23 June and 4 September. Visitor reactions, including time spent (with the cameras, studying related exhibits, reading labels), number and type of questions asked, return visits, and bringing friends or family, were observed and informally assessed in terms of more traditional, static exhibits. Student projects were reviewed and examples retained. Input was obtained from students, teachers, and the general public through spot interviews, from a log book, and from visitor comment cards. *Format* – The East Amatuli remote video log book, visitor comment cards, student project work, still photographs and videotapes of education/outreach activities, U.S. Fish and Wildlife Service interpreter/observer assessment, and museum staff summary are retained at the Pratt Museum. Text files are in MS Word and WordPerfect. *Custodian* – Contact Mike O'Meara, Projects Coordinator, Pratt Museum, 3779 Bartlett Street, Homer, Alaska 99603 (phone: 907-235-8635, fax: 907-235-2764, e-mail: mikeomea@prattmuseum.org). *Availability* – All materials are available for review at the Pratt Museum. Text files are available in electronic or hard copy form upon request.

Research – This project resulted in data sets from regular observations of adult postures, nest site content, and numbers of murres on a nesting-cliff plot, for camera and field observations. Raw data were recorded on paper data sheets; these data were compiled and results were calculated in spreadsheet computer file. Results included (for each nest site and for the plot) the number of eggs, chicks, and fledglings observed; dates of egg-laying, egg-hatching, and chick fledging; and (for the plot) hatching success (chicks/eggs), fledgling success (fledglings/chicks), and productivity (fledglings/eggs). Other files explain spreadsheet field names and methods used for recording data and calculating results. *Format* – Summaries and calculations are in Microsoft Excel format. Explanation files are in WordPerfect. *Custodian* – Contact Arthur Kettle at the Alaska Maritime National Wildlife Refuge, 2355 Kachemak Bay Drive / Ste. 101, Homer, AK 99603-8021 (work phone: (907) 235-6546; fax: (907) 234-7783) or e-mail Arthur_Kettle@fws.gov). *Availability*: Copies of all data and related explanation files are available in hard copy and electronic form.

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EXECUTIVE SUMMARY

Introduction: Increasing the general public's understanding and appreciation of spill area resources and long-term research can be a daunting task. The time commitment and expense required to reach remote areas denies most people access. Large numbers of people in the field would be disruptive in any event. Field measurement of common murre reproductive success and counts of adult murres are made by regularly observing groups of nest-sites by binoculars throughout the nesting season. Data for adult incubation and brooding postures and (when possible) nest-site content (empty, egg, chick) are recorded for each nest-site in mapped cliff plots. Logistical constraints at some locations can limit the frequency, duration, or within-day timing of these observations. Images broadcast from the cliffs to another location could augment field measurements. This project gave us the opportunity to test remote video technology as a way for the public to see and learn first hand about seabirds and associated research and to supplement field observations of common murre nest sites. To address both issues, the education/outreach component of the project functioned jointly with a research component.

Objectives:

1. Test the potential of remote video technology to supplement and support data collection by field crews for long-term monitoring of species injured by the spill.

2. Test the remote video system under some of the harshest field conditions in Alaska and over long distances in preparation for other long-range monitoring projects.

3. Develop public programs and educational opportunities using remote video technology for real-time observations of wildlife and student research projects.

4. Provide interaction between students and researchers.

Methods: *Public outreach/education* – Two remotely-controlled video cameras were installed at Alaska Maritime National Wildlife Refuge study plots on East Amatuli Island. Live images of nesting seabirds were broadcast to a Barren Islands education/research center which was added to the Pratt Museum's marine gallery. Staff training sessions, student programs, and public outreach activities took place there between 23 June and 4 September. There were 3 components to the education outreach program: (1) public interpretation; (2) a summer science program for middle school students; and (3) high school internships. U.S. Fish and Wildlife staff from the Alaska Maritime National Wildlife Refuge worked in the gallery approximately 20 hours each week as educator/interpreters, also recording nest observations made by camera. Data collection took 20-45 minutes, allowing remaining time for work with students and other museum visitors. At least 14,696 people spent time in the education/research center during the study period. High school interns and middle school students received instruction about the seabirds and research from staff. Students learned to assist with public interpretation and participated in informal data gathering and other learning activities. Visitor reactions, including time spent with the cameras, studying related exhibits, reading labels, number and type of questions asked, return visits, bringing friends or family, were observed and informally assessed in terms of more traditional, static exhibits. Student projects were reviewed and examples retained. Spot interviews were conducted with students, teachers, and the general public and written input was obtained through a log book and visitor comment cards. A summary of resulting observations was prepared, formal assessment being beyond the scope of the project.

Research – Before egg-laying had begun, a remotely-controlled video camera was installed on East Amatuli Island to view cliff areas that contained Alaska Maritime National Wildlife Refuge study plots; it was removed after chicks had fledged. The camera was located within 3 meters of the field observers' post. The nearest monitoring plot, about 20-30 meters away, was used for comparisons of field and remote camera observations. Camera and field observations followed Refuge protocol. Throughout the nesting season, adult incubation and brooding postures and (when possible) nest-site content (empty, egg, chick) was noted and adults were counted. Field observations were made on 29 days; camera observations on 46 days. Video taped camera views of the study plot were reviewed by the field crew upon their return. Data from the observations were compiled and we calculated egg-laying, hatching, and chick-fledging dates; the number of eggs laid, chicks hatched, and chicks fledged; hatching success, fledging success, and productivity (fledglings per eggs). Camera and field results were then compared; statistical tests were used when appropriate.

