Mounting An Expedition

SUMMARY

Mounting an expedition to Amchitka Island to gather physical data and biological samples to address the goals of the Amchitka Science Plan was a complex, interrelated, iterative endeavor. It was made more difficult by the remoteness of Amchitka, making it imperative that all supplies and equipment were on board once the ship set sail, that all personnel were safe at all times, and that sufficient redundancy was built in to assure success of the expedition. The main questions addressed in this chapter are:

1. What were the essential components of the project to meet the highest priority objectives of the approved *Science Plan,* considering budget and schedule constraints?
2. Where should the reference site be located?
3. When was the optimum time and what was the appropriate timing of the components and where should they embark?
4. Who were the project leaders and personnel?
5. What permits were needed and obtained?
6. How was the ship selected?
7. How did CRESP secure the collaboration of NOAA-NMFS and the US Navy?
8. What were the logistical challenges in acquiring and transporting equipment and supplies?
9. How was a Health and Safety Plan (including radiation and dive safety) developed and implemented?

Listing these items creates the illusion that they were accomplished sequentially, when in fact the decisions were inter-dependent. These selection, procurement, and planning tasks occurred within a framework of time and cost constraints that required iterative planning up until the time the first expedition sailed.

The main aspects of mounting an expedition to Amchitka involved finalizing the expedition projects components, selecting the optimum time including the order and duration for the components, selecting a reference site, selecting team leaders and personnel, procuring a wide range of equipment (including the specialized personnel and equipment negotiated with the U.S. Navy), and choosing appropriate research vessels, and developing a health and safety plan and appropriate training.

Each aspect of mounting the expedition is discussed below, including the development of a Health and Safety Plan, and of a Personnel Radiation Dosimetry Plan and report. Radiation exposure to expedition personnel above normal background averaged 0 mrem per year, and there were no differences in radiation exposure for expedition members during the expedition compared to a similar time period after the expedition.

INTRODUCTION

The heart of the Amchitka *Science Plan* was the collection of physical and biological data and samples that would address the main goals of

1) Determining whether current potential radionuclide releases from the shot cavities to the marine environment pose significant risks to human health and the ecosystem,
2) Reducing uncertainty about the extent of the hazard and nature of the risks to human health and the marine ecosystem associated with any potential current or future radionuclide releases to the marine environment, and
3) Providing information that could serve as a basis for developing a biomonitoring plan to detect potential future risks to human health and the marine ecosystem.

The Amchitka *Science Plan* was a comprehensive research plan to provide the information necessary to answer the above questions, thus providing sufficient data to develop a protective, long-term stewardship plan for Amchitka. It described a series of hypotheses that CRESP would be testing in furtherance of the *Science Plan*. Funding and available time for completion of the entire Science Plan, however, was not forthcoming. Thus, the planning for the research described in the *Science Plan* required continued iterations to maximize the research components and the data obtained. With few exceptions, the data and samples necessary to answer these questions were to be obtained during expeditions to Amchitka and a reference site. Although originally planned to cover a three year period, the expeditions were conducted in one year (2004) because of funding amount and availability constraints. From the beginning of the development of the Amchitka Independent Assessment Plan we acknowledged that both physical and biological data were essential to determine whether there was a current or future risk to humans and the marine environment, to reduce uncertainties in the ground water and human health risk models, and to provide information to serve as a basis for developing a long-term stewardship plan. Data analysis of the physical components, sample preparation and radionuclide analysis, and analysis of the radionuclide data followed the expedition.

The objectives, personnel needs, and equipment needs of mounting a physical expedition, and a biological expedition, soon made it clear that these two phases could not occur at the same time, on the same ship. This resulted in a series of decisions that related to research components, research and logistical personnel, procurement of equipment, supplies and a ship, and a health and safety plan.

In this chapter we describe the process of mounting an expedition to Amchitka and the reference site. The overall time-table for the Amchitka project is given in Appendix 4.A. In this chapter, we address the following questions:

1. What were the essential components of the project to meet the highest priority

objectives of the approved *Science Plan,* considering budget and schedule constraints?

2. Where should the reference site be located?

3. When was the optimum time and what was the appropriate timing of the components and where should they embark?

4. Who were the appropriate project leaders and personnel?

5. What permits were needed and obtained?

6. How was the ship selected?

7. How did CRESP secure the collaboration of NOAA-NMFS and the US Navy?

8. What were the logistical challenges in acquiring and transporting equipment and supplies?

9. How was a Health and Safety Plan (including radiation and dive safety) developed and implemented?

In essence, this chapter describes the major issues and obstacles that were addressed to ensure the success of the expeditions to Amchitka and the reference site that occurred in the summer of 2004. It describes the processes necessary to put all the pieces together so that all the personnel and equipment were on board to conduct the necessary data acquisition and biological sampling, with enough redundancy so that the work would proceed smoothly, contingency planning in the face of known adverse weather conditions, cost-effectiveness within the limited budget and time frame, always keeping in mind the safety and health of all participants. The overall summary of the expedition plans, prior to our expedition, can be found in Appendix 4.B. The major components of mounting this expedition are shown in Fig. 4.1.

