Review of the Population Assessment of the Hawaiian Monk Seal

by

Don Bowen

External Peer Review

Prepared for the University of Miami Independent System for Peer Reviews

12 Febraury 2001

Executive Summary

1. The author of this report met with NMFS staff in Honolulu from November 30 to December 2, 2000 to review methods used to assess the population dynamics of the Hawaiian monk seal (*Monachus schauinslandi*) and to determine if those methods were reliable. The other external reviewer, Dr. D. Siniff, also attended the November 30 to December 2 meeting with NMFS personnel. My report is based on the discussions with the monk seal researchers, relevant documents that were sent to me prior to the meeting, and those provided during the meeting.

2. The population assessment of monk seals is particularly challenging given the long breeding season, the number of breeding colonies, the remoteness of these colonies, and logistic support required to reach breeding colonies. In the face of such difficulties, the monk seal research team has done an excellent job of ensuring uniform and high standards of data collection and data management.

3. The methods used to conduct the field programs and analyze assessment data were examined in detail resulting in 13 recommendations.

4. Sightings of permanently and semi-permanently marked individual seals during censuses at each of the six sites, where virtually all pups are born each year, provide the primary data used to estimate vital rates and population trends. These sightings are used to construct a beach count index to track trends in abundance. In my opinion, the current assessment methods provide solid basis for reaching scientifically defensible conclusions about trends in the number of monk seals at individual sites and for the population as a whole. However, they do not provide an estimate of total population size or, in some cases, estimates of the precision associated with population parameters. Therefore, the assessment would profit by using state-of-the-art mark-recapture methods to provide better estimates of population abundance, vital rates, and the precision of such estimates.

5. I am concerned that the amount of time the staff of the Hawaiian monk seal program dedicate to logistic planning, meeting with clients, and internal report writing detracts from their ability to fully explore the assessment data that have been collected on the population dynamics of this species. Measures should be taken to give the staff more time for thoughtful analyses and preparation of papers for peer reviewed literature. This will serve both to promote excellence in the population assessment and to further develop the expertise of NMFS staff.

6. Finally, several of my recommendations could be most effectively addressed by holding several small (i.e., less than 10 people) targeted workshops in the following areas: a) mark-recapture methods as a means of extracting more information from the sighting data, b) assessment of the growing monk seal population on the Main Hawaiian Islands, c) the management implications of increased use of the Main Islands by monk seals, and d) the integration of ecosystem factors into the population assessment.

Review of the Population Assessment of the Hawaiian Monk Seal

Dr. Siniff and I met with scientists from the NMFS monk seal program from 30 November through 2 December, 2000 to review methods used to assess the Hawaiian monk seal (*Monachus schauinslandi*) population. The objectives of this review were to 1) evaluate the methods used in to assess the status Hawaiian Monk seal population, 2) to determine if these methods are reliable, and 3) to make recommendations regarding future research and monitoring of the Hawaiian monk seal population. During the three days of the meeting, we were provided a complete overview of the program, a detailed account of data collection procedures, and the methods used to assess population status. I appreciate the time taken by NMFS staff to insure that I had a complete understanding of all aspects of the program. Appendix A gives the agenda that was followed during our discussions.

Population status

Hawaiian monk seals are distributed over a distance of 2000 km among the islands and atolls in the Northwest Hawaiian Islands and increasingly on the main Hawaiian Islands, particularly those of Niihau and Kauai. The majority of pups are born at six sites within the Northwest Hawaiian Islands, but a small number of pups are also born on the main islands. The species is fragmented into small, discrete populations, each with somewhat different vital rates and population trajectories. This metapopulation has been and continues to be subjected to human impacts and stochastic environmental effects.

The species was designated as depleted under the Marine Mammal Protection Act and endangered under the Endangered Species Act, both in 1976, following a 50% decrease in beach counts, the primary index of abundance. Critical habitat was designated in 1988 from the beaches to a depth of 37 m around breeding islands in the Northwest Hawaiian Islands and Maro Reef. Mean beach counts at breeding sites indicate that the size of the population declined through the 1990s, mainly due to a sharp decrease at French Frigate Shoals, the largest breeding colony, although there has been little change at French Frigate since 1995. The 1999 beach count index of abundance indicated a minimum population size of 1300-1400 individuals (Honolulu Laboratory, External Program Review 2000, August 22-24)

Methods used to assess the population

In the narrow sense, a population assessment is the estimation of the trends in population numbers and the birth and death rates that generate those trends. Although this represents what might be considered the core of a population assessment, I believe that in the context of monk seal conservation, a population assessment should also encompass an attempt to understand the causes underlying demographic change. This understanding is critical to the development and implementation of management

measures designed to foster the recovery of the species. It is this broader definition that seems to characterize the philosophy underlying the current approach to the population assessment of Hawaiian monk seals by NMFS staff.

