Restoring Watershed Health: Peacetime Military Contributions and Federalwide Agency Implications

Diane C.Drigot

Environmental impacts of peacetime military training are under heightened scrutiny by outspoken publics all over the world. Public environmental concerns are increasingly linked to sociocultural well-being and economic vitality in affected communities. Demonstrating leadership in environmental stewardship in this broader community context is essential for the military to ensure continuing public support of its mission in a post-Cold War era. Federal land management agencies are mandated to follow an ecosystem approach to resource management, such as a watershed approach to Clean Water Act compliance. This provides promising opportunities for military installations to link peacetime activities with host community well-being. The transdisciplinary basis and policy frameworks for this approach are reviewed. Examples from Marine Corps Base Hawaii are described. Use of this approach by other resource management agencies facing similar challenges is encouraged. © 2000 John Wiley & Sons, inc.

INTRODUCTION

In 1995,14 federal land-based agencies, including the Department of Defense (DOD), signed a Memorandum of Understanding (MOU) to foster an ecosystem approach to resource and environmental management.1 As stated in the MOU, the goal of ecosystem management is "to restore and sustain the health, productivity and biological diversity of ecosystems and their overall quality of life through a natural resources

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Ecosystem health is one among several transdisciplinary approaches to environmental management that emerged in the last decade.

management approach that is fully integrated with social and economic goals." Resource management decisions must be based not just on "*best* science" but on "associated cultural values," "improved communication with the general public," and "forming partnerships" with government, non-government agencies and other stakeholders."

Military installation resource managers were provided with DOD Instruction 4715.3 of May 3,1996 to help implement this approach. The ten guidelines in the instruction contain recurring reference to the term *ecosystem health.* Ecosystem health is one among several transdisciplinary approaches to environmental management that emerged in the last decade. Two others are *ecological economics* and *ecological engineering.* Ecosystem health holds promise for being the most integrative of them all because it is developing a framework for wedding knowledge of how environmental systems work with the knowledge of what is desirable and acceptable.[2] Such a framework is needed to guide federal resource managers toward increased consideration of social-cultural perspectives as well as biophysical ones when performing land use and resource management.

The U.S. Department of Agriculture and the U.S. Environmental Protection Agency's recent promulgation of a Unified Watershed Assessment Framework under the federal Clean Water Action Plan of February 1998 reflects these agencies' shift to an ecosystem-based perspective.[3] The 1972 Clean Water Act (CWA) (33 U.S.C. 1251 et. seq.) goal of zero discharge of pollutants and fishable and swimmable waters throughout the United States was first approached through a narrower focus on reducing end-of-the-pipe point discharges. Although much progress has been made since the 1970s in this regard, the more pervasive nonpoint sources of water pollution remain. Failure to achieve CWA goals in a timely fashion has been attributed to "failure to recognize the inter-related processes and important linkages in ecological systems of entire watersheds."[4]

Under an ecosystem-based watershed assessment approach, agencies are expected to look holistically at human communities, how they interact with the water in their watersheds, and devise strategies for reducing nonpoint pollution in this broader context. For example, they are required to follow *best management practices*[5] to reduce their share of the communitywide nonpoint pollution load. They are encouraged to play a leadership role in uniting often disparate stakeholder interests on a regional watershed basis and to collaboratively develop a vision of desired future conditions of improved watershed health.

TRANSDISCIPLINARY FRAMEWORK FOR ECOSYSTEM/ WATERSHED HEALTH RESTORATION

The emergent transdisciplinary science of watershed health offers a useful framework for federal resource managers and others involved in implementing ecosystem management and watershed assessment guidelines.6 Watershed health can be viewed as having as least two components: (1) concern for the biophysical integrity of water bodies as affected by human action in a given watershed, and (2) consideration of the

sociocultural and economic aspects of how communities are organized that live in or otherwise influence the watershed. There has been more research progress in the former than in the latter. Jim Karr, for example, is a widely recognized pioneer in operationalizing the first component.' He developed the Index of Biotic Integrity, or IBI. The IBI is a means of quantitatively comparing the health of various aquatic ecosystems to a reference standard (Best Regional Stream). The health of other streams or stream reaches in the same regional ecosystem or basin can be compared against this standard. While this method is still being perfected and is not fully applicable to highly altered urbanized watersheds, it represents a significant advance in environmental science. It shows how more meaningful water quality assessments can be if they include a measure of the intactness of the structure, function, and composition or "natural capital" of an in situ ecosystem.8