Results and Discussion: *Public outreach/education* – Of the 14,696 people visiting the gallery during the study period, 12,464 (85%) were adults and 2,232 (15%) were children (under 18 years). Visitors spent an average 15-90 minutes in the Pratt Museum marine gallery. Prior to installation of remote video systems and the Barren Islands education/research center, the average visitor spent 5-30 minutes in the gallery. About 60% of visitors attempted to control the cameras to view more of the seabird colony. Without an interpreter, many visitors would control the cameras randomly for a few minutes and move on. With interpreter guidance, visitors made more effective use of cameras and developed greater awareness of what they were seeing. Groups of 5-15 people often gathered as interpreters used living examples to illustrate explanations of seabird behavior, anatomy, and habitat. When the camera system was not functioning people moved on after 5 or 10 minutes in the gallery.

Interaction among visitors, students, and staff interpreters stimulated discussions of related topics such as the *Exxon Valdez* oil spill, how science works, other marine organisms, management of public resources, and the *Exxon Valdez* Trustee Council. As daily progress of specific birds was followed, "story lines" developed about their activities. Visitors often stayed in the gallery for long periods or returned several times to see one of these stories unfold. When camera observations were being recorded for the study plot, visitors were fascinated to see real scientific research. Many waited or returned to question interpreter/data collectors about the process and recorded their own observations in the camera log book.

Research – Nest-site content (empty, egg, chick) was identified less frequently in the camera observations than in the field. Adult incubation and brooding postures were more frequently misidentified with the camera than in the field. About twice as many nests in camera data as in field data had imprecise hatch dates. Fledging success calculated from the camera data was higher than that calculated from field data. Hatching success and productivity results from the two observation methods were similar. The mean hatch date calculated from camera data was 5 days earlier than the date calculated from field data for this plot.

Earlier apparent hatch dates with the camera were caused by the small number of empty nest-site content observations and by the misidentification of adult postures. Possible causes of the lower number of empty nests, eggs and chicks; misidentified postures of adults; lower numbers of adults, and longer data collection sessions in camera observations include poorer image quality and slower zoom, pan, and tilt control than with binoculars in the field, and less observer experience by the camera observers than field observers. These factors were not quantified in this study.

We had intended to test this equipment for measuring productivity of Black-legged Kittiwakes. However, kittiwake productivity monitoring relies more on observation of nest content than does murre monitoring, and content of kittiwake nests is more difficult to see than is that of murres. Because of limitations of the control and magnification of the camera and of personnel time, we were unable to obtain camera data for kittiwakes.

Conclusions: *Public outreach/education* – The combination of high quality video images of wildlife from remote field sites and skilled, knowledgeable interpreters proved a compelling educational tool. Linking public outreach and education with research made it possible to present basic information about and *Exxon Valdez* Trustee Council-sponsored research in a tangible manner and provided an opportunity for museum staff and observer/interpreters to be trained by the scientists. It gave context and focus to the informal observation of the seabirds. Students were exposed to real scientists and their research, learning and practicing basic science skills in a real-world situation. However, the benefits of a combined research/outreach education project came at a cost. Interpreter/data collectors may have been distracted by their dual roles. Differences between data collected by camera and in the field indicate the need to segregate certain elements of research and outreach components in future projects of this type (see research Discussion). Nonetheless, seeing actual research in progress and discussing it with the people involved provides an irreplaceable learning experience that should be retained. Additional staffing and redesign of the research/education center to reduce distractions for observers during data collection should be examined for future projects of this sort.

SeeMore Wildlife Systems (formerly Broadcast Services of Alaska) provided all equipment, installation, maintenance, and end of season removal as a package. The total cost was $45,000 for 66 days of usable service ($681.82 per day). For a short-term, experimental project this appears to be a sensible but relatively costly arrangement. For less complicated or long-term installations it would almost certainly be more cost effective to purchase equipment and handle logistics and maintenance in-house. Separate, dedicated cameras may be required to optimize research and outreach activities. The camera system used was more adequate for education and outreach than for data gathering (see research Discussion). The technical contractor failed to provide adequate written instructions, modified software frequently without notification, and failed to successfully protect the system from hackers. This created ongoing problems for marine room staff, volunteers, and students. Cameras were inoperative and went without maintenance for 11 days between 23 July and 2 August. Planning for any similar future project should focus on ways to reduce costs and prevent such problems.

A significant limitation of the project was that the seabird nesting season and the school year do not coincide. Teachers expressed enthusiasm for the project's educational values and frustration for being unable to involve their students.

Research – Video tape recordings indicated that when viewing conditions were good (good lighting, no rain on the camera housing window, no signal interference) the resolution of the image from the camera was adequate for identification of murre nest-site content and adult postures, except that identification of eggs under adults was more difficult than with binoculars. Resolution also seemed adequate for counting adults, except possibly where adults were crowded into shaded areas (there were not enough images recorded on tape for quantitatively testing our ability to see eggs or count crowded areas). Fewer observations of nest-site content in camera data was probably partly caused by differences in observer experience or by differences in the ability to pan and zoom. A more substantial limitation of this camera's capability for monitoring was its magnification power. Field protocol for productivity observations and population counts of cliff nesting seabirds uses many widespread plots (groups of nest-sites) as sample units. This causes many plots to be more distant from the observation point than was the plot used in this study. The camera magnification was adequate for the nearest plot but not for more distant plots.