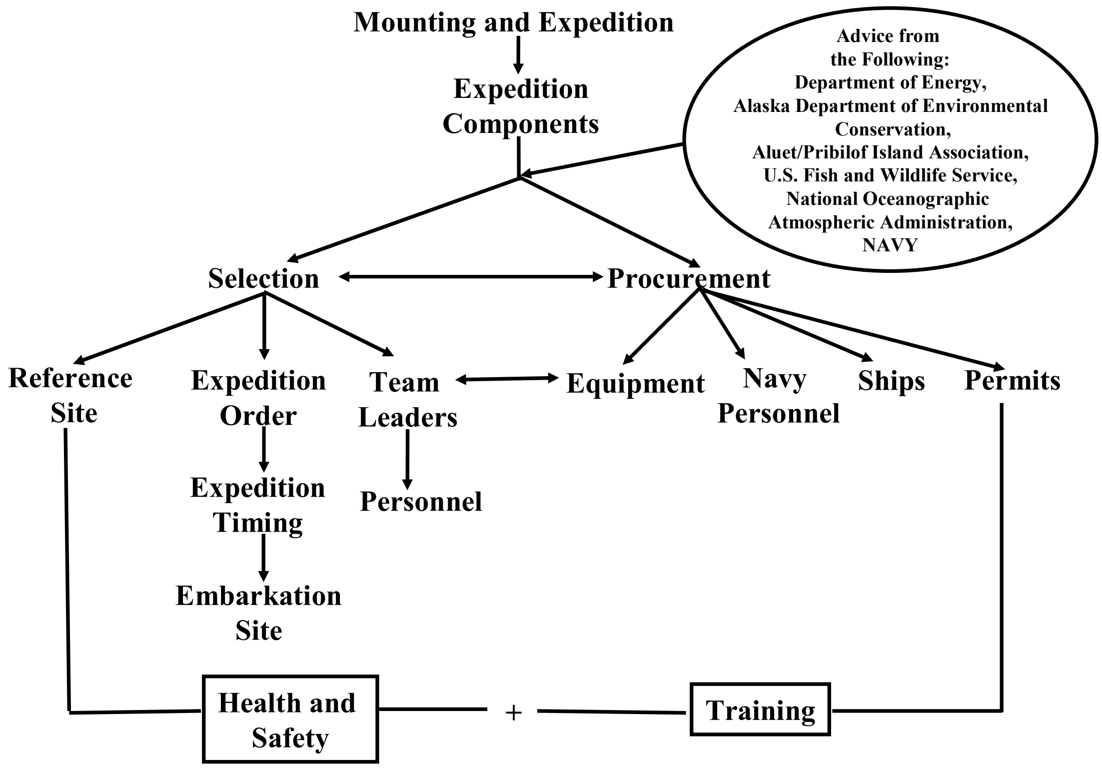

Figure 4.1 Overview Issues Involved in Mounting an Expedition to Amchitka

METHODS

The oversight and management of the research embodied in this report was conducted by the Principle Investigator, in conjunction with C. Volz and the designated project leaders. A wider group of university scientists functioned to review all plans and protocols, provide advice on study objectives, species selection and radionuclide selection, and any other matters that arose during the project. Further, a number of resource trustees, DOE, the Navy, and others experienced in field work in the Aleutians, were consulted throughout the process of mounting the expedition to solicit advice on logistics, selection of reference sites, selection of a ship, and other matters essential to the expedition. The overall expedition structure was established in the plan. The roles of the primary personnel (Powers, Burger, Kosson, Gochfeld, and project leaders) were established in the *Science Plan*, and this group enlisted an expedition manager (Conrad (Dan) Volz) to coordinate the logistics of mounting the expedition (Fig. 4.2).

MOUNTING THE EXPEDITIONS

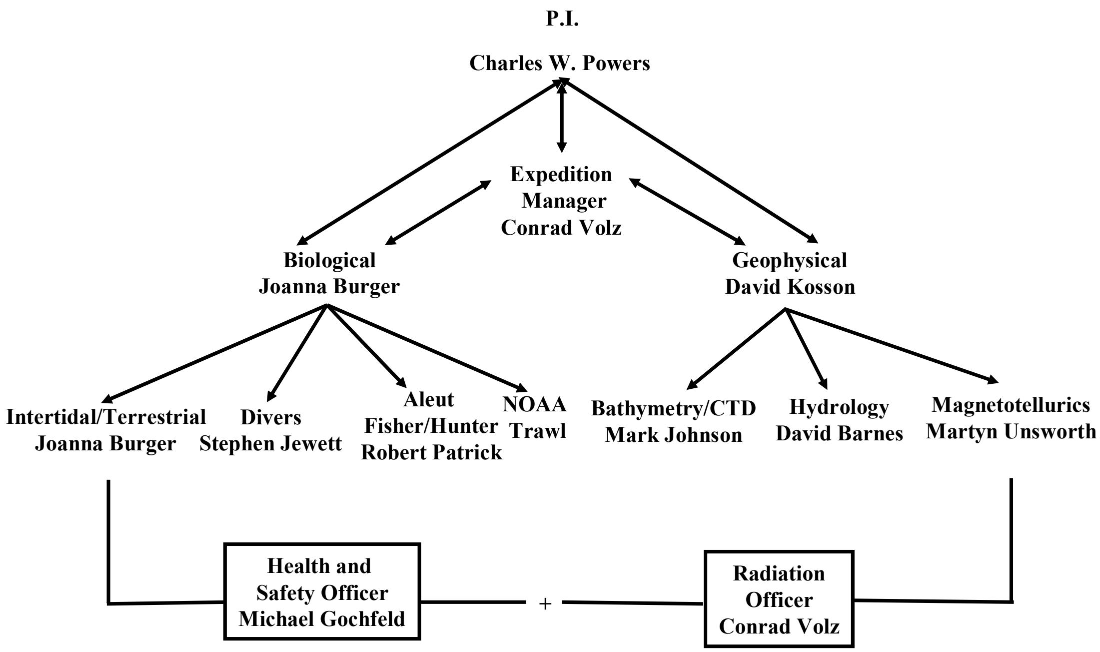

Figure 4.2 Management of the Amchitka Expedition

Once the primary personnel were selected, they functioned to address the other issues necessary to mount the expedition. The main tasks of mounting the expedition related to the entire expedition, as well as to particular projects:

Expedition Tasks:
- Selecting reference sites
- Determining expedition order and timing
- Procuring a ship
- Selecting embarkation points for personnel and equipment
- Procuring expedition equipment
- Obtaining use and collecting permits
- Developing a health and safety plan

Project Tasks:
- Selecting Personnel
- Selecting sampling and collecting sites
- Procuring project-specific equipment/supplies
- Arranging for transport of equipment to Seattle or Adak

RESULTS

While the overall components of the Amchitka expedition were set forth in the *Science Plan*, refinement was required because of cost and time constraints. These fall into major decisions that revolved around the biological and the physical phases. The objective of the biological task was to collect biota to reflect subsistence/commercial foods, food chain accumulation, and indicator species. The plan divided the biological sampling into three types: scientist/diver, subsistence, and commercial fisheries. After much discussion, we realized that all three of these activities could not be accomplished on the same vessel since the equipment and activities of a fisheries trawler differ from a research ship. Thus, the biological sampling task was divided into two separate expeditions: 1) one with terrestrial/intertidal scientists, diver/scientists, and subsistence collections and 2) one for trawling.

Similarly, there were a number of interrelated physical tasks that all addressed uncertainties in the physical environment around Amchitka that might provide information on the time course and pathway of potential radionuclide release from the test shots which in turn might inform the biological sampling. Three separate physical components were deemed essential to facilitating the biological sampling and reducing the uncertainties in the groundwater models: 1) Bathymetry of the ocean floor, 2) Conductivity, temperature and density (CTD), and 3) magnetotelluric assessment of island resistivity.

The objectives of these expedition components were:

1. Biological expeditions to collect biota from the vicinity of all three test shots and the reference site for radionuclide analysis that could be used to assess current and future risks to human health and the marine ecosystem and provide guidance and baseline for long-term biomonitoring.