Counts and marking of monk seals

Most of the data collected to assess the population come from walks through each sub-population called “censuses “ and “patrols”. Censuses are standardized counts of all monk seals hauled out or seen in nearshore waters around an entire island or atoll at regular intervals throughout the season. Identified individuals (i.e., from marks or tags) that are sighted more than once during a census are included only once in the total count. These timed counts are standardized to complete the entire count of a site within the same day. They begin about 13:00 on Laysan and Lisianski Islands and earlier at the atolls because of the time required traveling among sites within an atoll. Censuses often occur over a two-day period at larger sites such as French Frigate Shoals. Data are collected on all seals sighted, but only those seen on land are used to generate the "beach count". The mean of a series of beach counts at each site is used as the index of abundance to examine long-term trends. A patrol is an untimed complete coverage of a site to collect data on monk seal behavior, identifying animals and bleach-mark animals that are not individually marked with a tag or natural scarring, and to collect scat and spew samples for diet analysis (Johanos and Baker 1999). Based on these marks and tags, researchers attempt to identify most of the individuals using each of the six sites over the course of the field season each year. In addition to censuses and patrols, all pups that survive to weaning are tagged with two tags in the rear flippers and their girth and length are measured. These data are used to indicate interannual variation in maternal energy investment in offspring and as covariates in survival rate analyses (see below).

The value of the beach-count population index is that it provides a relatively consistent series to examine long-term trends in abundance within sites and for the metapopulation as a whole. This and the fact that they are easy to conduct are the important advantages of such beach counts. However, they do not provide an estimate of total population size, and because they can be strongly affected by weather and temporal distribution of sampling throughout the season, they not likely to provide a good index of year-to-year changes in abundance at a site. Nevertheless, the beach counts appear to provide the only comparison with historic counts and therefore as an index of long-term population trends they should be continued.

At present, total population size of monk seals is not estimated. Rather, the cumulative number of permanently marked individuals at each site is used as an estimate of the minimum population at the time when all of the pups have been born. As researchers spend many months at most sites, continuously marking unmarked animals throughout the season, it is both thought and assumed that there is a close relationship between this minimum estimate and total population. However, this assumption has not been formally tested. Therefore, it is **recommended** that the cumulative sighting curve of identified individuals at each site be examined to determine if there is evidence that an asymptote is in fact reached within site, each year. The absence of these counts reaching

an asymptote would indicate that the number of identified individuals may significantly underestimate abundance and that other estimation methods would be needed to estimate total population size.

Given the nature of the data collected during censuses, it might be possible to use mark-recapture models to extract more information from these data than is currently the practice. However, there are complications in the monk seal sighting data that may make this approach difficult (see below). For example, individuals may have very different sighting probabilities within each census and over time. This is caused by differences in the behavior of different sex and age classes. To date, these sighting probabilities have not been investigated. Therefore, it is **recommended** that an analysis of the sighting data be conducted to determine if it is possible to model sighting probabilities and that mark-recapture methods be investigated as a means of extracting more information from the sighting data.

Reproductive and survival rates

The estimation of reproductive rates is based on sightings of monk seals identified from tags, natural marks, or bleach marks placed on unmarked seals during the season. Reproductive rates are estimated for "parous" females, defined as animals that were known to have reproduced at some previous time, and for "all females" by including in the calculation all females classified as adults, based on size, at a site during a field season (Johanos et al. 1994). These rates are useful as indices of trends in reproductive performance at each site, but it is age-specific birth rates that are of most interest. Estimates of age-specific birth rates are available for only two sites, Laysan Island and French Frigate Shoals. This understandable lack of estimates at other sites, nonetheless does introduces some added uncertainty in the population model (see below).

Survival rates for each sub-population are estimated using standard Jolly-Seber mark-recapture methods (Craig and Ragen 1999). Survival of pups to weaning is also calculated from census data as the ratio of the number born to the number surviving to weaning. Although there can be some uncertainty as to whether a pup has survived or not, most pups are either seen after weaning, found dead, or seen in very poor condition and not seen again, in which case the pup can be reasonably assumed to have died. Thus, it is unlikely that such estimates are seriously biased.