Vibration from wind was another factor that at times limited image quality. This factor would be magnified if a higher-power lens were used, but it could probably be corrected with better damping. Rain on the camera housing window impaired the image at times. A second housing installed outside the camera housing could keep rain off the camera window and also protect the camera housing from effects of the wind.

If a similar study is done in the future, it could be improved if more time were spent in the design of quantitative comparisons between the fieldwork and camera work. One way to do this would be to transmit the image to the field camp during the season. Then the same observers would make both the camera and field observations. If this were not possible then the camera crew should record entire observation sessions on video tape so that the field crew could see how the camera was used, could analyze the same images, and could compare resulting data with what the camera crew wrote down. So that effort with the camera could be better quantified, camera data collection should occur during a time dedicated for that purpose, separate from interpretation for visitors.

With improvements in reliability and control, the equipment used in this study could be useful in augmenting field measurement of productivity and attendance of murres in plots near to the camera. With other improvements supplementary monitoring of more distant murre plots, and possibly of kittiwake plots, may be possible.

Part A: Public Outreach/Education
Michael S. O'Meara

INTRODUCTION

Developing the general public's awareness of spill area resources and promoting understanding and appreciation of the nature and value of long-term research at remote sites can be a daunting task. For the most part, access to remote areas is unavailable to people. The presence of large numbers of students or tourists in the field would be disruptive to both the resource and researchers in any event. Yet public outreach and the ability to involve students in research projects have been identified by the *Exxon Valdez* Trustee Council as important parts of the restoration process. Common murres, especially at the Barren Islands, were among the resources most severely injured by the *Exxon Valdez* oil spill. Nonetheless, the general public appears to know little about this species. For many people, science and field research are as distant and unfamiliar as the Barren Islands and the seabirds that nest there. To address this, the project's education/outreach and research components functioned jointly, linking students and other museum visitors to the seabirds and scientific research through technology.

Two remotely operated video cameras were installed near common murre (*Uria aalge*) observation posts at E. Amatuli Island on 22 May. A single common murre study plot was selected for observation by camera and in the field. All of the project's remote video outreach/education and research activities were centered in the museum's marine gallery in close proximity to salt water aquaria, mounted seabird exhibits, and other relevant educational exhibit material. Interpretive staff, volunteers, and students received training in research protocols, camera operation, and relevant natural history. The project provided opportunities for museum visitors to watch data collection in progress and learn about science from the people conducting research. Live images from the island reinforced interpreter discussion of seabird behavior and natural history. The opportunity to control cameras for themselves allowed people to discover examples of what they learned. Students enjoyed the added experience of teaching others what they learned by acting as museum interpreters.

With its control center located in the Pratt Museum, the East Amatuli Island Remote Video Link project provided an outstanding vehicle for informing a broad audience about seabirds and research. The very high quality live images of seabirds and positive interactions between interpreter/data collectors, museum staff, students, and the general public generated and sustained a high level of interest throughout the season. On average, visitors stayed in the marine gallery three times longer following installation of the cameras. Many returned one or more times, bringing other family members or friends. Visitors spent the longest time, asked more questions, and made more effective use of the cameras when interpreter/data collectors were present to work with them. Students enthusiastically completed a variety of projects which involved public demonstrations of seabird adaptation and behavior using the cameras and artifacts (preserved wings, feet, skulls, full mounts, eggs) from the museum's biological collections. They also learned to identify murre brooding postures and recorded data from their observations, supplementing this with video recordings.

Presence of a an authentic research component and knowledgeable, skilled interpreters clearly contributed to the project's success with public outreach/education activities. Conversely, the presence of students and the general public probably limited interpreter/data collectors' ability to make and record accurate study plot observations using the camera.

OBJECTIVES

1. Test the potential of remote video technology to supplement and support data collection by field crews for long-term monitoring of species injured by the spill.

2. Test the remote video system under some the harshest field conditions in Alaska and over long distances in preparation for other long-range monitoring projects.

3. Develop public programs and educational opportunities using remote video technology for real-time observations of wildlife and student research projects.

4. Provide interaction between students and researchers.

METHODS

A Barren Islands education and research center was added to the Pratt Museum marine gallery prior to installation of cameras on East Amatuli Island. This consisted of a console housing the control computer, touch screen video display terminal, and VCR; a wall mounted, 27-inch color television monitor; and associated maps, posters, and seabird exhibits. Between 23 June and 4 September, the center was used for relevant staff training sessions, student programs, public outreach, and for recording data from remote observations of the East Amatuli Island study plot. In June, training sessions were held at the museum for interpretive staff, volunteers, and students. Project scientists provided instruction in the use of plot maps, plot photographs, and data sheets for making nesting observations from the cameras. This included video tapes and photographs showing examples of common murre incubation and brooding postures. Broadcast Services of Alaska (now SeeMore Wildlife Systems) staff provided instruction in operating the camera system.

