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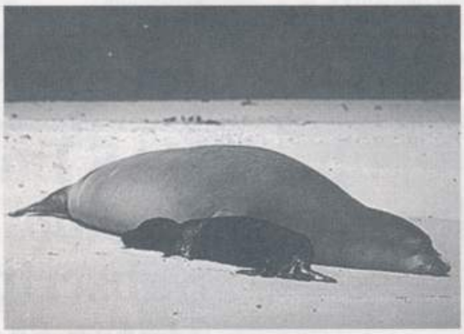
Assessing Extinction Risks for Endangered Species:

A Case Study Using the Hawaiian Monk Seal

by Karen B. Lombard[1]

As species become increasingly rare due to habitat destruction, introductions of alien species, disease, and other factors, techniques are needed in conservation biology to assist in determining extinction risks. Over the last ten years, population viability analysis (PVA) has developed as a method of assessing the viability of an individual species. Despite recent emphasis towards the management of entire ecosystems as a way of protecting endangered species, individual species will still become rare and may need specialized management.

Population viability analysis (PVA) uses computer modeling to evaluate the influence of interacting deterministic (predictable) and stochastic (random) factors on the survival probability of endangered species. The theoretical basis of PVA developed from the idea that small populations face a number of extinction risks not faced by larger populations. These deterministic and stochastic risks need to be examined carefully and together when assessing long-term viability or management options for populations (Shaffer 1981). Deterministic forces include changes in population size or growth rate due to a predictable or inexorable force such as habitat destruction or harvesting (Gilpin and Soule 1986). Stochasticity incorporates the natural variability of the environment including random differences between individuals and the effects of environmental variation on organisms. Stochastic forces usually are categorized as demographic, environmental, genetic and catastrophic events (Shaffer 1981).



Hawaiian Monk Seal and Pup

Photo courtesy of National Marine Fisheries Service

Demographic stochasticity is the random change in reproduction or survival due to differences among individuals. When an individual is "sampled" from a population, it will have a certain chance of reproduction or mortality that will vary from the mean (Lacy and Clark 1990). For example, although on average the sex ratio at birth may be 1:1 in a population, in any particular year the sex ratio may vary from this average.

Environmental stochasticity involves variation in the mean rates of birth and death so that all individuals are affected simultaneously. This type of stochasticity includes random changes in environmental variables such as weather, prey abundance, predator abundance and disease (Shaffer 1981; Lacy and Clark 1990).

Catastrophes may be critical in determining the long term persistence of a population (Mangel and Tier 1994; Harwood and Hall 1990). Catastrophes are extreme environmental events such as fires, floods, disease outbreaks or droughts that cause severe population declines or extinction of subpopulations (Ewens et al. 1987; Shaffer 1981). They may occur once or a number of times over a 100-year interval. Catastrophic events tend to be modeled separately because of their severity and the fact that they often occur more frequently than would be expected for extreme events (Young 1994).

The amount of genetic variation in small populations may be reduced by genetic drift or inbreeding. Genetic drift occurs when gametes are randomly selected for the next generation and the frequencies of alleles (alternate forms of the same gene) vary. Such variation is more common in small populations and thus leads to more rapid loss of genetic variation than in large populations (Hartl 1988; Lacy 1987). This loss of variation may make a population less able to respond to changes in the environment or may decrease disease resistance. Inbreeding occurs when close relatives in a population breed with each other. Over the short term, inbreeding causes declines in fecundity and greater juvenile mortality (Ralls and Ballou 1983). Over the long term, theory suggests that the evolutionary potential of a species is compromised when variation is lost through inbreeding (Selander 1983).

Interactions among the four factors also are important. Below a certain population size, such interactions may send a species into an "extinction vortex" (Figure 1) (Gilpin and Soule 1986). In the example illustrated in Figure 1, a small population is susceptible to inbreeding which may decrease reproduction and survival which may slow growth rates which in turn cause the population to become even smaller and closer to extinction (Lacy 1993). Catastrophes or environmental events may also enter into the loop to steepen the spiral. Because of

Figure 1. Extinction Vortex caused by negative feedback effects of inbreeding in small populations (from Lacy 1993).