Monk seals are known to be sensitive to human disturbance. This conclusion is based on the impact of military occupation of certain islands used by this species (Gerrodette and Gilmartin 1990). Thus, during censuses and patrols great care is taken to avoid unnecessary disturbance of individuals. For example, monk seals are only dyed with bleach when they are sleeping. During censuses animals are not disturbed if tags, dye marks, and natural scars are not visible because of the position of the body or rear flippers of the seal. However, because of this concern for disturbance during censuses, it is possible for marked animals to be present in the population that season, but to be recorded as missing. This complicates the estimation of the reproductive and survival rates and almost certainly introduces bias. It is assumed that few identifiable animals that

come to a study site fall into this category because of the frequent observations periods. However, records of individual pupping histories of females indicate that some females are not sighted in some years even though they were seen in subsequent years (see Johanos et al. 1994). Thus, it is **recommended** that there be a careful analysis of existing data to determine to what extent vital rates might be biased by failing to identify marked seals.

Marking techniques

Marking forms the basis for the estimation of minimum population size and vital rates, therefore, it is important that individuals are reliably identified over time. Individual Hawaiian monk seals are identified by four semi-permanent marking techniques: flipper tags, pit tags, bleach marks, and natural scarring. Flipper tags are the primary means of marking monk seals. With the exception of pit tags, these methods of marking are standard tools used on many other species, and their limitations are reasonably well known. Foremost among these limitations is that tags are often lost and with that the identity of the seal. Monk seal researchers attempt to avoid this problem by double tagging individuals and replacing tags that are lost on animals that also have natural marks. A less common problem facing monk seal researchers is that tags may become unreadable due to the abrasive nature of the coral sand. Given that some tags are lost and others become unreadable, it is important to understand the extent which these factors may bias estimates derived from the sighting of marked individuals. However, it does not appear that there has been a thorough review of monk seal tag loss. In light of this, it is **recommended** that an analysis of tag loss be conducted and that estimates using marked individuals be appropriately corrected.

In principle, the use of pit tags could provide a means of long-term identification that overcomes the limitations of other marking techniques. However, the short distance over which a pit tag can be read limits the value of the current generation of such tags. This is a technical problem, which if solved would be a significant advance for the population assessment of this and other pinniped species. Therefore, it is **recommended** that the monk seal research program pursue the further development of the pit tag as a means of permanently marking individual seals. Specifically, this would involve reliable placement on the animal and the ability to read the tag under field conditions at a distance (say 5-10 m) that would not disturb monk seals.

Population dynamics models

The Hawaiian monk seal program has used age-structure population models as research and management tools since the early to mid 1990s. Several models have been developed for different purposes (T. Regan, unpublished, Starfield, Roth, and Ralls 1995). More recently, the Regan population model has been extended by a contract to D. Goodman and A. B. Harting at Montana State University. This model uses a starting age structure for each site estimated from the distribution of known-aged plus minimum-aged seals, survival rate estimates from each site, and age-specific reproductive rates from

Laysan Island and French Frigate Shoals. Age-specific reproductive rates are not available from the other sites, thus Laysan Island rates are presently used.

The population model that is under development provides a framework to explore alternative management options with respect to mobbing and shark predation on pups. It also permits simulations of population trends at each site under different age structures and vital rates. However, I would urge caution in using the model to forecast long-term behavior of the population. There are several reasons for this. First, there is considerable uncertainty in trends of vital rates among sub-populations. Second, without an understanding of the effects of density-dependence and stochastic events on this metapopulation, such forecasts will inevitably be wrong. The model allows the incorporation of a density-dependent function that requires the establishment carrying capacities for each sub-population. This is clearly undesirable because we know very little about the carrying capacity of the different sites within this metapopulation. On the other hand, some form of density dependence will likely operate at the sub-population level and therefore research in this area is needed. This research will be difficult and by nature multi-disciplinary. Therefore, it is **recommended** that research on carry capacity be conducted within a broader ecological investigation of the reef ecosystems involved.

In addition to its role of simulating the response of individual sites or the metapopulation as a whole to management or other influences, the population model could be used in others ways. The model could be used to help estimate vital rates that are not currently available and to check if the vital rates that are now being estimated are consistent with the current dynamics of the various island populations. For example, do the estimates of age-specific reproductive and survival rates give growth rates of sub-populations that match what has been observed? If not, estimates of crude birth rate could be estimated by fitting the model to the observed trends in pup production at each site.