The second component of watershed health is not so well operationalized. It involves, among other things, considering intactness of the "social capital" of the human community in a given watershed. Social capital refers to the features of social organization (e.g., the networks, norms, and social trust) that facilitate coordination and cooperation for mutual benefit.[9] It comprises the community of people in a self-defined geographic area; their survival networks of friends, families, and associates; and their living patterns, routines, and manner in which they resolve issues (e.g., civic culture). It is the social capital of a community that is drawn upon to help cope with a crisis that might arise (e.g., a natural disaster or an intrusion of a disruptive element such as an unwanted commercial development in a quiet neighborhood). Communities with an intact, undepleted stock of social capital have a rich social infrastructure and web of mutually supporting interrelationships; a high capacity and motivation among members to predict, participate in, and control their own environment, and who feel empowered to choose and implement a preferred future.

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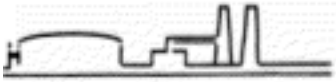
Environmental scientists and natural resource managers are more accustomed to considering the structure and function of a natural ecosystem and its resilience to stress. Less familiar to them is how to look at the structure and function of a human community, its "social capital" and resilience to stress. A community with a high degree of social capital is analogous to a natural ecosystem with a high degree of "natural capital"; i.e., it is more likely to assimilate change and adapt without adverse disruptive effects—or modify the change to enhance the community's well-being or resist the change if it has no considered beneficial effects.

Agencies that pay attention to the social capital of communities impacted by its activities are more likely to be successful in implementing their programs there. Evidence for this is three decades of failed development projects around the world that neglected to consider social capital. For example, a World Bank retrospective analysis of 25 of its development projects in Africa, Asia, and Latin America found that over half of them failed because they ignored the social factor.[10] Those that had sustained success did purposive institution building in host communi-

ties. They included grassroots participation and other sociological factors, along with economic and ecological ones.

In summary, while designing projects to restore ecosystem health, balanced consideration of both natural and social capital in the affected communities is important. Restoring ecosystem health is a process whereby restorable natural capital and the affected community's social capital are strengthened and ecological attributes are restored that confer organizational integrity, productivity, and resilience, regardless of species composition.



NEPA was the first national expression of a policy link between restoring land health and human health (i.e., restoring natural and social capital).

POLICY FRAMEWORK FOR ECOSYSTEM/WATERSHED HEALTH RESTORATION

Jim Kent and Kevin Preister are among pioneers to operationalize more balanced consideration of both social and natural capital aspects of communities in an ecosystem-based watershed health restoration framework. They are guided by a useful conceptual *Bio-Social Ecosystem Model of Productive Harmony*, which was developed through their experience performing environmental assessments under the National Environmental Policy Act (NEPA) of 1969 (42 U.S.C. 4321 et. seq.) in a number of diverse community settings.[11] In simplified terms, this model suggests that if you enter a community with an ecosystem or watershed health restoration project focused on the "right side" of the model (i.e., paying attention to "natural capital" only) and ignore the "left side" of the model (i.e., the "social capital" of the affected community), then your approach is not likely to be sustainable or it may even create unhealthy conditions in the human community affected. See Exhibit 1.