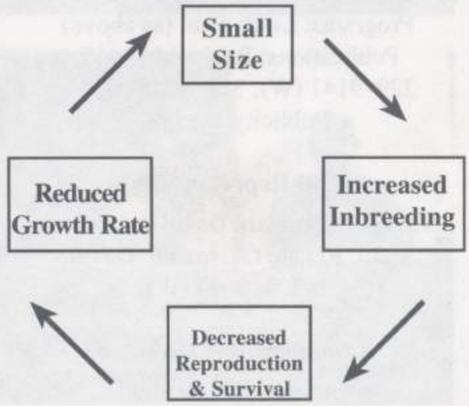


Table 1: Parameters included in the basic scenario constructed for the Laysan Island subpopulation.

Parameters	
Mating system	Age distribution
Age at first reproduction	Subpopulation size
Maximum age*	Castastrophe frequency and severity*
Sex ratio at birth	Carrying capacity*
Density dependence (reproductive function)*	Environmental variation in carrying capacity*
Environmental variation in reproduction*	Harvest or supplementation of the population
Mortality rates (female/male)**	Migration (metapopulation model)
Environmental variation in mortality*	Inbreeding*
Percent adult males breeding*	

*Estimated parameters
**Mortality rates after the end of the first year of life were estimated.

the difficulty of predicting exact outcomes from the interaction of these many variables, and because of their potential for influencing population trends, conservation and population biologists need to include these forms of stochasticity in models of endangered populations.

I used the computer program, VORTEX (Lacy et al. 1993), to examine the risk of extinction for the Hawaiian monk seal, *Monachus schauinslandi*, an endangered seal species found only in the Northwestern Hawaiian Islands (Lombard 1996). This species had major declines in the 1800s due to harvesting, and more recently for less clear-cut reasons (Ragen 1993). The monk seal population is currently declining at four per cent each year despite management efforts (Ragen pers. comm.).

The PVA approach also has been applied in Hawaii to the 'alala or Hawaiian crow (*Corvus hawaiiensis*), the akohekohe or crested honeycreeper (*Palmeria dolei*), and the palila (*Loxoides bailleui*) (Ellis et al. 1992). Because of long term monitoring efforts of monk seal populations by the National Marine Fisheries Service, however, more data exist for this species than for many species for which population viability has been analyzed. Objectives of this study were to identify the probability of persistence after thirty and one hundred years for the Laysan Island subpopulation, and to conduct a sensitivity analysis on key parameters that may affect population persistence. In addition, I examined the effects of metapopulation structure (interisland migration) and current management activities on monk seal persistence at other islands and atolls (Lombard 1996).

This PVA used data from several of the better known monk seal subpopulations to construct a "basic scenario" for the Laysan Island subpopulation (Table 1) (Lombard 1996). Parameters in this scenario were then varied in a sensitivity analysis to determine which may have the greatest effect on the persistence of a monk seal subpopulation. Each simulation began with the 1994 population size and age distribution as well as survival and mortality rates that gave a deterministic growth rate of six percent before catastrophes were included. Probabilities of extinction and growth rates were compared after each analysis. During the inbreeding analysis, the amount of genetic variation remaining in the subpopulation was compared. Each analysis was based on one thousand simulations that were aver-

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aged to obtain mean population sizes and probabilities of extinction (because of the stochasticity included in the model, the result of each run is different) (Lombard 1996).