There were 3 components to the education outreach program: (1) public interpretation; (2) a summer science program for middle school students; and (3) high school internships. U.S. Fish and Wildlife Service staff from the Alaska Maritime National Wildlife Refuge worked in the gallery approximately 20 hours each week as public interpreters and recording data from study plot observations which they made using the camera. Observations were made every 1-3 days (except during malfunctions) between 24 Jun-1 Sep. Methods for recording productivity data were the same as those used for field data. Data collection took 20-45 minutes, allowing remaining time for work with students and other museum visitors. At least 14,696 people spent time in the education/research center during the study period. The public outreach program provided opportunities for museum visitors to watch data collection in progress. Interpreter/data collectors explained what was being done. Descriptions of the data gathering process and background on this and other *Exxon Valdez* Trustee Council supported research projects were provided between formal observation periods. Interpreter/data collectors demonstrated how the cameras worked, using live images to teach about the seabirds. Visitors were then given an opportunity to manipulate the cameras, and encouraged to make their own observations.

Two pilot student programs were conducted during the months of June, July, and August. All students received instruction about the seabirds and research from interpreter/data collectors and learned from museum staff to assist with public interpretation. Two high school interns worked for 20 hours each week as paid museum staff. While they were responsible for a variety of duties, the bulk of their time was spent working in the marine gallery to assist museum educators and project interpreter/data collectors. They also served as mentors for younger students involved in the project. Five middle school students were enrolled in the museum's summer science program, attending alternating morning and afternoon sessions for two hours each Wednesday and Thursday. Half their time was devoted to work in the museum's marine gallery.

Museum educators developed a series of activities designed to help the students learn about ecosystem relationships in marine environments and the ways scientists study this topic. Each week, student activities focused on a single topic, such as adaptation to cold environments. Students conducted research using the museum's exhibits and library, interviewed interpreter/data collectors, and participated in demonstration projects. As an example, to investigate the issue of seabird and sea mammal insulation, hand coverings were made using feathers and Crisco (a substitute for blubber). Students submerged bare hands and insulated hands in ice water for comparison. Projects of this sort were done in the gallery to engage visitors in the process and resulting discussions. Activities also included a schedule of regular seabird observations using the cameras. Students used the same methods employed by field observes to record data. In addition, each student selected an area within camera range to track over the season, keeping a log in which interesting seabird behaviors and the questions raised were written. All students had their own video cassettes on which to record the best of these observations, and the group collaborated to produce a compilation video at the end of the summer. Students were encouraged to share their logs and video tapes with their classes upon returning to school in the fall. Several of these youngsters became quite knowledgeable and effective public interpreters.

Visitor reactions, including time spent with the cameras, studying related exhibits, reading labels, number and type of questions asked, return visits, bringing friends or family, were observed and informally assessed in terms of more traditional, static exhibits. Student projects were reviewed and examples retained. Spot interviews were conducted with students, teachers, and the general public and written input was obtained through a log book and visitor comment cards. A summary of resulting observations was prepared, formal assessment being beyond the scope of the project.

RESULTS and DISCUSSION

Of the 14,696 people visiting the Pratt Museum marine gallery during the study period, 12,464 (85%) were adults and 2,232 (15%) were children (under 18 years). Because the school year and seabird nesting season do not coincide, only one teacher was able to bring her classes to participate. When U.S. Fish and Wildlife Service or other knowledgeable interpreters were present, visitors spent an average 15- 90 minutes in the Pratt Museum marine gallery. In the absence of a trained interpreter, visitors stayed for shorter periods. Prior to installation of remote video systems and the Barren Islands education/research center, even when interpreters were present, the average visitor spent 5-30 minutes in the gallery (except on aquarium feeding days). Every Tuesday and Friday adults with children are admitted to the gallery at no charge to participate in feeding fish and other marine organisms and tend to stay for longer periods of time. When the cameras were operating, the majority of people entering the gallery were immediately drawn to the seabird images on the television monitor. Most visitors expressed astonishment at the clarity and detail of the images. In spite of clear labeling, a surprising number did not realize that they were viewing live transmissions from East Amatuli Island until this was explained to them. If another person was not already doing so, about 60% of visitors would attempt to control the cameras to view more of the seabird colony. Others only watched. Without an interpreter, many visitors would watch or attempt to control the cameras for a few minutes and move on to look at associated maps, seabird mounts, and other exhibits associated with the camera. When interpreters were present, visitors quickly learned to make more effective use of cameras and developed greater awareness of what they were seeing.

Seeing live, close-up images of seabirds appeared to increase visitor interest enough that more time was spent reading labels than is typical in a museum setting. Visitors would also often seek out staff or volunteers with questions raised by what they had seen on the cameras. Impromptu discussion groups of 5-15 people often gathered as interpreters used living examples to illustrate explanations of seabird behavior, anatomy, and habitat. Interaction around the cameras between visitors, students, and staff interpreters stimulated discussions of related topics such as the *Exxon Valdez* oil spill, how science works, other marine organisms, management of public resources, and the *Exxon Valdez* Trustee Council. As daily progress of specific birds was followed, "story lines" developed about activities of individual birds. Visitors often stayed in the gallery for long periods or returned several times during the season so that they might see one of these stories unfold. When camera observations were being recorded for the study plot, visitors were fascinated to learn that they were witnessing real scientific research. Many would wait or return to question interpreter/data collectors about the process in order to learn more about the study and to take time to record their own observations in the camera log book. Teachers visited the gallery throughout the season. All expressed disappointment that it was impossible for most of them to bring their classes to participate in the project.

On those occasions when the camera system was not functioning people expressed strong disappointment and moved on after 5 or 10 minutes in the gallery. Some visitors had come long distances, as far away as Seattle, specifically to view seabirds after learning about the project from news coverage. Many returned at another time when the camera was functioning properly.