2. Physical expeditions to collect data that reduces uncertainty in the groundwater and human health risk models, and to provide relevant information for the biological collections.

a. Bathymetry including water and sediment sampling- to provide information on the benthic marine environment and substrate.

b. Conductivity, temperature, density profiles (CTD) - to identify variations in salinity that might localize freshwater outfalls or seeps.

c. Magnetotellurics - to analyze on-land subsurface resistivity structure, to help identify the depth and possible locations of the subsurface freshwater/saltwater interface and direction of groundwater flow as well as faults.

The overarching objectives were to ensure the safety of the food supply and to "focus on model verification and reduction of risk uncertainty" (DOE's Letter of Intent). With this suite of expedition objective we were able to collect biota samples, collect information on the presence of diverse marine organisms, and provide information on the seafloor, possible salinity differences in the benthic zone, and on the freshwater/saltwater interface under the island. Each of these aspects of the expedition is described in detail in the following chapters (chapters 5-11).

Splitting the biological component of the expedition into two phases was another critical expedition decision that was made early in the process. This decision was made because conducting trawls (that mimic commercial fisheries) is a difficult and complex task that requires dedicated equipment, expertise, and staff. Fortunately, the National Marine Fisheries Service (NMFS) of the National Oceanographic and Atmospheric Administrations (NOAA) conducts a survey of commercial fish in the Aleutians every two years, called the Bottom Trawl Survey of the Aleutian Islands. We were able to place a fisheries biologist on board to collect fish during their trawl samples in the vicinity of Amchitka.

Selecting a Reference Site

There are several ways to interpret the importance of levels of radionuclides in biota. These include comparisons with a reference site (presumably not subject to the same sources as the site of interest), comparisons with data from elsewhere in the region or the world (refer back to chapter 2), and comparisons with levels known to cause adverse effects in human or biota. Thus one critical element of the Amchitka Science Plan was the selection of a reference site. In the *Science Plan* we suggested Adak, but our intention was to refine choice this based on discussions with appropriate interested and affected parties.

Our overall process of selecting a reference site, led by Burger, was to define the appropriate characteristics, develop a list of candidate sites, and choose among them based on expedition needs (suitability, comparability, proximity) and advice from stakeholders (Fig. 4.3)

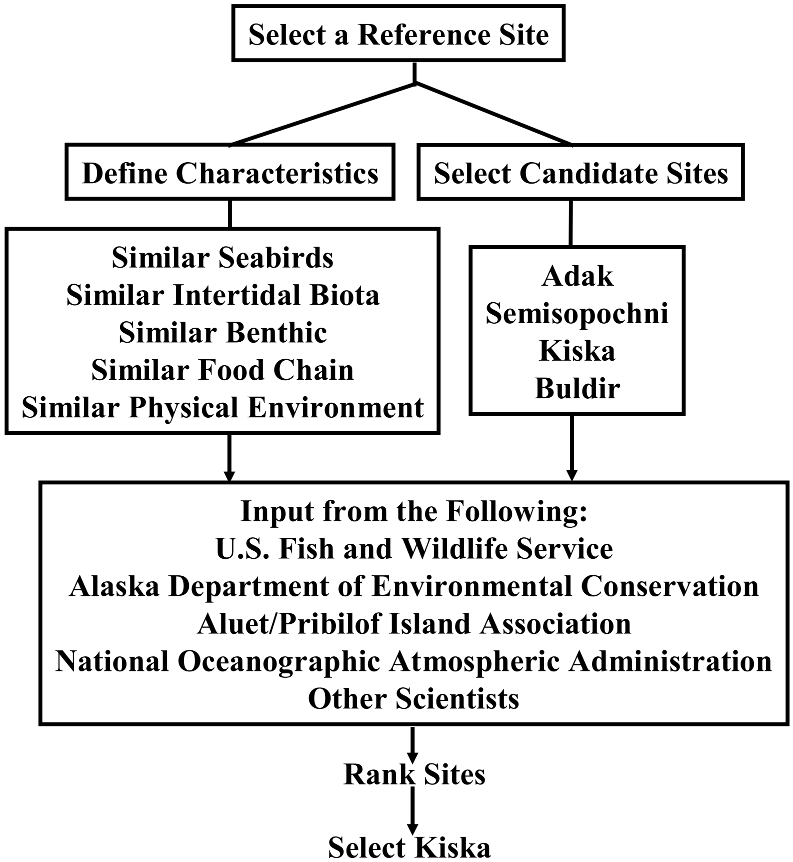

Figure 4.3 Steps in Selecting a Reference Site

While we obtained input from a number of sources, the primary input was from Anne Morkill and others at the U.S. Fish & Wildlife Service, who provided us with detailed information on seabird communities, intertidal biota, and marine environments. Although Adak was a good candidate in terms of the marine ecosystem, it had extensive military activity and there was concern we would not find undisturbed marine communities. Semisopochnoi, an island close to Amchitka in the Rat Island group, was eliminated because the steep volcanic structure of the island would make the bathymetry very different from Amchitka, and it would not have the same marine biota. The combination of Kiska/Buldir was thus selected as the appropriate reference site, based on island structure, benthic environments, seabird communities, and intertidal communities. Prior to the expedition we considered Kiska/Buldir as our reference site, with the proviso that we would prefer to use Kiska alone if possible because it was closer to Amchitka (lessening the ship travel time and allowing more time for biological sampling). However, the U.S. Fish & Wildlife Service scientists indicated that the presence of foxes on Amchitka had severely impacted the eider and seabird communities, requiring us to add consider the fox-free island of Little Kiska/Buldir which had large and flourishing seabird colonies. However, we expected that some of the off shore islands near Kiska (including Little Kiska) might be fox-free as they are adjacent to Amchitka. The marine biology around Buldir was not ideal, and the presence of Sea Lion colonies, subject to disturbance by ship activities, precluded using Buldir alone as the reference site.

Thus after extensive discussions, Kiska-Buldir was chosen as the reference site. Once on the expedition, we went first to the west side of Kiska because of an intense easterly storm and dangerous wave action which precluded operating on the eastern side for two days. We found that there were seabird colonies on the cliffs which our Aleut team was able to access, as well as biologically similar benthic and intertidal ecosystems, although there were few nesting eiders. Having determined that we could collect the majority of our target biota, we sampled first on the west side, and then after two days when weather permitted, we traveled to the east side of Kiska, where we had access to the fox-free island of Little Kiska, just outside of Kiska harbor. Little Kiska had both very active seabird colonies and nesting eiders. This allowed us to collect the requisite biota, and Kiska proved to be an excellent reference site (see chapter 10 for biological comparisons between Amchitka and Kiska).

