

# **NOAA Coral Reef Ecological Assessment Checklist for Guidance in Development Mitigation in the Hawaiian Archipelago**

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On 5–6 August 2003, the National Marine Fisheries Service Pacific Island Regional Office (NOAA Fisheries), in collaboration with the Hawaii-based coral reef mitigation working group (U.S. Fish & Wildlife Service, Environmental Protection Agency, U.S. Army Corps of Engineers, NOAA Fisheries, and the Hawaii State Division of Aquatic Resources), sponsored a workshop on Resources, Functions and Ecological Value in the Hawaiian Coral Reef Ecosystem: Field Assessment in Mitigation Endeavors. Coral reef scientists and managers (see attached list) were invited to discuss and establish ecological criteria with an ecosystem perspective that incorporated population, community and functional aspects of reefs, to be considered in assessing Hawaiian reef areas for federally funded/permitted development projects. The process involved identifying organisms, structures, interactions and processes that require special attention in terms of maintaining and contributing to regional reef diversity, stability, resistance, resilience, productivity, accretion, recycling and connectivity. An intended goal was the creation of a coral reef ecological assessment checklist that could serve as a basis for guidance in mitigating development impacts.

To be effective, guidance for mitigating development impacts must be based on the most comprehensive understanding that can be attained about reef components, functions and connections throughout the area of concern. This checklist consolidates information and ideas provided by the 2003 workshop participants and includes many of the items identified in the Pacific Island Coral Reef Examination Sheet (Richmond 2000), which was used as one of three base outlines for workgroup development. All workshop activities were digitally recorded and recordings were reviewed during checklist development. A draft checklist was distributed to all 2003 workshop participants and other interested parties for review. Attempts were made to make this checklist short, concise, and yet comprehensive. The complexity of reef ecosystems made this a challenging endeavor. This checklist is structured as a series of 66 questions (four subtopic areas) for project applicants and managers to consider in their ecological assessments and reviews of development projects that have potential to impact coral reefs. It is not intended as a mandatory list of items to assess, but is provided as a non-limiting framework of assessment topics for reference. Further modification may be needed to allow for appropriate application in other U.S. affiliated island areas.

## **Site History**

The history of disturbance is important to assessing cumulative impacts to reefs and may provide information relevant to understanding community composition with respect to “shifting baselines” on ecological time scales. An assessment of cumulative impacts (both spatial and temporal) is a NEPA requirement.

1. Is there any information that indicates reef/intertidal status and community composition prior to any direct human modification? Are historical summaries, methods of determination and references provided?
2. What types of natural disturbances are known to have occurred at the site and with what frequency? Are site impacts/effects of natural disturbances, if any, adequately known and described? Is information on resilience and recovery known and described?
3. Is there any account of cumulative human impacts at the site? Is information on resilience and recovery known and described?
4. Are cumulative human impacts accounted for at a regional level?
5. Are risks of development-related impacts that result from synergistic natural and/or anthropogenic events addressed?
6. Are development-related impacts to human cultural use of the site adequately described?
7. What potential impacts threaten the site prior to and following planned development?
8. Has a before and after controlled impact analysis (BACI) been conducted? If not, will one be done?

9. Is the assessment/monitoring design rigorous enough to address key questions in an appropriate manner? If pertinent, are results of statistical power analyses provided and discussed?

## **Population-Community-Ecosystem Attributes and Functions**

### **Habitat**

Habitat characteristics can be described at multiple spatial and temporal scales, with a multitude being useful to an assessment overview. Organisms themselves can be defined as habitat. Since coral reef habitats and usage are spatially and temporally heterogeneous, it is important that isolated pockets of reef community composition and biological activity be identified and described, as opposed to being incorporated as outliers and lost in indicators of central tendency in statistical procedures.

#### *General*

10. Are general habitat categories indicated and adequately described (see NOAA coral reef zone and habitat classification system for the Hawaiian Islands <http://biogeo.nos.noaa.gov> and Holthus and Maragos 1995)?
11. Are sub-habitats and unique benthic features identified and described adequately (e.g., sand patches, ridges, spurs, grooves, caves, caverns, pinnacles, concentrated areas of seagrass, algae, coral, large individual corals, etc.)? Is a diversity index indicated?
12. Have habitat interfaces (i.e., transition zones from one habitat type to another) and their relationships to community composition and utilization (i.e., edge effects) been assessed and adequately described?
13. Have areas adjacent to the intended zone of impact been assessed and adequately described (including coastal dunes, anchialine pools, wetlands, estuaries, streams, riparian habitat, etc.)?

#### *Benthic*

14. Is the dominant substrate clastic (modern or pre-Holocene) or carbonate (basalt, lithified mud stone or man made)?
15. Are sediment types, sorting, grain sizes, distribution and cover characterized and described for regions of development impact?
16. Do foundation species define the dominant benthic habitat? If so, are the species, forms and general abundance indicated and adequately described?
17. Is there any indication of substrate topographic complexity (such as rugosity) and its relationship to utilization by reef community members? How was topographic complexity measured (techniques, spatial scales, etc.)?
18. Will the proposed development modify benthic characteristics in the immediate, adjacent and/or down-current areas? Have likely changes to these areas and their biological communities been adequately assessed and described (spatially and temporally)?