It should not be surprising that NEPA mandates an integrative framework for this biosocial approach. NEPA was the first national expression of a policy link between restoring land health and human health (i.e., restoring natural and social capital). Although NEPA is more widely known for its action-enforcing impact statement provision (Section 102(2)(a)), the substantive portions of the Act (Section 101(a)) were equally groundbreaking.[12]

Thus, NEPA's stated purpose is "to encourage *productive and enjoyable harmony* between man and his environment.. .and to stimulate the health and welfare of man." Section 101 (a) of the Act says a goal is to "create and maintain conditions under which man and nature can exist in *productive harmony,* and fulfill the social, economic, and other requirements of present and future generations of Americans"—i.e., a goal of the Act is to improve "ecosystem health," by promoting and enhancing the link between land health and healthy human communities. Dr. Lynton K. Caidwell, a principal architect of NEPA, recently confirmed that this indeed was what was intended by the framers of the Act, although, in his words, the courts have "refused" to recognize it.13

MARINE CORPS BASE HAWAII'S ECOSYSTEM/WATERSHED HEALTH PROGRAM

It is useful to describe Marine Corps Base Hawaii's (MCBH's) watershed health restoration program within the above-described frame

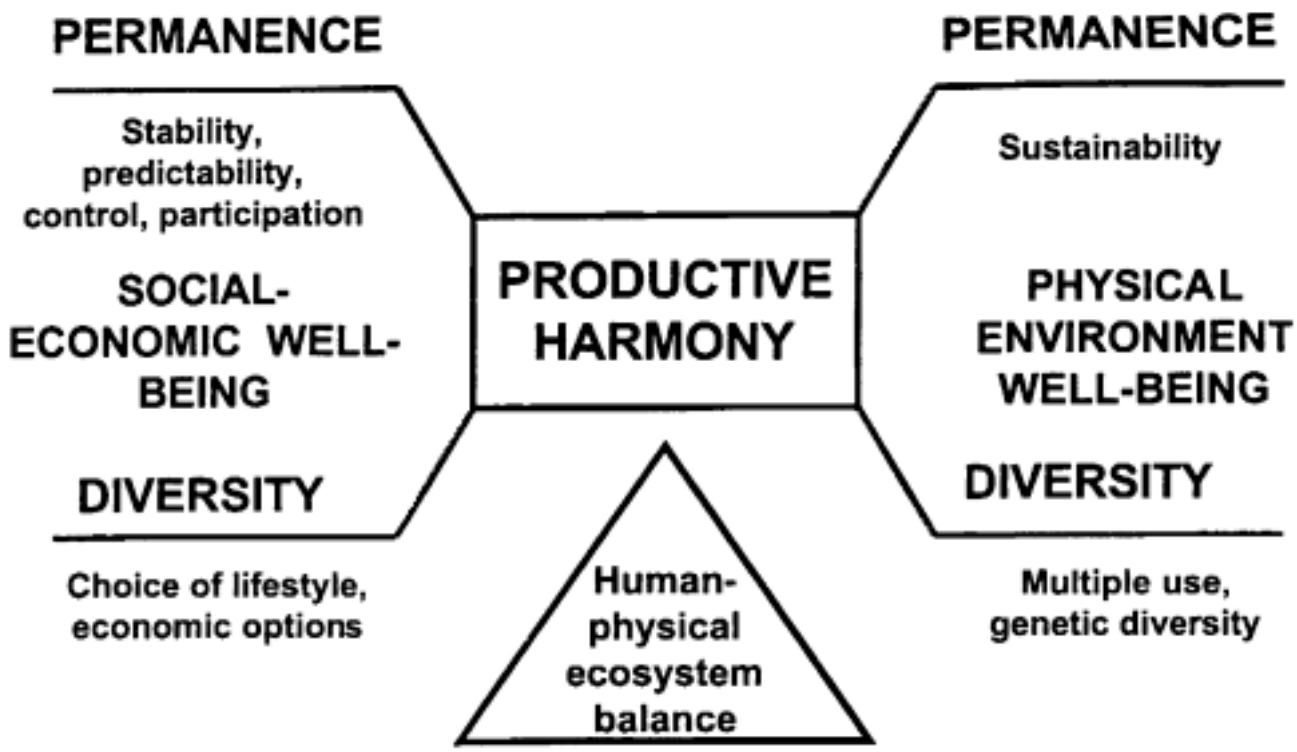


Exhibit 1. Productive Harmony Model

work. Several examples follow, after a geographic orientation to the watershed region in which they occur. In these examples, the resource restoration programs show evidence of improving the status of the target natural resources while also strengthening the involved communities' sense of place, stewardship ethic, and cooperative linkages.