There seems to be significant movement of individuals between some of the sub-populations. The degree to which this movement influences population parameters for each sup-population does not seem to have been explored fully. This type of analysis might be useful in determining if the current designations of the sub-populations are appropriate from a demographic point of view. Significant movement of adult females might mean that some sites, such as the Kure, Midway and Pearl and Hermes reef sub-populations, could be combined in the model or are more likely to have similar vital rates. Such an analysis could influence also the logistic program support needed to obtain demographic data from the metapopulation. Therefore, it is **recommended** that a more complete analysis of the movement of individuals with respect to the structure of the monk seal metapopulation be conducted and that consideration be given to how these findings might affect the procedures used and logistic support required for population assessment.

Program management

Data collection

The data collection procedures used by the Hawaiian monk seal programs are well documented in a thorough field manual (Marine Mammal Research Program, NMFS Honolulu Laboratory, 2000 Field Manual for Research on the Hawaiian Monk Seal). The manual serves as a working document (i.e., it evolves over time as required) with the following objectives: 1) training and orientation of research staff, 2) standardization of all field research procedures, and 3) the provision of an annual record of field methods used. I found the manual comprehensive, reflecting a commitment to achieving and maintaining high standards of data quality and safety, but at the same time respecting the fragile nature of the reef ecosystems and the need to avoid unnecessary disturbance to monk seals and other wildlife.

Data management

In the field, data are entered into a simplified version of a relational database as time permits. This permits errors to be corrected while animals are still available to be resighted. Back in Honolulu, each site leader is responsible for further data auditing and producing a written summary of the data collected at that site. These summaries are combined into a NOAA TECHNICAL MEMORANDUM to serve as a reference for the research conducted each year. Audited field data are then loaded into an ORACLE database by the database manager, backed up, and secured in off-site storage. It is my understanding that new field computers will allow the entire database to be taken into the field. This should streamline data entry and auditing and further increase the quality of the field data by permitting fuller auditing in the field. I commend this development and suggest that, to the extent possible, all field data be entered into the database while investigators are in the field.

Field logistics

The monk seal field program is extremely challenging and difficult to execute because of the logistics involved in supporting six remote field camps, each separated by great distances. The sheer magnitude of this effort is underscored by the fact that it requires two cruises by the NOAA ship Townsend Cromwell to supply these camps, in addition to the use of aircraft to supply Midway and French Frigate Shoals. Population assessment data are collected over periods of 3 to 6 months, depending on site, by about 18 researchers in teams of three. At each site, one person is designated as the camp leader. Temporary field staff members, hired through the Joint Institute of Marine and Atmospheric Research (JIMAR) at the University of Hawaii, Honolulu, collect most of the field data. The camp leader may be a JIMAR or a NMFS employee. Although much of the work is clearly short-term and seasonal, senior NMFS staff members spend considerable time in the annual recruiting and training of qualified temporary personnel. Given the importance of maintaining continuity and a high standard of data quality, it is **recommended** that camp leaders be employees of the NMFS.

Logistics, purchasing food and scientific supplies for the annual field research also seem to put excessive demands on full-time staff, such that they have insufficient time for data analysis and for publishing findings in the primary scientific literature. The

monk seal research team has done a good job of finding economies within the context of the current approach. However, given the demands on staff time and the continuing need to collect annual demographic data, it is **recommended** that ways be found to lessen the time commitment given to provisioning and planning the field camps. This might include contracting the provisioning of field camps to private companies that perform such functions on a routine basis. Also, having single teams cover nearby sites by rotating from site to site over two-week periods could reduce the number of field teams. There is ample information in the monk seal database to determine which sites might benefit from this approach and how large the rotation window could be without loss of data quality.

I believe that some changes in approach to the collection of population assessment data will provide long-term benefits to the quality of science conducted by the program. For example, the apparent increasing trend in the number of monk seals using the Main Hawaiian Islands will in itself require new methods and more effort devoted to the collection of population assessment data. Increased abundance of monk seals at the Main Islands will also bring further management challenges. In this connection, it is **recommended** that NMFS consider holding two small workshops, one to determine the most appropriate ways to assess monk seal abundance in the Main Hawaiian Islands and the other to consider the management implications of monk seals using popular beach habitat. NMFS has done a good job in anticipating the Main Island as important monk seal habitat and these workshops would provide NMFS with the opportunity be proactive on these issues.