#### *Water column*

19. Are physical water movement parameters (tidal range, depth, residence time, wave exposure, mean and maximum wave heights, current direction, stream input, etc.) adequately described (spatially and temporally) and/or mapped?
20. Is there any indication or reason to believe that patterns of water movement may change seasonally, decadal or on a somewhat predictable level (including changes associated with storms and high wave events)? If so, are such changes and their relationship to the development and its impacts adequately described?
21. Has water quality and chemistry been measured and described (i.e., salinity, temperature, total alkalinity, DOC, POC, DO, BOD, nutrients, bacteria, chlorophyll, suspended sediment, turbidity, SPMD analysis for pollutants)?
22. Do proposed/recent changes to water quality and chemistry consider impacts to the multiple life history stages of representative marine organisms at the site? Are impacts from hydrophilic and hydrophobic additives considered?

23. Will the proposed development modify water column characteristics in the immediate, adjacent and/or down-current areas? Have likely changes to these areas and their biological communities been adequately assessed and described (spatially and temporally)?

**Corals, Other Invertebrates, Algae and Seagrasses**

24. Are project-related methods for assessing coral, macro-invertebrate, algae and seagrass communities adequately described and referenced? Do these methods adequately account for assemblage structure within the topographic complexity of the substrates present at the site?
25. Are species, diversity, cover, growth forms, abundance, densities and size distributions of corals, macro-invertebrates, algae and seagrasses adequately described and compared for general habitats and sub-habitats (if pertinent) within predicted impact zones, adjacent areas and reference areas (if pertinent)?
26. Is abundance of coralline algae (as a group) assessed and its functional attributes within the site described?
27. Has nocturnal community activity and area utilization been adequately assessed and described? Is there any reason to believe significant nocturnal activity occurs in the area?
28. Are burrows, mounds, feeding pits or other evidence of biological activity not directly observed mentioned, described and/or quantified?
29. Has an assessment of infauna been made? If so, is the infaunal community and its functional relationships adequately described?
30. Is the presence of foundation, keystone and highly influential species identified and adequately described?
31. To what extent are exploited species found within the impact area? Is there evidence the community or any of its components have been impacted/altered by fishing or collection activities?
32. Do indicator species exist in the area and, if so, what do they indicate?
33. Do notable symbiotic, commensal and/or obligate organism interactions exist at the site? If so, are these adequately described? Are the physical and ecological implications of their presence/absence discussed?
34. Is trophic complexity and energy flow addressed? Are impacts to trophic relationships within the broader community considered and adequately described?
35. Is information on reproductive status, mode and timing of pertinent species presented, discussed and referenced?
36. Has the impact of development to reproductive potential in the area been considered? To what extent is spawning and fruiting known or believed to occur in the area? Have secondary impacts been considered in terms of area-specific disturbance to reproductive connectivity with the broader region?
37. Is there evidence (historical and/or present day) or reason to believe the impact area supports recruitment, juvenile and/or subadult life-history stages? Have assessments for such been made with methods and results presented and adequately described?
38. Is any evidence presented to suggest recruitment of species present in the area will recur following development?
39. Are projected rates and types of community recovery to impacted areas presented, discussed and referenced? How might the development interfere with community recovery following disturbance?

**Fishes and other Pelagics (Elasmobranchs, Reptiles and Marine Mammals)**

40. Are project-related methods for assessing fishes and other pelagic communities adequately described and referenced? Do these methods adequately account for assemblage structure both within and above the topographic complexity of the substrates present?

41. Are species, diversity, abundance, densities, biomass, size and sex distributions and guilds of fishes and other pelagics adequately described for general habitats and sub-habitats (if pertinent) within predicted impact zones, adjacent areas and reference areas (if pertinent)?
42. Has nocturnal activity and area utilization by fishes and other pelagics been adequately assessed and described? Is there any reason to believe significant nocturnal activity occurs in the area?
43. Is the presence of keystone and highly influential species identified and adequately described?
44. Do indicator species exist in the area and if so, what do they indicate?
45. To what extent are exploited species found within the impact area? Is there evidence the community or any of its components have been impacted/altered by fishing or collection activities?
46. Is there any attempt to describe the range and relative abundance of strongly territorial species that will be impacted by project implementation? Are species that integrate multiple habitats identified and quantified?
47. Are corridors for fish and/or other pelagics in the area known and described?
48. Are trophic dependencies of fishes and other pelagics on other community members considered and adequately described? Are impacts of development to trophic relationships with other community members addressed?
49. Do notable symbiotic, commensal and/or obligate interactions exist at the site? Is there any evidence or reason to believe that cleaner stations are present within the zone of likely impact? Is utilization of cleaner stations described?
50. To what extent will development structure offset habitat loss or enhance habitat characteristics preferred by coral reef fishes and other pelagics? Is management in place to oversee and control potential impacts to structurally related fish community aggregations from targeted fishing activities?
51. Are demersal and pelagic spawning activities considered and described for the area of development?
52. Is there evidence (historical and/or present day) or reason to believe the impact area supports recruitment, juvenile and/or subadult life-history stages of fishes and/or other pelagics? If so, have assessments for such been made and results presented and adequately described? What methods were used to determine this?
53. Are development related changes in habitat and community structure likely to impact fish and other pelagic recruitment and utilization of the area (change in water flow patterns, loss of habitat, recruitment signals such as sound and odor, trophic structure, etc.)? If so, are such changes considered and adequately discussed?