Timing

Timing was a critical issue throughout the planning and execution of the expedition. Indeed, all aspects outlined in figure 4.1 had to be integrated into the schedule so that each was performed at the appropriate time to allow the expedition to proceed in a cost-effective manner at the best time for the biological sampling (e.g. seabird breeding seasons) and weather conditions. Key timing issues were:

1) The order of the expeditions,
2) The length of each expedition or expedition component,
3) The time necessary to de-brief between expeditions
4) The time necessary to procure personnel, equipment, and a ship.

The order of the expedition was set by the need to have sufficient physical information to inform the biological expedition in its final selection of sampling transects, and to ensure the health and safety of personnel conducting the biological expedition. That is, while the initial biological sampling locations were suggested in the *Science Plan* some refinement was necessary during the physical expedition, and to coordinate between the biological and physical sampling (see chapter 3). Secondly, one important task of the physical expedition was to collect water and sediment samples that could be screened for radioactivity before divers went into the benthic environment to collect biological samples. The safety of all personnel was an overarching concern throughout the expedition.

The length of each expedition was determined by the individual needs of each component, by time and weather constraints, and by logistics and cost. While this was an iterative process, the decision process included: 1) determining the time required by the divers to collect the organisms described in the *Science Plan*, 2) the time the Aleut hunters/fishers and other on-board scientists required to collect seabirds, subsistence foods, and intertidal biota, 3) additional contingency days imposed by weather obstacles, 4) optimal number of days the physical teams needed for each of their projects, and 5) travel days to and from Amchitka and Adak for each expedition.

Advice on the percent of days divers and land personnel would be unable to work came from the diving experience of our team scientists, U. S. Fish and Wildlife Service personnel who were stationed in the Aleutians or worked there, and others who had recently worked in the Aleutians (e.g. R. Patrick, D. Dasher and others). Determining the minimum number of days each physical and biological group needed for the main expedition was a difficult process of give and take among the PI and scientists, with discussions with the ship managers and the Navy (needed for the side-scan sonar work, see below).

Three timing elements that might not be obvious, but were critical to the success of the expedition were 1) inclusion of enough time in dock to allow for installation and de-installation of required equipment and supplies, 2) time at our embarkation site to allow teams to test protocols, procedures and equipment, and 3) adequate time between expeditions to provide coordination and impart critical information to inform the biological collections. The former was essential to optimizing our work on Amchitka and Kiska because it insured that all equipment was present and working, and that procedures were refined. For the biological component it also allowed us to refine permit allowances (some organisms were smaller than anticipated, necessitating increases in collection numbers) and to increase our speed and efficiency in collection and sample preparation. Both tasks allowed the biological collecting to proceed more efficaciously once on the ship.

The meetings between the physical and biological expeditions provided an opportunity for the personnel from the first and second expeditions to meet, along with the PI (on Adak) and D. Kosson (via phone). The main objectives of these meetings were to review safety and logistical observations, discuss results from the physical studies that might inform the biological sampling, and to finalize benthic sampling transects. The latter was accomplished by extending the CTD sampling transects on the Bering Sea shoreward until they intersected the intertidal zone. A computer mapping program (blue chart) was used to identify depth locations along these transects. This yielded the GPS coordinates that corresponded to the 15, 30, 60, and 90 foot depth sampling locations along the transects.

The three previous timing issues (ordering the expedition, determining the length of each expedition, building in the between-expedition discussions), as well as the time required to deploy personnel and equipment, all impacted our choice of embarkation site. Although Amchitka has a large airstrip, the frequency of adverse weather and the lack of landing lights, as well as the cost of chartering aircraft, precluded relying on the airstrip for routine operations. It remained an emergency evacuation option. The only viable options were Dutch Harbor and Adak because these were the sites the research ships could use, had land-based hotels and vehicles, and that were viable in terms of getting supplies, equipment, and personnel to and from the ship. Our decision to use Adak was largely a result of scheduling personnel and the ship, reliable and timely airplane schedules to move personnel, equipment and supplies, and an ability to ship our biological samples from Adak in a timely fashion. The shifting of Air Alaska's biweekly 737 flights from Dutch Harbor to Adak, influenced this decision.

Two final timing issues related to acquisition of supplies and equipment, and obtaining land use and collecting permits. Acquisition of supplies and equipment fell into two categories: for the expeditions in general, and for the individual projects. These three aspects will be discussed below under procurement.

All of the above considerations contributed to the timing of the expeditions are shown in Table 4.1. The timing for the NOAA expedition was set by NOAA's schedule of sampling in the Aleutians and its departure and return to Adak.

Table 4.1. Timing of the expeditions to Amchitka and Kiska

Physical Expedition (Amchitka) - June 12 - June 22, 2004
Ocean Explorer

Integration of physical and biological teams (Adak) - June 23 - June 26, 2004

Biological Expedition (Adak field methods validation) dates
Amchitka and Kiska June 27 - July 21, 2004
Ocean Explorer

Gladiator - July 18, 2004 - August, 8 2004

Selection of Team Leaders and Personnel

The selection of personnel for each project in both the biological and the physical components of the expedition were the responsibility of the project team leaders, in dialogue with the PI, expedition manager, and health and safety officer. One key feature of the biological sampling was the inclusion of Aleut hunters/fishers on the expedition. Thus, special discussions were conducted between Burger, Powers, and Robert Patrick (Aleutian/Pribilof Island Association, A/PIA) to arrange this part of the biological expedition.

The characteristics used to select all personnel were technical expertise, complementary abilities, congeniality and team players, physical fitness, and availability. The primary characteristics for selection involved technical expertise and the complementarity of different researchers. However, it was extremely important to select people who could work together in close quarters for nearly four weeks (in the case of the biological expedition), for long hours, in trying conditions. Personnel had to be able to commit the time required for the expedition, including time for travel, equipment and protocol checks at Adak, and possible time delays in arrival and departure at Adak due to weather. Finally, all personnel had to be healthy enough to work in the extreme environments of Amchitka, and to be medically cleared for the expedition. Divers, had additional special requirements (see Appendix 4.D for the health and safety plan).

Obtaining Permits

Two types of permits were required to conduct the research:

1. Use permits for work on Amchitka and Kiska Islands
   U.S. Fish & Wildlife

2. Collecting permits for invertebrates, fish, and wildlife
   Invertebrates and fish - ADEC
   Birds - U. S Fish & Wildlife and ADEC

During the physical expedition, personnel were continually present on the island and in the intertidal zone. They set up a temporary base camp on Amchitka Island. Personnel were traveling with off-road vehicles on the established roads, and walking over difficult terrain to the test shots. During the second expedition, personnel also drove vehicles over roads and walked overland and in the intertidal. Since Amchitka Island is part of the Alaska Maritime National Wildlife Refuge, the acquisition of use permits was coordinated through the U.S. Fish & Wildlife (USFWS) Office, with aid and coordination with A. Morkill.