Geographic Setting for MCBH's Watershed Region

MCBH owns several land parcels on the Hawaiian island of O'ahu, over 4,000 acres of which are located within three properties on windward O'ahu within the Ko'olaupoko District. This district comprises an almost idealized tropical landscape of mountain peaks, coastal wetlands, three bays, offshore fringing reefs, and 11 catchments or watersheds. It is populated by diverse urban to rural, ethnically mixed to Native Hawaiian, relatively affluent to low income communities. Flooding, nonpoint pollution, invasive alien vegetation encroachment, and cumulative development impacts have contributed to wildlife habitat loss and nonpoint pollution problems within this resource-rich region. Concern about these interrelated environmental impacts has led to

several public and private initiatives in the region to restore watershed health. The state has ranked this region as Priority One for watershed restoration attention under the National Clean Water Action Plan. See Exhibit 2.

A collaborative vision of restored watershed health articulated by many government documents and community groups in Hawaii is to revive elements of the ancient ahupua'a-based management system in precontact Hawaiian times.[15] A typical *ahupua'a* comprised a wedgeshaped land/water integrated management unit extending from mountain tops to beyond the reefs, often having boundaries similar to those of hydrological units known as "watersheds" today.[16] Among the resource management protocols guiding early Polynesian residents of an ahupua'a were: (1) equal access rights to use what grew within the mountain-to-sea

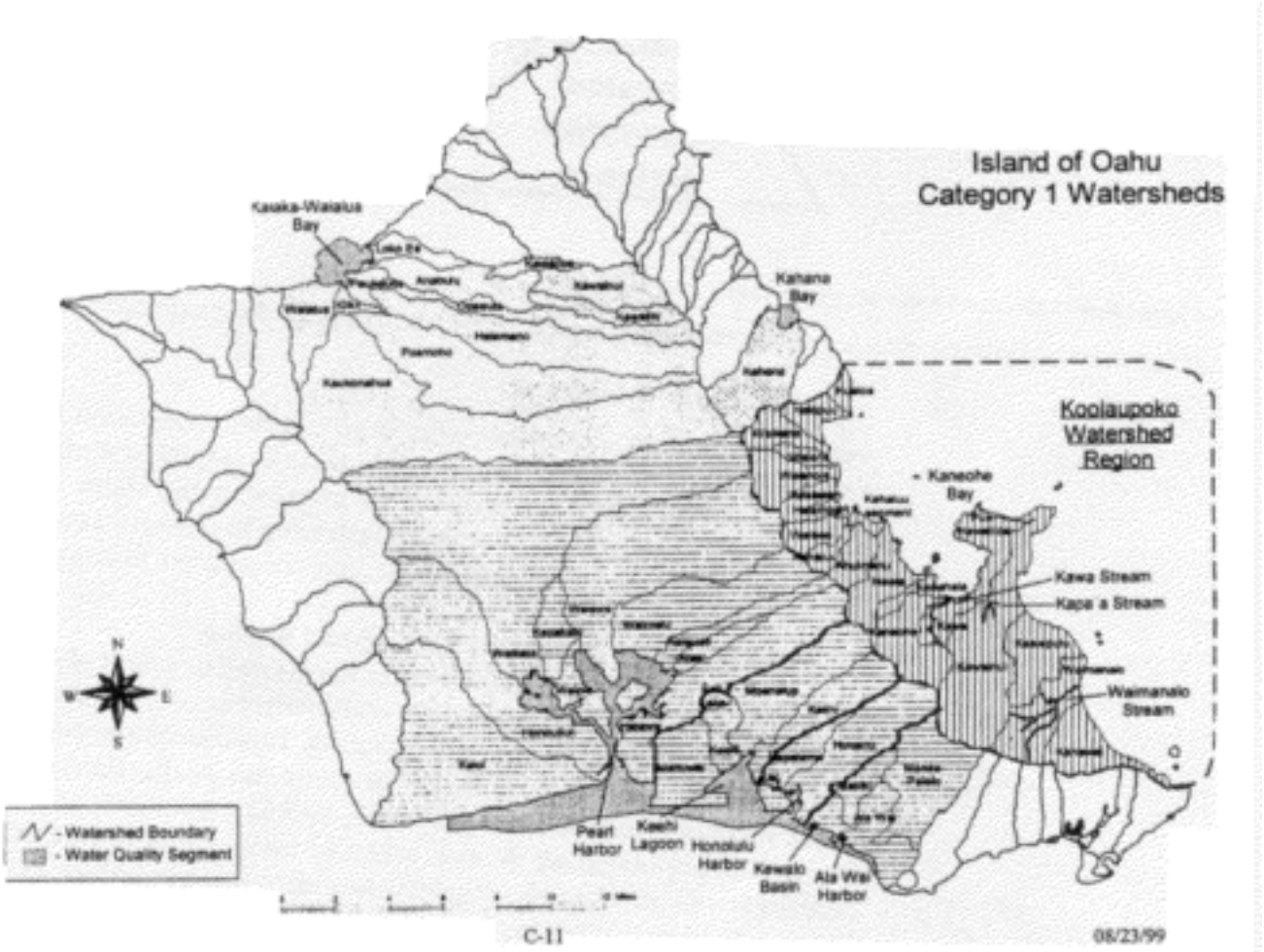
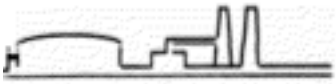