Results from running the basic scenario indicated that the Hawaiian monk seal has a high survival probability (100%) over the next 30-100 years (Lombard 1996). Actual declines observed in subpopulations, however, suggest that simulations may be too optimistic. Results of sensitivity analyses indicated that survival is the most important factor in the persistence of this species. Only decreases in survival rates and or increases in environmental variation or catastrophes affecting survival increased the probability of extinction above zero for the Laysan subpopulation (Lombard 1996). This result agrees with theoretical studies showing that growth rate of marine mammal populations is very sensitive to adult female survival (Goodman 1981; Eberhardt and Siniff 1977). The metapopulation structure of the Hawaiian monk seal reduced the amount of variation in mean population sizes and may be important to the persistence of the smallest population at Midway Atoll. The Midway population was susceptible to inbreeding because of its small size. Simulations also suggested that current management efforts augmenting depleted subpopulations were likely to increase mean population sizes at thirty and one hundred years (Lombard 1996).

Although VORTEX simulations identified survival as a key factor to persistence of the species, population viability simulations do not explain why declines are occurring. Studies thus far (Ragen 1993) suggest that the reasons for decline may vary in the different subpopulations of the monk seal, and it would be difficult for one model to identify all possible reasons. In many cases temporary measures may be taken to arrest declines as a monk seal stocking program at Kure Atoll has done. Yet, if the causes of decline are not identified, the decline may continue once management efforts are removed.

PVAs also tend to ignore ecological factors such as interactions with disease, predators or prey that may strongly influence population dynamics (Boyce 1992), although interspecies interactions may be implicitly included in the environmental variation experienced by the organism (Ralls and Taylor 1997). Human activities with unknown impacts on a species are also difficult to model accurately. The monk seals may be suffering increased mortality directly or through competition for prey by commercial fishing activities (including lobstering, bottom fishing or pelagic long line fishing) (Ragen 1993) and these impacts were not included in this PVA.

In addition, interactions between demography and behavior are ignored in PVA models but may have significant effects for this species. At Laysan Island, mobbing is thought to be a significant factor in observed declines (Ragen 1993). Mobbing occurs when many adult males attempt to mate with one female, which may cause severe injury or death of the female. Adult males were recently removed at Laysan Island in an attempt to balance the adult sex ratio (currently heavily weighted towards males) and lower the mobbing rate. The effect of removal of adult females (simulating mobbing) and the removal of adult males (simulating current management) was examined using VORTEX.

Because these above factors are not included, it is likely that the true risk of extinction for the Hawaiian monk seal is underestimated by the model (Lombard 1996). Over ten years of data exist for this species; however, many parameters are still needed to be estimated (Table 1.). Several other aspects of this PVA, including the use of average adult survival and reproductive rates, also may be unrealistic for this species. These problems with the VORTEX model suggest that species with substantial population data available, such as the monk seal, may benefit from models tailored to their specific population variables.

Despite these criticisms, PVA is still recognized as useful and should be used as just one aspect of endangered species management rather than as a predictive tool (Ralls and Taylor 1997). Management efforts can be viewed as experiments, and management can be modified as results of the experiment become available (Walters 1986; Holling 1978). The models can also assist in pointing out which parameters are important, help in prioritizing research or in deciding among management options (Ralls and Taylor 1997; Possingham et al. 1993; Lindenmayer et al. 1993; Lacy 1993). A clearer perception of the problem may develop from gathering the data and articulating assumptions during the PVA process. The PVA for the monk seal suggests that understanding the causes of mortality for this species is critical and that future research should focus on this area.

Acknowledgments

This paper represents a summary of a thesis submitted by the author to the University of Michigan in partial fulfillment of the requirements for a Master of Science Degree. I thank Timothy J. Ragen of the National Marine Fisheries Service, J. David Allan of the School of Natural Resources and Environment at the University of Michigan, and Robert Lacy of the Chicago Zoological Society for their assistance with this analysis. I also thank Elizabeth Flint and Patricia Sanborn for their assistance in reviewing this article. This research was supported by grants from the Hawaii Audubon Society, The Sussman Foundation Environmental Internships Program and Rackham Graduate School at the University of Michigan.