The issuing of collecting permits was coordinated among different state and federal agencies. Invertebrates and fish collecting permits were handled with the Alaska Department of Environmental Conservation (ADEC). Bird permits for eiders, gulls, puffins and guillemots were obtained from the regional office of the USFWS and ADEC. Additional permits were required for collecting Bald Eagle eggs, chicks and feathers required the signature of the Secretary of the USFWS, in conjunction with the regional USFWS office and ADEC because eagles are on the federal endangered species list. Marine mammals proved difficult because of low population levels and endangered status. The once thriving Sea Otter population of Amchitka (Merritt and Fuller 1977) had crashed and we were dissuaded from disturbing the endangered Steller Sea Lion.

A list of permits obtained can be found in Appendix 4.C.

Procuring Ships

One of the key decisions of the expedition was choosing an appropriate ship for the physical and biological expeditions. The choice of a ship for the commercial fisheries (trawling) component of the biological expedition was determined by NOAA because they conduct a Bottom Trawl Survey of the Aleutian Islands every two years in the Aleutians. This required extensive negotiations between Burger and Mark Wilkins, director of the NOAA trawl surveys to ensure that we could place a fisheries biologist on board (James Weston), to help with their surveys and to collect the specimens we needed. The NOAA trawl ship was the *Gladiator*. Our use of this mechanism was ideal because we could use their ship and expertise, and because it allowed us to examine the possibility of using this mechanism to conduct future biomonitoring of contaminants in fish from Amchitka and Kiska.

We solicited information on ship options for the main expeditions from several sources, and considered a number of different ships of different sizes, configurations, and capabilities. Suggestions for ships and advice on particular ships was provided by the U.S. Fish & Wildlife Service, A/PIA, NOAA, Alaska Department of Environmental Conservation (ADEC), National Science Foundation, and several other scientists. From the initial list of possible research and trawling ships, we eliminated many based on non-availability for the summer of 2004.

Programmatic and logistical concerns influenced the decision of which ship to procure for our main expeditions (Fig. 4.4). First and foremost, the ship had to meet the needs for the physical and biological components of the Amchitka Science Plan. Secondly, the ship had to be available and fit our schedule, and to meet a number of logistical concerns (Fig. 4.4). As with all the decisions involved in mounting the expedition, all of these complexities had to be considered separately and together to arrive at the best fit for all concerned. In addition to all the constraints shown in figure 4.5, it was imperative that the ship provide a safe and healthy environment for all personnel and activities.

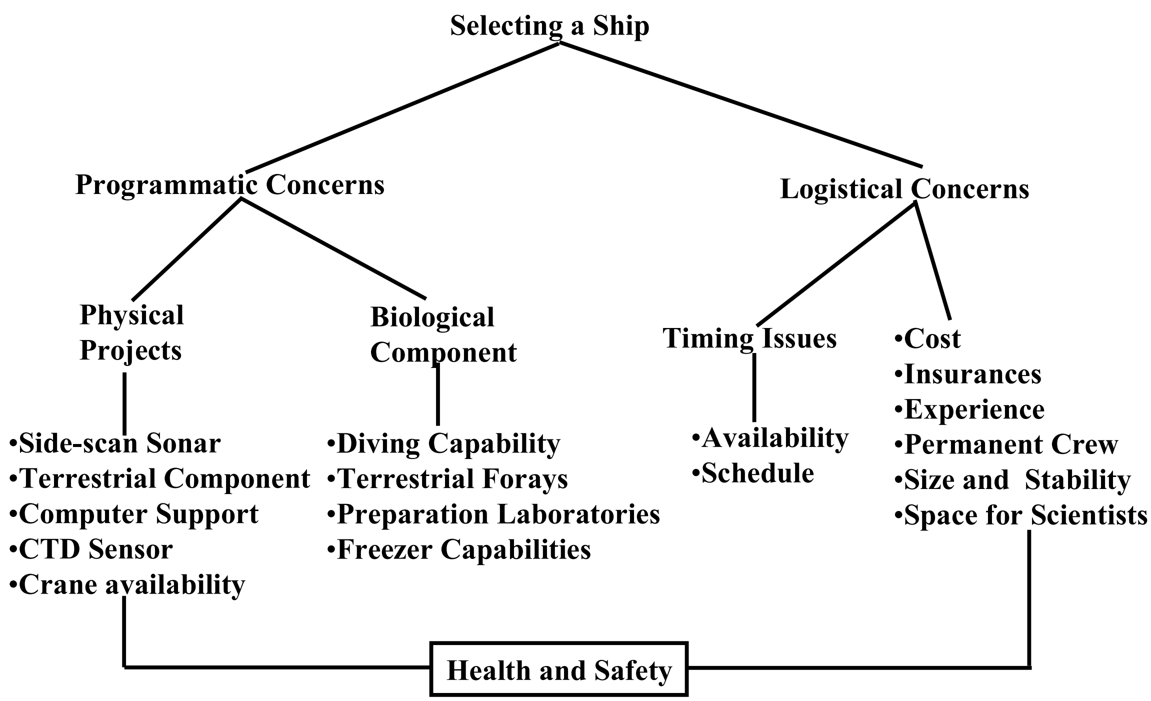

Figure 4.4 Steps and Considerations for Selecting a Ship

The key programmatic concerns were that the ship be able to carry and conduct the tasks required by the physical components of the expedition, and to have diving capabilities and laboratories for sample preparation on board. Laboratories meant the presence of sufficient work stations with running water, dry stations for labeling and quality control, and freezer space for preparing and storing biological specimens. Ease of access for personnel and equipment, conducting experiments, deploying diving operations, and collecting water and sediment samples were important.

The key logistical concerns were scheduling the ship, insurance and cost constraints, experience of the captain and crew in the Aleutians and with researchers, size and stability of the boat, and suitable and sufficient space for researchers. The experience of the captain and the crew was an essential ingredient in insuring both the success of the expedition and the health and safety of all personnel. Overall size was an issue because of the need to have large and complicated equipment on board (such as side-scan sonar), and computer facilities, diving operations, preparation laboratory, deck room, and crane capacity for four off-road vehicles and several small skiffs. An example of the need for redundancy was the fact that one of the skiff motors failed early in the expedition, but the remaining four functioned faithfully. Finally, we required a ship that had sufficient space for the personnel required since the biological expedition had three main components on board: diver/scientists, terrestrial/intertidal scientists, and hunter/fishers from the A/PIA (as well as the expedition manager).