CONCLUSIONS

Experience with this project reinforced the previous year's experience with the Gull Island prototype. The combination of high quality video images of wildlife from remote field sites and knowledgeable interpreters proved a compelling educational tool. The ability to watch nesting seabirds for a few feet away without disturbing their normal activities easily captivated people and stimulated natural curiosity. For most, this was an absolutely unique experience that could be duplicated in no other way. We believe that when presented through a museum or other appropriate public venue, research-linked remote video technology has potential to greatly increase public awareness of and appreciation for EVOS-sponsored research and science in general. Several things seem to be required for full realization of this potential.

It very quickly became clear that a knowledgeable and skilled interpreter is essential if students and the general public are to get the most out of any experience with the cameras. This person should have a good grounding in science, knowledge of the species being viewed, and an understanding of relevant research. He or she should be a trained interpreter or teacher if at all possible. Remote video is a spectacular technological innovation but requires the guidance of such a person to serve as more than casual entertainment.

Having an actual research component enhanced the education/outreach component of the project. It provided an opportunity for museum staff and interpreter/data collectors to be trained by the scientists. It gave context and focus to the informal observation of the seabirds, providing some specific examples of things people could watch for. Students were exposed to real scientists and their research and given an opportunity to lean and practice basic science skills in a real-world situation. The interaction between museum and U.S Fish and Wildlife staff, students, and the general public created a positive dynamic which helped many people see a relationship between wildlife, science, and resource management for the first time. It also provided an introduction to the role of the *Exxon Valdez* Trustee Council for the majority of marine room visitors. While interpreter/data collectors may have been distracted by their dual roles, it would be worth maintaining this linkage between research and outreach in future projects of this type. Clearly, differences between data collected by camera and in the field indicate the need to segregate certain elements of the research and outreach components in future projects (see research discussion). Hopefully, this can be done without sacrificing linkage. Seeing the actual research in progress provides an irreplaceable learning experience. Adding another interpreter/data collector to the staff would allow counts to be done at the museum by one person while the other worked with the public. Schedules could be staggered to overlap in a way that would not require a doubling of hours. A special observation station could be set up, removed from but still visible to the public. Even if formal data collection were no longer done in the museum, interpreter/data collectors could continue to maintain a related, informal, observation program for students and the general public in the marine room.

SeeMore Wildlife Systems (formerly Broadcast Services of Alaska) was the technical contractor and service provider for this project. All equipment, installation, maintenance, and removal at the end of the season was part of a package. SeeMore retained ownership of all equipment and copyright to video images. As part of the package, SeeMore licenced the transmission signal to the Pratt Museum and U.S. Fish and Wildlife Service and authorized unlimited use of all resulting images for scientific and educational purposes. The contractor received $40,000 for the season. Another $5,000 was dedicated to related technical services at the museum, bringing the total cost for 66 days of usable service to $45,000. The per day cost for both data collection and public outreach/education uses of the camera system was $681.82. For a short-term, experimental project this appears to be a sensible arrangement. It avoids investment in expensive equipment and the need to commit or hire additional technical staff. However, the considerable per day cost seems excessive and would be difficult to justify for less complicated or long-term installations. For ongoing educational or research applications it would almost certainly prove more cost effective to acquire equipment and handle logistics and maintenance in-house. This would prevent potential conflicts over copyright issues as well. Another alternative would be to seek competitive bids. However, while there are suppliers of similar remote imaging equipment, we are not presently aware of any other firms offering a similar service package. Experience with three remote video sites in Alaska has shown that each application and installation is unique.

For the most part, configuration and deployment of the camera system was adequate for education and outreach activities. This was not the case for data gathering (see research Discussion). Separate, dedicated cameras may be required to optimize research and outreach activities. Periodic interference, wind vibration, rain and fogging on the camera housing window, and software/hardware malfunctions disrupted both research and educational/outreach programs, however. This was particularly true when the technical contractor was unable to address the problem in a timely manner. Most of the solutions proposed for research would also enhance public education and outreach. Museum staff experienced particular problems associated with programing of the camera control touch screen in the marine gallery. The technical contractor provided staff training following installation of the camera system but failed to provide adequate written instructions and trouble shooting information. The prototype software was then modified often without clearly informing museum or U.S. Fish and Wildlife staff. The resulting changes in operating protocol created great confusion among all staff, volunteers, and students on duty in the marine room. In spite of these many software changes, the technical contractor was never able to successfully protect the system from hackers. Visitors would periodically break in to the operating system, occasionally disabling it altogether. While this is somewhat understandable in a prototype situation, any similar future installation must be designed with these problems in mind. Understandable written documentation should be provided with the system. All changes in hardware or software configuration should be announced well in advance and staff should be retrained accordingly. The touch screen or any other user interface should be more effectively protected from unauthorized visitor programming. Hardware or software malfunctions should be corrected as quickly as possible. The nesting season is short and down time had a significant negative effect on both research and public outreach. Redundancy should be the rule for all equipment deployed at remote sites. In some instances, extra "plug and play" components which could be installed by field crews could help avoid maintenance delays caused by foul weather and other problems associated with transportation of maintenance crews.

Discontinuity between the seabird nesting season and the school year imposed a major limitation on the projects's public outreach/education component. Teachers who came to the marine gallery often expressed both great enthusiasm for the project's educational values and equal frustration for being unable to involve their students. Several suggested that greater use be made of video recording technology to preserve entire observational sessions that could be used with students during the school year in conjunction with a series of lessons in field observation and data collection protocol. It was suggested that since the field season would be finished, biologists could be available to collaborate in this process during the regular school year. Any future project of this sort should investigate the development of such a curriculum and teaching kit.