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The Future of Wildlife Protection

Endangered Natural Heritage Act Supported by Audubon Society

The Endangered Species Act (ESA) has prevented the extinction of many species: without the ESA the bald eagle, timber wolf, peregrine falcon, and humpback whale might have disappeared in the United States. Authorizing legislation for the Endangered Species Act expired in 1993; since that time, numerous attempts have been made to pass new legislation, but no bill has passed either house of Congress. In the 104th Congress, several bills were introduced that would significantly undermine the protections of the ESA; Audubon fought these draconian overhauls of the Act, and will oppose any bill weakening the Act.

A recent development may hold hope for a reauthorization bill that strengthens the Act. Grassroots members of the Endangered Species Coalition, of which Audubon is a member, have drafted an alternative reauthorization bill that would strengthen and fortify the embattled Endangered Species Act — the Endangered Natural Heritage Act (ENHA).

ENHA will strengthen protections for declining, candidate, and listed species by.

- Requiring Federal agencies to act proactively to conserve declining species before they need the full protections of the Endangered Species Act;
- Establishing a scientific commission to study and identify species and ecosystems at risk, as recommended by the National Academy of Sciences in last year's assessment of the ESA;
- Requiring the FWS (Fish and Wildlife Service) and NMFS (National Marine Fisheries Service) to list and protect candidate species in a timely manner before species decline to the brink of extinction;
- Increasing protection for plants on both public and private lands and strengthening enforcement of plant protections. ENHA authorizes the Secretary to list populations of plants if they are threatened with extinction in the entire U.S.

ENHA will strengthen protections for habitat of endangered and threatened species by:

- Requiring that known occupied habitat be designated and protected at the time a species is listed. Critical habitat should be refined and finalized in the final recovery plan. The widely abused exceptions to critical habitat designations should be limited;
- Clarifying that critical habitat is protected from modifications that reduce the likelihood of recovery for the listed species that depend on the habitat.

ENHA will emphasize recovery of species by;

- Requiring federal action agencies to participate in the implementation of recovery plans; and encouraging the participation of state and local governments in recovery plan implementation;
- Clarifying that objective scientific benchmarks should be established for listing, recovery, and delisting decisions;
- Establishing deadlines for the adoption and implementation of recovery plans;
- Reducing the total number of allowable annual incidental takes for species not making progress toward recovery;
- Clarify that federal agencies and holders of take permits have a duty to recover, not just maintain, listed species.

ENHA will require federal agencies to more effectively protect listed species by:

- Requiring written documentation and public access to records of formal and informal agency consultations regarding proposed federal agency actions that may impact listed species. In addition, agencies will be required to solicit public comment on draft biological opinions concerning the impacts of federal agency actions.

ENHA will strengthen public oversight of ESA implementation by:

- Improving the public's ability to enforce the terms of federal/state cooperative agreements and Habitat Conservation Plans (HCF);
- Allowing citizens to file immediate suit in any emergency situation involving a species or its habitat without the sixty-day notice requirement — current law gives this exemption only for emergency listing suits;

- Removing the incentives to violate the ESA by modernizing civil and criminal penalties, including natural resource damages;
- Requiring that HCPs be independently peer reviewed by persons without a conflict of interest;
- Requiring that HCPs be submitted for public comment sixty days after a draft HCP is submitted and ninety days after a final application is submitted. HCPs should be monitored continually and periodically reviewed to ensure the HCP is not interfering with recovery of the protected species. This periodic assessment should be required every three years and published for public comment. Revision of inadequate HCPs should be required.

ENHA will ensure that HCPs and incidental take permits help in the recovery of listed species by:

- Allowing holders of incidental take permits to proceed only if there is a scientific determination that the impact on listed species will be truly *de minimus* and not negatively impact recovery;
- Requiring permit holders to demonstrate their ability to fully fund and implement conservation mitigation measures before proceeding to take the species.