Data analysis and productivity

As noted above, in my opinion the senior personnel of the monk seal, population assessment program are overly taxed with the details of planning and the logistics of the field programs. In addition to these commitments, there is a heavy schedule of writing internal reports and responding to requests for information about the program. Clearly, there is a need to be responsive to clients, but I believe that some relief is needed if NMFS scientists are to contribute effectively to the peer reviewed scientific literature. Such contributions are essential to the ensure quality of the population assessment of Hawaiian monk seals and to develop the careers of the individual scientists responsible for the program. Given the size and complexity of the program, it is **recommend** that another position be staffed with an individual possessing good quantitative analysis skills and the demonstrated ability to write up the results of population assessment analyses in a timely fashion.

Censuses and cohort tagging of pups are conducted annually at each the major pupping colonies. Although reducing either the coverage each year (i.e., visiting fewer colonies) or reducing the frequency of coverage might seem like attractive ways to reduce the burden of field work on the program, I caution that either of these approaches would seriously compromise the quality of the population assessment of the monk seal metapopulation. There are two reasons for this. First, and perhaps most importantly, is that there is compelling evidence that the dynamics of the individual colonies within the metapopulation differ such that it would be difficult to track overall population trends by

selecting index sites. The second reason is that reducing the frequency of collecting population data would significantly reduce the statistical power to detect trends in population numbers. Therefore, it is **recommended** that the current practice of collecting annual population data be continued, and that efficiencies be pursued that do not compromise the ability to track both population size and vital rates (see recommendations under field logistics).

Ecological context of population assessment

There is a growing awareness of the need to consider the ecological relationships and the effects of the physical environments on the dynamics of marine populations (e.g., NRC 1999). The population assessment of Hawaiian monk seals can be regarded, for the most part, as a single-species assessment. In this regard, the monk seal assessment is not unlike the population assessment of many other pinniped species throughout the world. However, given the potential benefits of ecosystem-based management, it is **recommended** that recent efforts to understand the effects of natural and anthropogentic factors on monk seal prey abundance, diet, foraging ecology, and habitat use should be encouraged and pursued with even greater effort. These data may provide insights into the factors and mechanisms affecting the dynamics of Hawaiian monk seals that would not otherwise be possible if only the demography of this species was investigated. Furthermore, an ecosystem-based approach to monk seal population assessment will be needed to better understand the carrying capacity of monk seal habitat, how carrying capacity changes over time and the relevant temporal and spatial scales of changes in carrying capacity. Finally, although we strongly support studies aimed at gaining a better understanding of the factors affecting monk seal population dynamics, it is not clear how ecological data arising from studies on, for example, foraging ecology will be integrated with the monk seal population assessment. As I believe it is important to achieve this integration, this as another area where the program might benefit from a small targeted workshop.

Conclusions

In my opinion, the methods currently used to assess the abundance of Hawaiian monk seal provide a reasonable basis for reaching scientifically defensible conclusions about trends in the number of monk seals at individual sites and for the population as a whole. Personnel of the monk seal program have done an excellent job to ensure uniform and high standards in the collection of assessment data and data management. This is particularly noteworthy given the remoteness of monk seal breeding sites and the resulting logistic difficulties this imposes on field research. Nevertheless, I also believe that there could be greater use of other assessment methods to estimate population abundance, vital rates and the precision of such estimates. As with many other pinniped assessment programs, the methods used to assess the monk seal population have undoubtedly evolved with the program. This is understandable, but in this case it seems that other applicable procedures have been fully explored. Further analyses are needed to help identify the sources and magnitude of bias and to provide better estimates of precision of the various population parameters.

I am concerned that the amount of time the staff of the Hawaiian monk seal program dedicate to logistic planning, meeting with clients, and internal report writing detracts from their ability to fully explore the rich database that has been developed on the population dynamics of this species. I feel that measures should be taken to give the staff more time for thoughtful analyses and preparation of papers for the peer reviewed literature. This will serve both to promote excellence in the population assessment and to further develop the expertise of NMFS staff.