Remote video technology is a potentially effective educational tool. To become practical, costs must be significantly reduced and user needs better addressed by equipment vendors or service providers. To realize its full potential, it will also be necessary to employ skilled and knowledgeable interpreters when using such a system. In the case of this project, participation of interpreters in actual scientific research clearly enhanced the cameras' effectiveness for outreach. We expect that inclusion of a research component would have equally positive effects on other types of education and outreach projects.

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Part B: Research
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INTRODUCTION

Field measurement of Common Murre reproductive success is made by regularly observing with binoculars groups of nest-sites throughout the nesting season. Recorded in field notebooks are adult incubation and brooding postures and (when possible) observations of nest-site content for each nest-site in mapped cliff plots. Changes in numbers of murres are measured by periodically counting adults within plot boundaries. Logistical constraints at some locations can limit the frequency, duration, or within-day timing of these observations. If clear images of the nest-sites were transmitted from the cliffs to locations with fewer logistical constraints, observation of the images could augment field measurements of reproductive success and population size. This project gave us the opportunity to test the use of broadcast video images for these purposes.

OBJECTIVES

The purpose of this study was to evaluate the utility and reliability of a remotely-controlled video camera to measure murre reproductive success and numbers of murres on a nesting cliff. We wished to compare the results of these observations with data collected in the field by observers with binoculars.

METHODS

A remotely-controlled video camera was installed to view cliff areas that contained Alaska Maritime National Wildlife Refuge study plots on East Amatuli Island; images were broadcast to the Pratt Museum. The camera was installed before egg-laying had begun in the plots and was removed after the last chick had fledged. Refuge personnel collected data in the field also during this period. Camera and field observations followed Refuge protocol. For each nest in the plot, during each day of observations, adult incubation and brooding postures, and (when possible) nest-site content (empty, egg, chick) were noted and adults were counted.

The camera was located within 3 meters of the field observers' post and about 20-30 meters from the nearest plot; this plot was used for comparisons of field and camera observations. At first a camera with an 18X-power zoom was used; this proved to be inadequate for observation of this plot; it was replaced with a 20X camera partway though the season.

Field observations of murres on the study plot were made on 29 days during 23 June-4 September at intervals of 1-6 days. Camera observations were made on 46 days during the 24 June-1 September period; the observation interval was every 1-3 days except during the 11-day interval of 23 July-2 August, when technical problems with the camera prevented data collection. One observer made most (26 days) of the camera observations. Two others observed on 10 days, and on 10 days the observer′s name was not recorded. Field observations of this plot were shared between 2 people (1 person per day).

Camera observations for measurement of reproductive success (productivity) were made usually in late morning. Counts of adults in the plot were made as close to 1300 hrs as practicable. In the field, productivity measurements were made at various times of day and adults were counted as close to 1400 hrs as possible. The duration of each camera productivity session was about 30 to 45 minutes; each field observation averaged 30 minutes. Camera observations were sometimes combined with interpretation for museum visitors. When not combined with interpretation, productivity observations with the camera took 15-30 minutes. Counts of adults on this plot took 5-10 minutes with the camera and 1 minute in the field. Some images viewed with the camera were recorded on video tape for review by the field crew upon their return from the field.

Methods for recording and analyzing productivity data collected with the camera were the same as those used for field data. Data from the daily records were compiled and dates were determined for the last observation of an empty nest-site, the first and last time an egg was seen, and the first and last time a chick was seen. These dates were recorded on a summary spreadsheet and egg-laying, egg-hatching, and chick-fledging dates were calculated, and a mean hatch date was determined. Finally, the number of eggs laid, chicks hatched, and chicks fledged were summed for the plot. Camera results for hatching success (chicks/eggs), fledgling success (fledglings/chicks), and productivity (fledglings/eggs) were compared with results from the field observations with a likelihood ratio chi-square Test, at the 0.1 significance level. Hatch dates were compared with a 2-tailed *t*-test, at the 0.1 significance level. Counts of adults made during the “census period” (between peak egg-laying and the start of fledging, when adult attendance at the cliff is most stable) with the camera and in the field were compared with a 2-tailed *t*-test, at the 0.1 significance level.

RESULTS and DISCUSSION

Nest-site contents (empty, egg, chick) were identified less frequently in the camera observations than in the field (Table 1). Adult incubation and brooding postures were more frequently misidentified with the camera than in the field: during 24 June-21 July, before any eggs could have hatched in any of the plots (there were no eggs in any of the plots on 23 June and the incubation period is 32 days), there were 85 brooding postures recorded in the camera observations and none recorded in the field. Our method of analysis of productivity data excludes nest-sites with very imprecise egg-lay and egg-hatch data; after this exclusion the number of nest-sites remaining in the camera data was about half that for the field data (Table 2).

Fledging success calculated from the camera data was significantly higher than that calculated from field data (P=0.052; Table 3). Hatching success and productivity calculated from the camera plot were not significantly different from those calculated from the field data, although a difference in the productivity measurement was apparent; small sample sizes limited the power of the tests. The mean hatch date calculated from camera data was 5 days earlier than the date calculated from field data for this plot; this difference was significant (*P*=0.007, Table 4). The mean number of adults counted on the plot with the camera was 10% lower than field counts; this difference was significant (*P*=0.007).