Although no single vessel was optimal on all selection criteria, our final selection was the *Ocean Explorer*, a commercial trawler operated by B & N Fisheries Co. of Seattle. This had the advantages of serving all our programmatic needs, being available for the required time, having an experienced captain and crew, being of sufficient size to hold the necessary research personnel, equipment and laboratories, and being cost-effective.

The *Ocean Explorer* is 155 feet in length, 36 feet wide, with a draft of 16 feet (necessary to allow close work for the physical component of the expedition). It holds 70,000 gallons of fuel, with a sea endurance of at least 30 days (necessary to ensure that any weather delays would still allow us to come safely back to Adak). It accommodated 14 researchers, which was sufficient for our research needs. The ship had a full complement of modern electronics including phone, fax and email, suitable electronic capabilities for the physical expedition (side-scan sonar work) and for the biological expedition (sample labeling and record-keeping), complete wet work stations, and suitable diving support capabilities (Fig. 4.5 and 4.6).

Figure 4.5. The Ocean Explorer

Figure 4.6. The Laboratory on Board the Ocean Explorer. Shown are J. Burger and S. Burke processing mussels, and Dan and Ron Snigaroff with their halibut catch just prior to filleting them (Photos M.Gochfeld, J. Burger).

Procuring the Navy Participation

The objectives of enlisting the aid of U.S. Naval civil servants to assist CRESP during the Amchitka Expedition were to obtain the services of experienced operators and specialized equipment to perform ocean bathymetry and sub-bottom profiling and make measurements of ocean salinity as close to the ocean floor as possible and identify source locations of freshwater. Negotiations with the Navy began on April 23rd, 2004 and a draft research plan was submitted to CRESP on April 26th, 2004. Negotiators included Charles Powers, Conrad (Dan) Volz, David Kosson and Mark Johnson from CRESP and Mike Farnum from the Navy (Appendix 4.D).

It was agreed that Navy personnel would report directly to Mark Johnson, as Chief Oceanographic Scientist, for all on expedition work assignments and daily scheduling. The Navy proposed that the bathymetric survey be done using a vessel mounted SM200 Multibeam sonar with a Klein 3000 Side Scan Sonar and DataSonics SIS 1000 Side Scan Sonar/Sub Bottom Profiler for Subbottom profiling. The Navy also included a USBL system to insure accurate positioning with reference to the research vessel throughout the study. Negotiations between CRESP and. Bob McConnaughey (Bob.Mcconnaughey@noaa.gov) from the NOAA Sand Point Facility, Seattle, Washington occurred simultaneously. NOAA agreed to leave a USBL pole on the Ocean Explorer, between surveys, for CRESP use but needed contractual assurances that this pole, which holds the transducers for the sonar over the side of the vessel would be replaced if damaged or destroyed.

Salinity measurements were agreed to be made with a calibrated, high precision Conductivity/Density/Temperature probe (CTD) Seabird 19+. Other equipment to be provided by the Navy for equipment support, redundancy, proper tracking, real time measurements and data recording included GPS receivers (2), Gyro compass, Vessel Motion Reference Unit, back-up CTD Probe, Trackpoint II USBL Tracking system, CTD winches and the QINSy Integrated Navigation Package. The total cost of equipment to be brought on the expedition by the Navy totaled approximately $900,000. CRESP was required to accept responsibility for loss or damage to Navy equipment, unless through operator error, and insure each piece of equipment with available insurance underwriters.

Under the final contract (date) the Navy field team's responsibilities included:

(1) Advance preparation and coordination with the CRESP team.
(2) Pre and post calibration of all major electronic equipment, especially the CTD probe.
(3) Installation, operation and removal of USBL navigation system.
(4) Side scan sonar data acquisition, post-processing, groundtruthing, and mosaic preparation.
(5) Multibeam echosounder data acquisition, post-processing, groundtruthing and mosaic preparation.
(6) General support services and
(7) Preparation of a summary report and delivery of documented data products to UAF.

Figure 4.7. Deployment of Side-scan Sonar (Photos D. Volz)

Procuring Equipment and Supplies

There were two aspects of procurement of equipment and supplies: expedition equipment and project equipment. Expedition equipment and supplies were those items that were required for more than one project and would in some cases be used by all members of the expedition. Responsibility for procuring expedition equipment fell largely to the expedition manager, in consultation with the PI and project leaders. Project leaders were responsible for procuring project equipment. leaders, in consultation with the PI and expedition manager.

Expedition equipment included off-road vehicles, small skiffs, radios and communication devices, computers, freezers, batteries, camping equipment, GPS units, binoculars, cameras, life vests, expedition float coats, and safety supplies. After extensive inquiries and negotiations, we found that it was more cost-effective to rent off-road vehicles, small skiffs and freezers from the ship (B & N Fisheries), rather than purchasing them. Other equipment and supplies were largely purchased from commercial sources in Seattle, where the ship was docked before departure.

Equipment for individual projects was largely purchased by the project leaders. The key issue was to built in redundancy while being cost-effective. That is, once each expedition sailed, there was no option for return to Adak, and all necessary supplies and equipment had to be on board. Supply options in Adak were extremely limited. Thus, sufficient equipment and supplies had to be on board to conduct the research in a safe manner. This necessitated, for example, such things as purchasing: 1) extra scales so that should any one or two malfunction, others would be available, 2) extra hand-held scales in case the ship rocked too much for electronic balances, 3) extra camping gear in case any was ripped or destroyed during work, 4) extra batteries in case they malfunctioned, 5) sufficient dissecting knives for all eventualities, and for loss during the trip, 6) adequate plastic bags and sampling containers, 7) adequate cleaning, sanitizing, and preservative chemicals, 8) adequate fishing lures to compensate for the frequent loss under normal conditions, and 9) extra food supplies for terrestrial expeditions in case personnel were stranded due to bad weather. It also entailed having extra boats and motors on hand so that operations never ceased due to engine or boat repairs.

Finally, experiences during the first expedition informed the second expedition. As a result, we secured wind screens for the off-road vehicles, and purchased heavier boots for walking in the tundra, heavier rain gear for the foul weather, and additional gear for our subsistence fishermen, and bought some chocolate treats in Adak prior to departure. Testing field methods on Adak provided additional information such as the need for many more fishing lures and dissection knives than originally anticipated.

Health and Safety

One of the most important aspects of mounting an expedition was developing a Health and Safety Plan for the expedition, by the expedition health and safety officer (M. Gochfeld, MD, Appendix 4.E, 4.F and fig. 4.8), including a radiation safety plan (C. Volz) and dive safety plan (S. Jewett). This was a challenge because of the complexity and remoteness of the expedition, and because expedition personnel worked in so many conditions - on rocky and uneven terrain, in intertidal environments, diving underwater, and on a rolling ship.