Exhibit 2. Island of O'ahu, Category 1 Watersheds, Ko'olaupoko Watershed Region in State of Hawaii

boundaries of their ahupua'a; (2)a system of *kapu* (law) which determined how resources were conserved and distributed within these units; (3) an ethic to *malama* (share and take care of) the limited but diverse resources within the area; 4) an awareness that there is an interconnected relationship between land- and marine-based natural resources of an ahupua'a; and (5) a shared understanding that all actions taken by people within an ahupua'a were governed by principles such as *pono*, a concept that each person must do what is right and just (e.g., harvest an amount of resources that is appropriate for their own needs and no more).



The ahupua'a-based management system in the watersheds of the Ko'olaupoko District prior to European contact resulted in an abundance of natural wetlands, taro terraces (lo'i), and fishponds.

The ahupua'a-based management system in the watersheds of the Ko'olaupoko District prior to European contact resulted in an abundance of natural wetlands, taro terraces (lo'i), and fishponds. These features enhanced the human population, preserved wildlife habitat, filtered pollutants from storm water runoff, and provided flood protection in a manner such as advocated in the contemporary concept of *best management principles* under the CWA.[17]

By contrast, urbanization, modern systems of land tenure, and related pressures of modern life make it more difficult to sustain cohesive community-based protocols for managing the mountain-to-sea resources within these same watersheds today. They are threatened by accelerated siltation and polluted runoff from urban development and agricultural activity that have impaired their natural functions. For example, many downstream fishponds that once flourished in contiguous ahupua'a of the Ko'olaupoko District have vanished entirely due to deliberate filling. Other fishponds and adjacent coastal wetlands are clogged with excess nutrients, alien vegetation, and sediment which degrade their natural capacity to absorb floodwaters and filter nonpoint pollution from stormwater runoff.[18] Straightened and concrete-lined channel exits into the ocean from many streams, wetlands, and former fishponds in this district are often filled with visible plumes of nonpomt particulate pollution, especially after a heavy rain. Affected beaches are posted with health warning signs or temporarily closed with increasing frequency, until the pollution dissipates.[19]

It is in this challenging regional watershed context that the Marines have been implementing watershed restoration initiatives. Three examples follow.