Earlier apparent hatch dates with the camera were probably caused by the small number of empty nest-site content observations and by the misidentification of adult postures. Nonincubating birds were frequently identified as incubating, and there were very few observations of empty nest-sites to show that eggs had not yet been laid. Possible causes of the lower number of empty nest-sites, eggs, and chicks; misidentified postures of adults; lower numbers of adults, and longer data collection sessions in camera observations include poorer image quality and slower zoom, pan, and tilt control than with binoculars in the field, and less observer experience by the camera observers than field observers. These factors were not quantified in this study.

We had also intended to test this equipment for measuring productivity of Black-legged Kittiwakes. However, measurement of kittiwake productivity uses only direct observation of nest contents and not (as with murres) inference of contents from adult postures. This technique relies more on panning across the plot to look for moving birds than does the technique for murres, requires the identification of smaller and more cryptic eggs and chicks, requires identification of the number of eggs and chicks (murres lay only 1 egg; kittiwakes can lay 3), and is more time-consuming. Because of constraints on the control and magnification of the camera and on personnel time, we were not able to obtain camera data for kittiwakes.

CONCLUSIONS

Video tape recordings indicated that when viewing conditions were good (good lighting, no rain on the camera housing window, no signal interference) the resolution of the image from the higher magnification camera was adequate for identification of murre nest-site content and adult postures, except that identification of eggs under adults was more difficult than with binoculars. Resolution also seemed adequate for counting adults, except possibly where adults were crowded into shaded areas (there were not enough images recorded for testing our ability to see eggs or count crowded areas). Fewer observations of nest-site contents in camera data was probably partly caused by differences in observer experience or by differences in the ability to pan and zoom. Had a camera observer been previously trained in the field to identify eggs with partial glimpses and to distinguish individual adults on a crowded section of ledge, data collected with the camera may have been more similar to those collected in the field. The mechanical control of the camera may also have contributed to differences in observation of nest-site content. In the field, an observer constantly scans across the plot, looking for birds that are moving on their nest-sites; then concentrates observations on those birds, as nest-site content is usually seen only when a bird stands up. This process of actively scanning among nest-sites could not be duplicated well with the camera. Joy-stick control of the camera would be easier to use than the touch-screen control used in this project.

A more substantial limitation of this camera's capability for monitoring was its magnification power. Field protocol for productivity observations and population counts of cliff nesting seabirds uses plots (groups of nest-sites) as sample units. Because reproductive success and adult attendance times can be clumped by habitat type and within familial neighborhoods, and because the monitoring objective is to represent the whole colony with the plots, an attempt is made to 1) choose representative plots of the habitat types on the whole colony and 2) choose plots spaced widely apart. For statistical purposes it is desirable to have at least ten plots. These factors cause many plots to be more distant from the observation point than was the plot used in this study.

Cameras of two magnification powers were used in this project. The magnification of the first camera did not produce the resolution needed for the collection of data from even the closest plot. The second camera with higher magnification was adequate for the nearest plot but not for more distant plots; the distance to other plots was up to 4 times that of the plot used in this study. It is possible that the autofocus feature of the camera used in this project would not be needed in future projects. If the focus were changed manually (although still remotely) for each plot, it may not need to be adjusted while changing views among nest-sites within the plot. Another advantage of manual focus is that the lens would not focus on rain that is on the housing window or in the air between the camera and the plot.

Vibration from wind was another factor that at times limited image quality. This factor would be magnified with higher lens magnification, but it could probably be corrected with better damping. Rain on the camera housing window impaired the image at times. Building the camera into a larger housing with a protective overhang could make the window wiper unnecessary. A second housing installed outside the camera housing could keep rain off the camera window and also protect the camera housing from effects of the wind.

Redundant-equipment installations that could either be switched on remotely or switched manually by field crews would help make data collection more consistent during breakdowns, and would reduce the number of maintenance trips required.

If a similar study is done in the future, it could be improved if more time were spent in the design of quantitative comparisons between the fieldwork and camera work. One way to do this would be to transmit the image to the field camp during the season. Then the same observers would make both the camera and field observations, so the effect of differential observer experience would be minimized. If this were not possible then there should be more time spent on training the camera observers (especially in identifying postures), and if possible the field crew and camera crew should then work side by side for a time. The camera crew should record entire observation sessions on video tape so that the field crew could see how the camera was used, could analyze the same images, and could compare resulting data with what the camera crew wrote down. So that effort could be better compared, data to be compared with field data should be collected during a time dedicated for that purpose and not combined with interpretation for visitors.

With improvements in reliability and control, the equipment used in this study could be useful in augmenting field measurement of productivity and attendance of murres in plots near to the camera. With other improvements supplementary monitoring of more distant murre plots, and possibly of kittiwake plots, may be possible.

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Table 1. Comparison of observations of nest-site content.

	#Nest-sites	24 Jun-1 Sep # days of obs.	# Empty nest-sites per nest-site per day	# Eggs observed per nest-site per day	# Chicks observed per nest-site per day
Field Observations:	19	27	0.22	0.09	0.12
Camera Observations:	18	45	0.10	0.02	0.08

Table 2. Comparison of the number of nest-sites usable for calculation of productivity parameters[1].