ENHA will ensure that the U.S.-remains the leader in international wildlife conservation by:

- Extending the protections of Section 7 to U.S. agency actions in other countries in order to protect foreign threatened and endangered species.

For more information on National Audubon Society's Endangered Species Campaign, the Endangered Species Act, and the Endangered Natural Heritage Act, please contact Todd Tiucci, ESA Grassroots Coordinator at (202) 547–9009, or ttucci@audubon.org, or write: National Audubon Society, 1901 Pennsylvania Avenue NW, Washington, D.C.. 20006–3405

Source: National Audubon Society *Fact Sheet* July 1996

Zoos Help Save Endangered Birds of Micronesia

The Commonwealth of the Northern Mariana islands, a group of small tropical islands in northwestern Micronesia, is inhabited by an array of endemic tropical birds. Like other island ecosystems, the Mariana Islands have been subjected to a variety of pressures that have dramatically affected populations of native species. Several species and subspecies of birds have been forced to extinction and others are now considered to be highly endangered. Recognizing the need to preserve the islands' biodiversity, the Marianas Archipelago Rescue and Survey (MARS) project was started in 1992 to help the Rota bridled white-eye (*Zosterops conspicllata*), a candidate endemic subspecies, the endangered Mariana crow (*Corvus kubaryi*), and the Mariana fruit dove (*Ptilinopsu roseicopilla*). Funded by the U.S. Fish and Wildlife Service (USFWS) in conjunction with the Division of Wildlife of the Commonwealth of the Northern Mariana islands, the project currently includes the Honolulu Zoo and eight other American Zoo and Aquarium Association (AZA)-accredited institutions.

Bird species in the Commonwealth of the Northern Mariana islands face many of the same problems that have plagued bird populations on Guam, the southern most island in the Mariana Archipelago. All of the native forest birds on Guam are presently extinct in the wild; two species, the Guam rail (*Rallus owstoni*) and the Micronesian kingfisher (*Halcyon cinnamomina cinnamomina*), survive in captivity in U.S. zoos. Habitat destruction and alteration resulting primarily from World War II, introduction of predatory species, such as the brown tree snake (*Boiga irregularis*), and introduction of competitive species, such as the black drongo (*Dicrurus macrocercus*), all contributed to the catastrophic extinction of Guam's entire native forest avifauna. Similar types of forces face species found in the other islands of the archipelago; pressure from rapid development is an additional factor for the Mariana islands.

The MARS project addresses these problems through a combination of captive population management, research, education and support for habitat conservation. During the past few years, field trips have been taken to the island of Rota to collect Rota bridled white-eye, the Mariana crow and the Mariana fruit dove in order to develop protocols for captive management. These species were selected because they were all endemic and taxonomically unique with a high chance of success for captive management. Also, captive facilities and expertise already existed and habitat was still available if reintroduction became a necessity or a possibility.

Another aspect of the MARS project has been to conduct an historical avifaunal survey of the Mariana Islands. A research team, including a paleontologist and archeologist, a museum bird curator, and two zoo biologists, took a five-week field trip to three of the islands in the archipelago in 1994. This team investigated rock shelters and caves looking for fossil and subfossil bones of birds in sediments. Although still preliminary, results have identified a number of birds that were not previously recorded as being from these islands. Also, several species of birds historically known to be only from Guam may have occurred on other islands in the archipelago as well. Additional surveys are still needed to complete the analysis of the avifauna of the past for these islands. This information is valuable because it may help identify additional relocation sites for extant birds, if needed.

The MARS project plans to expand in the future. Educational material will be developed with local educators for school programs throughout the Mariana Islands. Local aviaries, built in snake-free areas of the islands, may be established by local biologists so that captive bred birds can eventually be released on appropriate islands. Captive birds in zoos or local aviaries could also be used for research purposes on the islands. Ultimately, local commitment and assistance will be key to the future development of the MARS project and the continued survival of the bird populations in the Mariana islands.