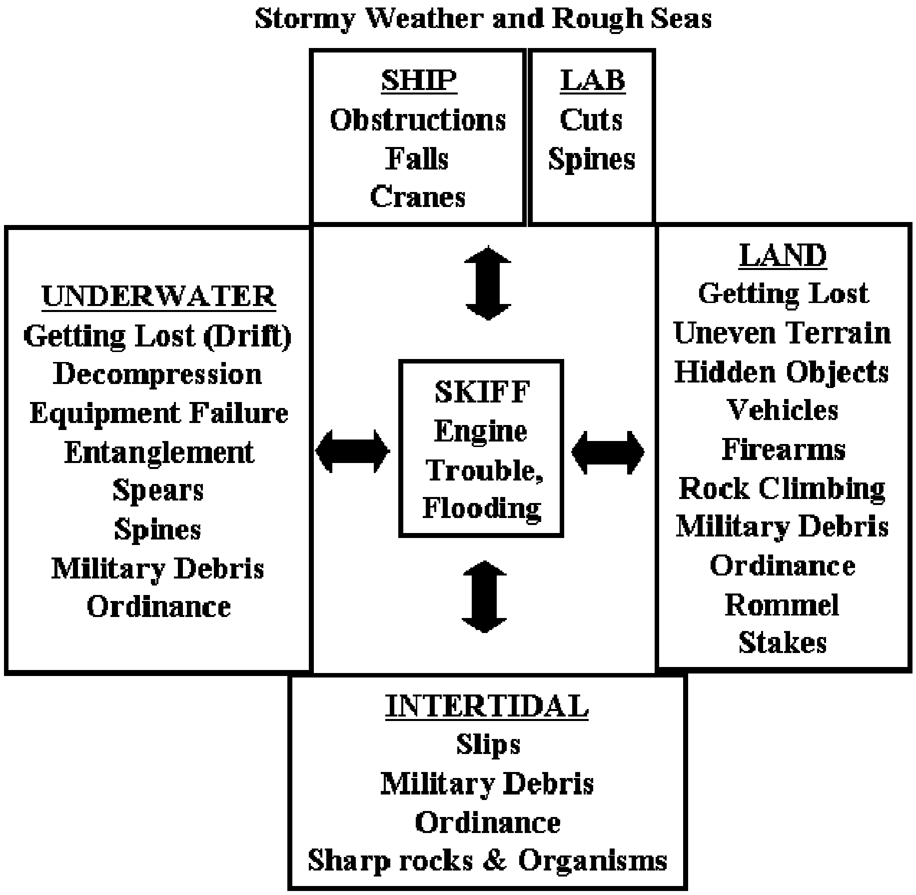

Figure 4.8 Schematic Diagram of the Health and Safety Hazards Encountered on Different Aspects of the CRESP Amchitka Project. Transfers from Ship to Skiff and from Skiff to Land, Intertidal and Diving Activities.

Accomplishing the multiple purposes of the Expeditions imposed significant demands on the researchers and the ships crew, with tight time limits complicated by frequent adverse weather conditions. Worker safety was always a primary consideration as well as a challenge. It required the designated Health and Safety Officer, dive safety officer, (S. Jewett) and radiation safety officer (Volz), to develop a Health and Safety Plan (HASP) intended to cover the broad range of potential hazards that might be encountered on the ship, in the water, in the intertidal zone, and on the land (Figure 4.8). Shipboard hazards were partly covered by the ship's own safety plan. The crew was experienced at sea and in small-boat operations, and crew members had emergency medical training. The diving safety was encompassed in the University of Alaska's Dive Safety Plan.

The HASP formed an umbrella referencing these plans and identifying hazards and safe operating procedures also for the terrestrial and intertidal activities. Prior to the expedition careful planning was required to assure that emergency equipment was on board, and that all personnel had all of the equipment they needed to work safety in the harsh environments for which they were responsible. This required purchase of certain new diving equipment as well as field equipment and foul weather gear for all participants. Diving safety posed the unique challenge that the nearest decompression chamber was 1200 miles away. Land operations required camping equipment and supplies for several days. Since the purpose of the expedition was to collect organisms that might have radioactive contamination, and in view of the possibility of undersea radiation leakage, a radiation safety plan was required, that included thermoluminescent dosimeters for all expedition members, as well as the field screening of all specimens with sodium iodide detectors. The Physical Expedition collected and screened water and sediment samples as a guidance for the Biological Expedition.

Developing the HASP was an iterative process (Fig. 4.8), influenced by regulations and guidelines, and taking into account the needs of each research team and that special hazards they might face. Once developed and reviewed the HASP was sent to all team leaders who were responsible for assuring that all personnel read the HASP. Prior to embarkation there was a HASP briefing and review session involving the entire research team. This covered all of the main HASP components as well as the general features of the Dive Safety and Ship Safety plans. All participants were informed of the need to use appropriate safety equipment at all times, the need to operate with a buddy both on land and under the water, and the need to be in radio contact with the ship. Given the limited number of research personnel, it became doubly important to deploy people in a manner consistent with the HASP. All dive teams operated as pairs, each pair tended by a skiff with a crew member-spotter. Land-based teams also operated in pairs or groups, and kept in radio contact with the ship.

Weather was a constant concern for the expedition. We had been adequately warned that we could expect to lose 1/3 of the days due to storms, high wind, waves, and rain. Since ship time was severely limited, team leaders were under pressure to accomplish their objectives. Therefore decisions were often made to abandon one location when several days of bad weather threatened, and to move to more sheltered areas so that work could continue. Although there were no reliable weather forecasts, the knowledge and experience of the ship's captain and the Aleut team, were very helpful in allowing the scientists to change plans and maximize field activities, without jeopardizing safety. In a real sense, the expedition made its own weather, by wise choices of where to spend time.

A crucial feature was establishing lines of stop-work authority. Ultimate responsibility lay with the ship's captain who would restrict or allow departures in the skiffs for diving or land operations, depending on wind and waves. The chief scientist (Burger), and each team leader (Jewett, Patrick) also had authority for whether or not to deploy their field teams. In addition, at the preliminary briefing each team member was told that they had the right to refuse hazardous duty.

A particularly hazardous environment was the ship's crowded deck, with frequent crane operations to load and unload cargo, vehicles, and skiffs, complicated by multiple scientific teams and many people with little shipboard experience. The risk of being struck by crane operations was well known and was thoroughly covered in the safety briefing. The opportunity for falls or being struck by hatch covers, movable objects, or overhead

structures, was particularly great when the ship was underway in foul weather.
The ship was patrolled regularly to identify non-permanent hazards such as ice-chests, fishing gear, and other movable obstructions.