Recommendations

It is recommended that:

1. the cumulative sighting curve of identified individuals at each site be examined to determine if there is evidence of an asymptotic relationship with time within year. This analysis will help provide researchers with a much better sense of the relationship between the estimated minimum population size and total population size,

2. an analysis of the sighting data be conducted to determine if it is possible to model sighting probabilities and that mark-recapture methods be investigated as a means of extracting more information from the sighting data,

3. there be a more careful analysis of existing data to determine to what extent estimates might be biased by failing to identify marked seals,

4. an analysis of tag loss be conducted and that estimates using marked individuals be appropriately corrected,

5. development of the pit tag as a means of permanently marking individual seals be pursued further,

6. research on carry capacity be conducted within a broader ecological investigation of the reef ecosystems involved,

7. a more complete analysis of the movement of individuals with respect to the structure of the monk seal metapopulation be conducted and that consideration be given to how these findings might affect the procedures used and logistic support required for population assessment,

8. camp leaders be employees of the NMFS,

9. ways be found to lessen the time commitment of senior researchers to the provisioning and planning the field research. This might include contracting the provisioning of field camps to companies that perform such functions on a routine basis,

10. NMFS consider holding two small workshops, one to determine the most appropriate ways to assess monk seal abundance in the Main Hawaiian Islands and the other to consider the management implications of monk seals using popular beach habitat,

11. another position be staffed with an individual possessing good quantitative analysis skills and the demonstrated ability to write up the results of population assessment analyses in a timely fashion,

12. the current practice of collecting annual population data be continued, and that efficiencies be pursued that do not compromise the ability to track both population size and vital rates (see recommendations under field logistics),

13. recent efforts to understand the effects of natural and anthropogentic factors on monk seal prey abundance, diet, foraging ecology, and habitat use be encouraged and pursued with even greater effort.

Literature cited

Craig, M.P. and T.J. Ragen. 1999. Body size, survival and decline of juvenile Hawaiian monk seals, *Monachus schauinslandi.* Marine Mammal Science 15:786-809.

Gerrodette, T. and W. G. Gilmartin. 1990. Demographic consequences of changed pupping and hauling sites of the Hawaiian monk seal. Conservation Biology 4:423-430.

Johanos, T. C., B. L. Becker, and T. J. Ragen. 1994. Annual reproductive cycle of the female Hawaiian monk seal (*Monachus schauinslandi*). Marine Mammal Science 10:13-30.

Johanos, T. and J. Baker. 1999. NOAA Technical Memorandum NMFS, The Hawaiian monk seal in the Northwestern Hawaiian Islands, 1999.

NRC. 1999. Sustaining Marine Fisheries, Committee on Ecosystem Management for Sustainable Marine Fisheries.

Starfield A.M., J.D. Roth and K Ralls. 1995. “Mobbing in monk seals: the value of simulation modeling in the absence of apparently critical data. Conservation Biology 9:166-174.

Appendix A.

External Review of Hawaiian Monk Seal Population Assessment Program

Final Draft Agenda

29 November 2000

1. Review agenda 0900-0910

2. Distribution of Hawaiian monk seal metapopulation 0910-0930
   a. Northwest Hawaiian Islands
   b. Main Hawaiian Island

3. Marine Mammal Research Program (MMRP), brief overview 0930-1000
   a. Population Assessment
   b. Foraging Ecology
   c. Health and Disease
   d. Marine Debris
   e. Public Outreach
   f. Budget

4. Schedule of field camps 1000-1100
   1. Midway - re-emerging population center (February - August)
   2. First deployment - Laysan/Lisianski (March – July
   3. Second deployment - Pearl & Hermes/Kure (May - July)
   4. French Frigate Shoals (April/May-August)
   5. Counts at Necker/Nihoa
   6. Main Hawaiian Island surveys
   7. Extra camps (epidemiology, satellite tracking, retagging, etc.)

5. Logistics 1100-1200
   1. Ship vs Air
   2. Supplies and equipment
   3. Temporary hires
   4. Camp conditions
      1. Tented camps (Laysan/Lisianski/Pearl & Hermes/Kure)
      2. Permanent infrastructure (French Frigate/Midway)

Lunch - 1200-1300

Data collection at annual field camps 1300-1330

   5. Activities
      1. Identification/Bleach
      2. Births/weaning (thoroughness depends on site)

3. Pup tagging
4. Pup condition at weaning
5. Survival Factors
6. Behavior (Laysan/Lisianski, French Frigate)
7. Male aggression/injury
8. Entanglement
9. Scats/spews
10. Debris removal
11. Tag condition
12. Tag replacement
13. Necropsies/other specimen collection
14. Disturbance