For more information, contact: John Groves, Curator of Reptiles and Amphibians, North Carolina Zoological Park, 4401 Zoo Parkway, Asheboro, NC 27203. Tel: (910) 879-7620.

Source: Endangered Species UPDATE, *Vol. 13 Nos. 7 & 8, July/August 1996*

Openings Still Available for May 5 Field Trips

Hike to Alakai Swamp and Boat Trip off O'ahu Available

Openings on two of the field trips HAS is cosponsoring with the Cooper Ornithological Society (COS) are still available to HAS and COS members and conference attendees. The trips to Alakai Swamp on Kaua'i and to observe pelagic seabirds off O'ahu will be held May 5, the day following the end of the 67th annual meeting of the Cooper Ornithological Society at the Hawai'i Naniloa Hotel in Hilo, Hawai'i. (See December/January *'Elepaio* for details.) The meeting is hosted by the Pacific Island Ecosystems Research Center (U.S.G.S. Biological Resources Division) the University of Hawaii and the Hawaii Audubon Society.

The trip to Alakai Swamp, led by field biologists Tom Snetsinger and Christina Herrmann, will allow hikers to sample the spectacular views of Kalalau Valley (clouds permitting) and the forest birds of the Alakai Wilderness. Participants must provide their own transportation to Kokee State Park and bring clean hiking boots (seed free), rain gear, binoculars, water and lunch. The hike begins at 7:30 a.m. The cost is $15.

The Pelagic Seabird Trip off O'ahu, led by Reggie David, will be a half-day pelagic birding trip during the peak season of seabird migrations through the Central-North Pacific. Participants should expect to observe twelve to sixteen species of birds and possibly some marine mammals. The boat leaves at 6:30 a.m. from Ala Moana Harbor. Bring binoculars, lunch, water and sunscreen. Cost is $65 per person.

Preregistration and payment for field trips is required to reserve slots through COS Annual Meeting. USGS/BRD P.O.Box 44 Hawaii National Park, HI 96718.

For further information on these HAS/COS sponsored birding trips contact Michelle Reynolds:
(e-mail michelle_reynolds@nbs.gov) or phone (808) 967-7396.

Red-billed Leiothrix at Haleakala Observatories

by Solomon F. Cushman[1]

The article by Tony Distasio in the February issue reminded me of my last tour on Haleakala.

His sightings were similar to mine, though much more organized. In approximately two years (1977–1978) at the summit, chukar and leiothrix were almost the only birdlife I saw. The chukar seemed to be in a family group. The group was evident for some weeks and then disappeared. Leiothrix appeared alone, very infrequently, stayed in bushes (which are not that common) almost entirely, and when flying, stayed very close to the ground. I also heard petrel, as I recall but never saw them. Pheasants appeared once or twice, but only at several hundred feet below the summit. I wish I could confirm his weather reports.

[1]*Former director at LURE (Lunar Ranging Experiment) Observatory, Haleakala, Mau'i*

PPs' Outer Island Winners

by Sylvianne Yee

The outer island preliminary competitions were held on February 22, March 1, and March 8 with eleven teams battling for the title of winner! After a number of hotly contested and often times close rounds, teams from **Mau'i High School**, **Hilo High School**, and **Waimea High School** were the victors. Ably coached by Ron Lau (Mau'i), Suzanne Cama (Hilo), and Deborah Chaffin (Waimea), they won the right to challenge the five O'ahu teams who made it to the playoff rounds

One of their prizes was a trip to O'ahu courtesy of Outrigger Hotels and Aloha Airlines to compete in the playoffs. Other prizes included an overnight hike to Pu'u Kukui on Mau'i, a bicycle beach tour, a tour of the National Tropical Botanical Garden on Kaua'i, and an Atlantis Submarine trip. Good luck to Mau'i, Hilo, and Waimea High Schools!