#### **Indigenous Species/Assemblages of Particular Concern**

Conservation of critical habitat for rare, threatened, endangered and fishery resource species is intended by Federal Law (ESA 1973, MSFCMA 1996). In 1999 the State of Hawaii Division of Aquatic Resources sponsored a workshop on candidate listing for Hawaiian marine species (Gulko 1999). A list of marine species of concern was proposed by invited academics and marine management specialists based on criteria that included restricted range, threats throughout range, limited reproduction and/or dispersal, prolonged time to reach maturity, obligate biological dependency, life history characteristics, depleted food/prey, over-fishing and competitive exclusion (Gulko 1999). Three of the species on the list have recently been formally proposed as Endangered Species Act candidates (Gulko pers. comm.).

54. Was there any investigation to determine whether threatened and/or endangered species utilize the impact area (diurnally or nocturnally)? What methods were used to investigate for this? If such species do inhabit/utilize the area, what activities are displayed in which (sub)habitats? Is the area considered critical habitat for the species continued existence?
55. Is there any indication or reason to believe that the site is utilized by any life history stage of listed species of concern (Gulko 1999), including those critical to active fisheries? What methods were used to investigate this (note standard line transect approaches are typically inadequate)? Are such species and life history stages adequately described? Are (sub)habitats where presence occurs indicated?

56. Are functional attributes of rare and/or protected species in the area considered and described?
57. What is the rarity of listed species of concern in the impact area relevant to their known Hawaiian populations? Is such rarity a function of life history strategy?
58. Is there reason to believe that species of concern in the impact area may at any time serve as a local and/or regional reproductive source? If not, is the source population for site species known or surmised?
59. Have endemic species in the impact area been identified and are any of specific conservation concern?
60. Are any “unique” community assemblages identified and described? What makes such assemblages unique?

### **Non-indigenous “Invasive” Species of Particular Concern and Diseased Organisms**

If not considered and controlled, development activities may enhance the establishment, spread and persistence of non-indigenous species and diseases. Current listings of known non-indigenous marine species for the Hawaiian Islands are found in Eldredge and Smith (2001), Eldredge and Evehuis (2003) and at the Bishop Museum web address (<http://www2.bishopmuseum.org/HBS/invertguide/index.htm>). Information on marine organism diseases is located in various published references and manuscripts in preparation (contact Thierry Works, USGS, [thierry\\_work@usgs.gov](mailto:thierry_work@usgs.gov)).

61. What non-indigenous species are present at the site (prior to and following development)? Are any identified as being “invasive” (i.e., having a recognizable impact to habitats and/or biological communities in the Hawaiian Archipelago)?
62. Is the extent of “invasive” species impacts to the indigenous community at the site described?
63. Do predators/grazers of “invasive” species inhabit the area? If so, in what concentrations? How will development impacts to predators/grazers effect natural control of “invasive” species in the area?
64. Are development-related dispersal risks and safeguards for non-indigenous species adequately assessed and described?
65. Will development create habitat suitable for colonization, transport or spread of non-indigenous species (particularly invasive algae and invertebrates including *Carijoa riisei*)? Are risks adequately described in terms of regional species presence?
66. Is there any indication or reason to believe that diseased or parasitized organisms inhabit the impact area? If so, are symptoms and abundance adequately described, along with development-related risks of dispersal?

### **References**

- Eldredge, L. G. and N. L. Evenhuis. 2003. Hawaii’s biodiversity: a detailed assessment of the number of species in the Hawaiian Islands. Records of the Hawaii Biological Survey for 2001-2002, Bishop Museum Occasional Papers 76: 1-28.
- Eldredge, L. G. and C. M. Smith (eds.). 2001. A guidebook of introduced marine species in Hawaii. Bishop Museum Technical Report 21, 114 pp.
- Gulko, D. 1999. Hawaiian marine species for ESA candidate listing consideration workshop. Division of Aquatic Resources, State of Hawaii, 15 pp.
- Holthus, P.F. and J.E. Maragos. 1995. Marine ecosystem classification for the tropical island Pacific, p. 239-280. *In* J.E. Maragos, M.N.A. Peterson, L.G. Eldredge, J.E. Bardach and H.F. Takeuchi (eds.) Marine and coastal biodiversity in the Tropical Island Pacific Region. East-West Center, Honolulu, Hawaii.
- Richmond, R. H. 2000. Coral reef examination sheet, Version 3/00. University of Guam Marine Laboratory, 6 pp.

## List of Workshop Participants

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