6. Research objectives 1330-1400
   1. Identify all individual seals in each major subpopulation
   2. Determine trends in subpopulation abundance (beach counts and total population)
   3. Assess survival rates
   4. Evaluate reproductive rates
   5. Determine trends in offspring condition
   6. Identify causes of morbidity/mortality
   7. Monitor research related disturbance

7. Management goals of field activities 1400-1415
   1. Mitigate entanglement mortality
      1. Disentangle seals
      2. Remove dangerous debris from beaches
   2. Mitigate aggressive male mortality
   3. Mitigate shark predation
   4. Detect possible disease epidemics or other events impeding population growth

8. Primary methods for demography data collection 1415-1500
   1. Standardized protocols and data forms
   2. Beach Counts (basis for abundance index)
   3. Match and maintain ID's using flipper tags, bleach, scars, natural marks. Update ID files with photos and scar ID sketches (excluding Necker, Nihoa, and main Hawaiian Islands).
   4. Engraved temple tags and PIT tags applied after weaning
   5. Standardized data collection on factors affecting survival (shark bites, other wounds, emaciation, entanglement, etc.)

Break - 1500-1530

6. Data Management 1530-1600

1. Field entry
2. Post-field editing
3. Oracle database
4. ASCII standard files
5. Standard Fortran analysis programs

7. Annual demography/research summaries 1600-1700

End of day

30 November 2000

8. Use of data 0900-1030
   1. Long-term monitoring
   2. Annual reporting
      1. Recovery Team Meeting
      2. Annual Report "Hawaiian monk seal in the NWHI" - NOAA Tech. Memo.
      3. Stock Assessment Report
      4. Honolulu Laboratory Program Review
      5. Data provided to Marine Mammal Commission for their annual report
   3. Peer-reviewed publications
   4. Input parameters in Monk Seal Simulation Model
   5. Ongoing management/conservation efforts

9. Monk Seal Simulation Model 1030-1200
   1. History (Ralls, Ragen, Harting/Goodman)
   2. Demonstration of model as management tool

Lunch 1200-1300

10 Discussion 1300-1500
   1. Questions/Feedback on assessment program
   2. How to improve efficiency of data collection?
   3. How to lower effort without giving up key data?

Break 1500-1530

11. Open discussion 1500-1700

End of day

1 December 2000

12. Reviewers prepare report with MMRP staff on hand for input 0900-1200

Lunch 1200-1300

13. Reviewers work on report 1300-1600

Adjourn

STATEMENT OF WORK

Consulting Agreement Between The University of Miami and Don Bowen

September 18, 2000

General

Accurate assessment of the endangered Hawaiian monk seal population is a critical component of NMFS efforts to recover this severely depleted species. A recent lawsuit against NMFS is based on the allegation that the lobster and bottomfish fisheries in the Northwestern Hawaiian Islands have negatively impacted the recovery of the endangered Hawaiian monk seal. This controversial issue has heightened the need to ensure that NMFS assessments of the monk seal population are as accurate as possible. A review of the methodology currently used to generate demographic trends may shed new light on the population dynamics of this critically endangered species.

The consultant shall be responsible for the review of methods used in the assessment of the Hawaiian monk seal population status (stock assessment process) and determination of relevant information on population dynamics. The consultant is also expected to determine whether methods of estimating Hawaiian monk seal population abundance and demographic trends are reliable and scientifically rigorous.

Specific

The consultant's duties shall not exceed a maximum total of three weeks- several days to read all pertinent literature and documents, attend a two-day meeting with population scientists at the NMFS Honolulu Laboratory, several days to produce a written report of the findings. Specific tasks and timings are itemized below:

1. Read and become familiar with the relevant documents provided in advance to the consultant, including (but not limited to) the following:
    a. Latest Stock Assessment Report
    b. Hawaiian monk seal field manual
    c. Recent data provided to the Recovery Team
    d. Recent Technical Memorandum (annual reports);

2. Discuss stock assessment methods and conclusions regarding stock status with scientists in Honolulu, Hawaii, over November 28-December 1, 2000;

3. No later than January 8, 2001, submit a written report of findings, analysis, and conclusions. The report should be addressed to the "UM Independent System for Peer Reviews, " and sent to David Die, UM/RSMAS, 4600 Rickenbacker Causeway, Miami, FL 33149 (or via email to ddie@rsmas.miami.edu).

Signed_____ Date_____