Donations Take Many Forms — Mahalo

by Susan Elliott Miller

Our supporters express their kokua in many ways. To Ardell Kuchenbecker, Leon Slawecki, and Richard Soehren, all recent contributors to the HAS annual appeal, our thanks.

Dr. Dexter Hinckley of Alexandria, Virginia responded to the note on our annual appeal letter telling of our lack of a copy of Hawaiian Birdlife by Andrew J. Berger by sending us a copy of the 1972 first printing, first edition! Mahalo for helping to fill in the puka in the HAS library.

Although the Society gains much of its income from *Hawaii's birds*, we have had few slides in the office. Thanks to Larry Kuhns, we now have a series of slides, Na Manu O Hawaii, taken by his late sister Louetta Kuhns. They cover waterbirds, migratory birds, native birds — both extant and extinct, and introduced birds. In addition, there are slides of birds in the western part of the U.S. Mainland taken during Ms. Kuhns' travels. We will continue to use and appreciate these slides for a long time - thank you!

Lahainaluna High School, Maui Runner-up

Maui High, Maui Paradise Pursuits Winner

On To The Playoffs & Championships

by Sylvianne Yee

The Paradise Pursuits preliminary games are *pau* for another year, but the memories and friendships will be lasting reminders of fun and challenging competitions. Now it's on to the playoff games for eight talented teams. On Friday, April 11, these teams will go buzzer to buzzer in the play off games to be televised later on the public access channels on all islands:

3:30–4:30
Mau'i vs. Waianae

4:30–5:30
Kailua vs. Kahuku

5:30–6:30
Hilo vs. Iolani

6:30–7:30
Kamehameha vs. Waimea

These games will determine which four teams will advance to the semifinal and championship rounds to be taped the following day, April 12, at KITY–4.

The playoffs are a new addition to the Paradise Pursuits format. They give teams an additional game to participate in and learn from and provide a chance for more teams to exhibit their awesome knowledge on television. With our own Hawaii Audubon Society Vice President John Harrison (a.k.a.. The Singing Host!) moderating these games, they should be anything but boring!

Pictured here are ten of the participating teams. Mau'i High and Lahainaluna High School team photos appear on page 96.

Calendar of Events

Monday, April 7 and May 5

Regular first Monday of the month meeting of the **Conservation Committee**, 6 p.m., at the U.H. Environmental Center (Crawford Hall, Room 317, 2550 Campus Road). All are welcome. For more information call chairperson Dan Sailer, 455–2311.

Thursday, April 3 and May 1

Monthly meeting of the **Education Committee**, 7 p.m. at BaLe Sandwich Shop in Manoa Marketplace (near Safeway). All are welcome. For more information, call chairperson Wendy Johnson, 261-5957.

Monday, April 14 and May 12

HAS Board meeting, (always open to all members) 6:30 p.m. at the HAS office.

Saturday, April 19

The April **field trip** will be a guided walk around Hanauma Bay with docent Jean Carr. Jean will explain the geology and history of the bay and discuss the sea creatures that visit. Ranger Jack Oerlein will share legends of the area. Jean can help us identify the fish and turtles commonly seen, and we can swim or snorkel afterwards. Meet for car pooling at the Punchbowl side of the State Library, mauka of King Street, at 8 a.m., or take TheBus #22 from Waikiki. At Hanauma Bay, we will gather at 9 a.m. at the overlook near the stairway leading to the bay ($1 parking fee). Requested donation, $2.00/person. Reserve by calling Mary Gaber at 247–0104.

Monday, April 21

HAS Program and Members' Meeting will feature traditional gathering practices, and what this means for Hawaii. The program will be given by scientists who are native Hawaiians. (Speakers to be announced) Bring your friends and join fellow HAS members at Paki Hall Conference Room, Bishop Museum at 7:30 p.m. Refreshments provided; HAS books, tapes, and T-shirts will be available for purchase.

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