One of the greatest hazards occurred during transferring from the ship to the skiffs and from the skiffs to the intertidal zone. The danger increased exponentially with wind and wave action, and this was the limiting factor in whether dive and land teams could be deployed on a given day. Landing in the intertidal zone posed the added hazard of damaging the boat bottoms on sharp rocks or taking on water from breakers, which had to be balanced against the need to stabilize the craft while off-loading people and equipment onto the slippery, algae-covered rocks.

Land-based hazards included vehicle operations, the need for hard hats and goggles while driving, and the challenge of carrying loads or hunting on uneven, shifting tundra terrain. This was complicated by the existence of unexploded ordnance, and sharp-pointed Rommel stakes left over from World War II. The use of firearms on land and in skiffs was a particular challenge when two or more hunters were working together. The training called for a shooter-leader and coordination.

Overall there were several minor injuries and near misses, but no major injuries or lost-time injuries. The contingency of having an emergency air medevac was fortunately not required. The comprehensive HASP, pre-expedition training and review, and the daily planning and safety discussions, coupled with wise decisions, were successful in protecting the expedition members.

Radiation Monitoring for Personnel Safety and Specimen Integrity

A final aspect of mounting the expedition was ensuring the safety of personnel during and after the expedition. While the health and safety plan covers the health of the personnel overall, here we describe the specific plans for radiation monitoring. The objectives of the personnel radiation dosimetry plan (Appendix 4.F) was to examine the radiation exposure of individual personnel on the expeditions, including the crew of the *Ocean Explorer*. It is customarily used in circumstances where workers might reasonably be exposed to ionizing radiation in the course of their work, such as DOE remediation workers, x-ray technicians, nuclear power plant employees or researchers using radioactive tracers.

Radiation monitoring was both an endpoint for our expedition, and a health concern. That is, personnel wore radiation monitors both to assess potential radiation exposure and to assure personnel of limited risk. Health physicists at both Rutgers University (Rutgers Environmental Health Services) and Vanderbilt University (Department of Radiology and Radiological Sciences) concluded that any potential exposure of personnel on the expedition would be below the thresholds at which either university would require badging with thermoluminiescent dosimetry badges, or radiation training.

Expedition members were thus considered to be "members of the public" (not radiation workers), and the decision was made to use the public limit of 100 mrem per year above background as the Occupational Exposure Limit (OEL), rather than the radiation worker standard of 5000 mrem/year. An expedition guideline of 10 mrem was chosen, since any one member of the expedition would be at or near Amchitka not more than a tenth of a year.

Even though they were not recommended by our universities, the Health and Safety Director and P.I. decided that all expedition personnel should wear badges during the expedition, and a control badge should be worn for an equal time period following the expedition. Personnel wore these personal dosimeters at all times; divers wore them under their dive suits; spot checks to ensure compliance were made sporadically by the expedition manager. Suitable personal controls, transit controls, blank controls, and spike controls were established for each expedition (Appendix 4.F). The procedure to evaluate exposure was to obtain the total exposure in mrem and adjust this exposure to reflect the exposure time period, and to compare on-expedition exposure to an equal time period following the expedition.

The hypothesis was that expedition personnel were exposed to no ionizing radiation over background, and therefore net cumulative exposure of expedition personnel above normal background was 0 mrem. This hypothesis was confirmed. The mean of the expedition exposure was - 0.422 mrem, with a 95 % confidence interval of $\pm$ 1.036 (Appendix 4.F). Further, none of the expedition radiation exposures were statistically distinguishable from the transit control dosimeter readings. Further, the post-expedition exposures of expedition members did not differ significantly from expedition exposures.

All "on expedition" survey meter monitoring data indicate that no radiation source above background was encountered during Phase I and II operations both during land and sea based activities. All water and sediment samples screened on the boat using both the gamma scintillation probe and the alpha, beta and gamma probe were within background levels. No biological samples or preparation areas contained activity over background during monitoring periods. Perhaps most importantly, analysis of Phase I sediment grab samples found "no suggestion of any fission product or fissile material contamination" (Appendix 4.G).

DISCUSSION AND IMPLICATIONS

The preparation and planning necessary to mount the expedition was a complicated process that involved making decisions about personnel, logistics, and timing that were interconnected. The first decisions involved selection of the main components of the expeditions, project leaders, and an expedition manager. However, once the main components of the expeditions were selected, all other decisions were iterative in that each had to be reviewed again once the other decisions were made. In other words, the process of mounting the expeditions was not linear, and refinement of different aspects was required. Most tasks had to be accomplished simultaneously, and were initiated immediately upon deciding to move forward with the Amchitka Assessment Plan. The key tasks were selecting ships, selecting expedition order and lengths, obtaining collection and use permits, securing major equipment, and developing a health and safety plan (with a suitable radiation monitoring component). Being able to refine plans during the planning process was critical to fitting all the pieces together. Being able to make each decision in a timely manner was critical to the overall scheduling. Many of these decisions were facilitated by a development of a web-based communication system with controlled access within and among research groups and universities. (Appendix 4.H)

Mounting the expedition in such a way that sound-science, redundancy, safety, and cost-effectiveness were built in was a monumental challenge for the key expedition personnel (Powers, Burger, Kosson, Gochfeld, Volz), as well as the individual project leaders for the first (Johnson, Unsworth, Barnes) and the second (Burger, Jewett, Gochfeld, Patrick) expeditions. The overall success of the entire Science Plan was dependent on the results from the three expeditions. Interactions between all expedition members about the needs of individual projects and the needs of the overall expedition equipment ensured that the needed redundancy was present while still being cost-effective and safe.

Appendices for Chapter 4 (See attached CD-ROM)

4.A. Time Table for overall process for CRESP Amchitka by C.W. Powers
4.B. CRESP Amchitka Expedition Summary by C.W. Powers
4.C. List of Permits for Research on Amchitka and Kiska Islands
4.D. CRESP Amchitka Project Health and Safety Plan (June 8, 2004) by M. Gochfeld, B. Friedlander and S. Jewett.
4.E. Developing a health and safety plan for hazardous field work in remote areas. By M. Gochfeld, C. Volz, S. Jewett, J. Burger, C. W. Powers and B. Friedlander
4.F. Personnel Radiation Dosimetry Phase I and II by C. Volz
4.G. CRESP Amchitka Expedition Radiation Survey Monitoring Report by C. Volz
4.H. Use of a Web-based Communication for Mounting an Expedition and the Amchitka Independent Assessment Plan by L. Bliss, J. Burger, C.W. Powers, V. Vyas, and M. Gochfeld

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