	Hatching Success	Fledging Success	Productivity
Field Observations:	19	17	19
Camera Observations:	10	9	10

[1]Only chicks for which we could calculate a hatch date to within 8 days' certainty were used for these calculations.

Table 3. Comparison of murre reproductive performance calculated from camera data and field observations.

	# Eggs observed[1]	# Chicks observed	# Hatch dates[2]	Median hatch date	#Fledglings[3]	Hatching success	Fledging success	Fledglings/ eggs[4]
Field Observations:	19	17	17	6 Aug	13	0.89	0.76	0.68
Camera Observations:	18	16	11	1 Aug	9	0.89	1.00	0.89

[1]One egg per nest-site.

[2]Only chicks for which we could calculate a hatch date to within 8 days' certainty were used for calculations involving fledglings. This column shows the number of chicks that met this criterion.

[3]Fledglings that met the criterion in footnote 2.

[4]Subtracted from the number of eggs used in this calculation was a proportion of eggs that did not produce chicks equal to the proportion of observed chicks for which we could not calculate precise hatch dates (according to footnote 2). (Otherwise when we excluded from the calculations chicks or fledglings with imprecise hatch dates, nest-sites with eggs that did not produce chicks would have been over represented).

Table 4. Comparison of numbers of murres counted with the remote video camera and in the field.

	# Observation-days	Number of murres counted	
		Mean	*Standard deviation*
Field Observations:	18	51.8	4.3
Camera Observations:	28	46.7	6.4

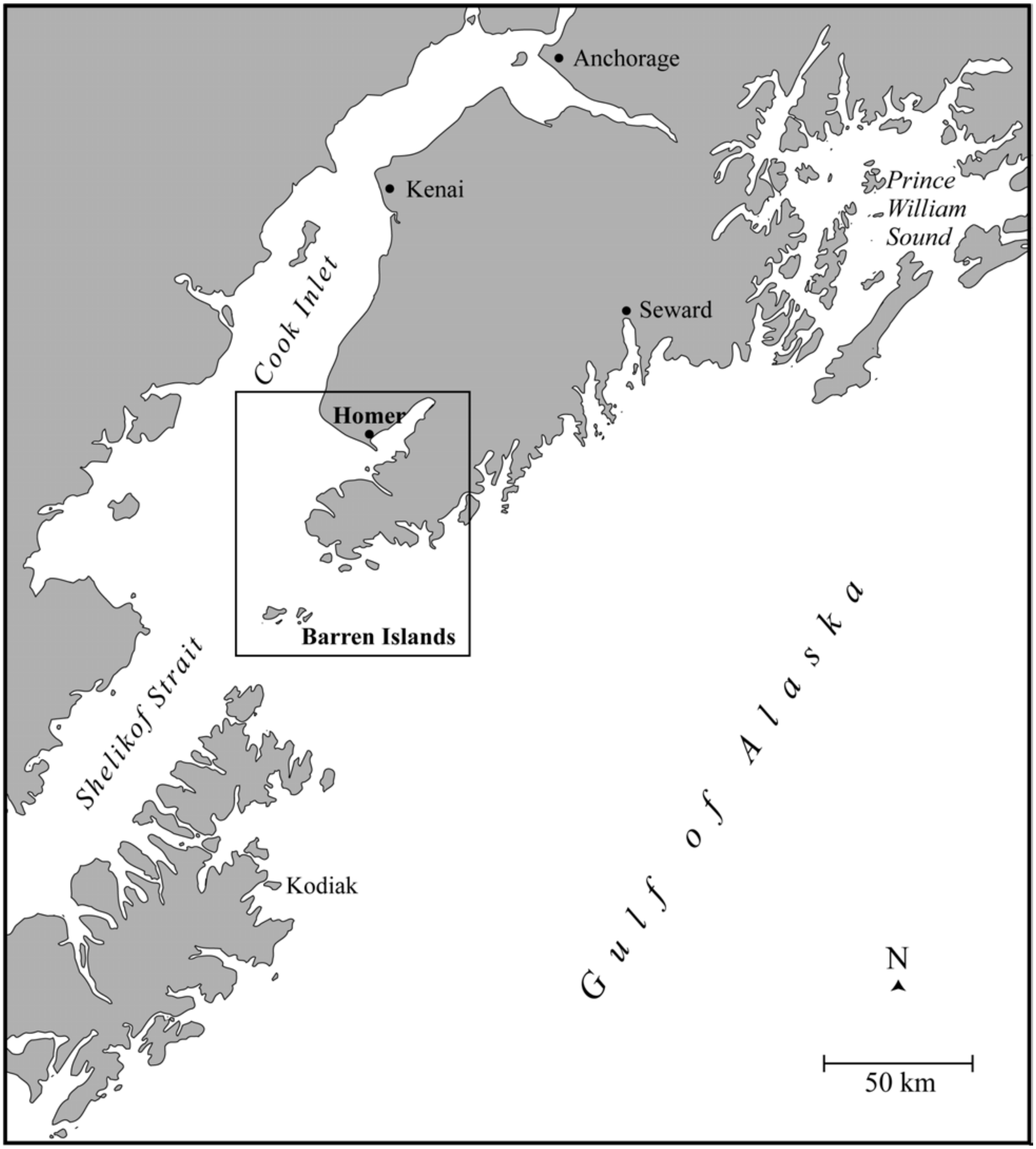

Figure 1. Location of Homer and the Barren Islands.

Figure 2. Path of microwave signals between East Amatuli Island and the Pratt Museum.