Example 1. Amphibious Assault Vehicle (AAV) Deployment for Wetland/Wildlife Habitat Enhancement

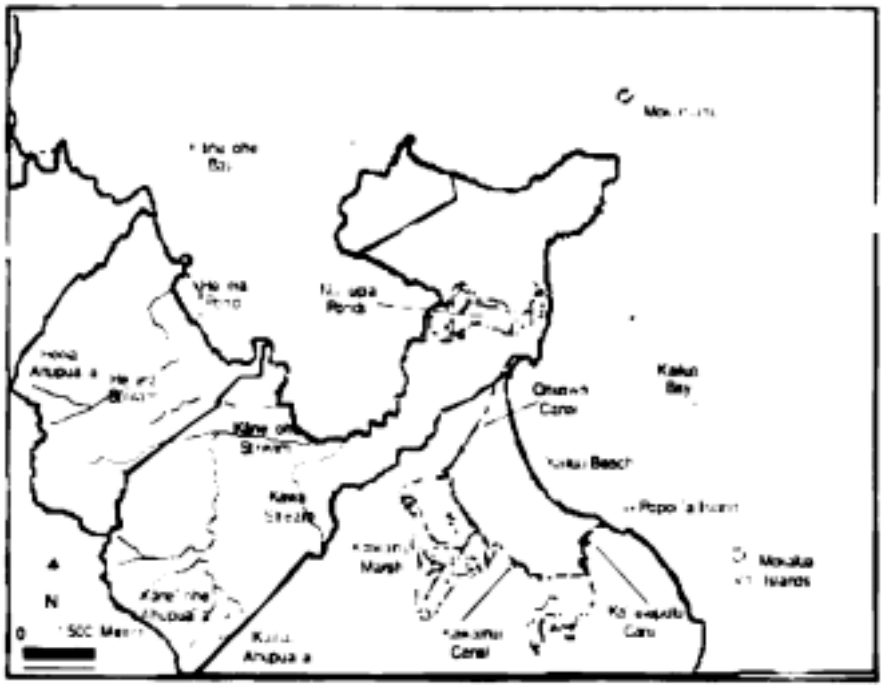
A principal MCBH parcel in this district is the 2,951-acre Mokapu Peninsula. A 482-acre Nu'upia Ponds Wildlife Management Area straddles the neck of the peninsula, connecting MCBH to the rest of this watershed region. These Ponds comprise the last remnant of 30 ancient Hawaiian fishponds that once existed around Kane'ohe Bay. The Marines have kept this resource relatively intact as an endangered waterbird habitat, protected wetland, national historic property, and valued security buffer from development encroachment. See Exhibit 3.

Among the protected wildlife in Nu'upia Ponds is a resident population of endangered Hawaiian stilt *(Himantopus mexicanus knudseni).* One of the biggest threats to the birds' survival here and in the windward wetlands of this region in general, is intrusive alien vegetation along shoreline shallow water and mudflat areas used by these endemic waterbirds for feeding and on-ground nesting. Among the most significant vegetation threats in the region are alien mangrove *(Rhizophora mangle)* and pickleweed *(Batis maritima).*

About 20 years ago, Nu'upia Ponds resource managers determined that an appropriate technology for restoring bird use of this habitat in this military community is Amphibious Assault Vehicles or AAVs. Normally used in securing a beachhead, these 26-ton tracked vehicles are able to easily maneuver in soft mud and aqueous areas to mechanically clear weeds. By their sheer weight, using back and forth plowing action, AAVs can also contour the landscape to create a checkerboard mosaic of "moat and island" terrain favored by the stilt for feeding and nest building. Newly hatched stilt thus gain improved access to its water-resident food sources, a critical factor since stilt must largely fend for themselves from birth. See Exhibit 4.

By annually using this technique for habitat restoration, just before nesting season, weed regrowth is kept in check and Marines involved acquire a novel training opportunity, working in unfamiliar terrain nor-

Exhibit 3. Map Showing Nu'upia Ponds WMA and Mokapu Peninsula in Regional Context



Modified from Wilcox, B.A., et. al. 1998. Mokapu: Manual for watershed health and water quality by Institute for Sustainable Development and AECOS, Inc., for Marine Corps Base Hawaii Environmental Affairs Division.

Exhibit 4. Photo of a Marine Amphibious Assault Vehicle in Nu'upia Ponds Plowing Mudflats Of Nu'upia Ponds, Crushing Invasive Weeds and Opening Water Channels to Expand and Improve Hawaiian Stilt Nesting and Feeding Opportunities

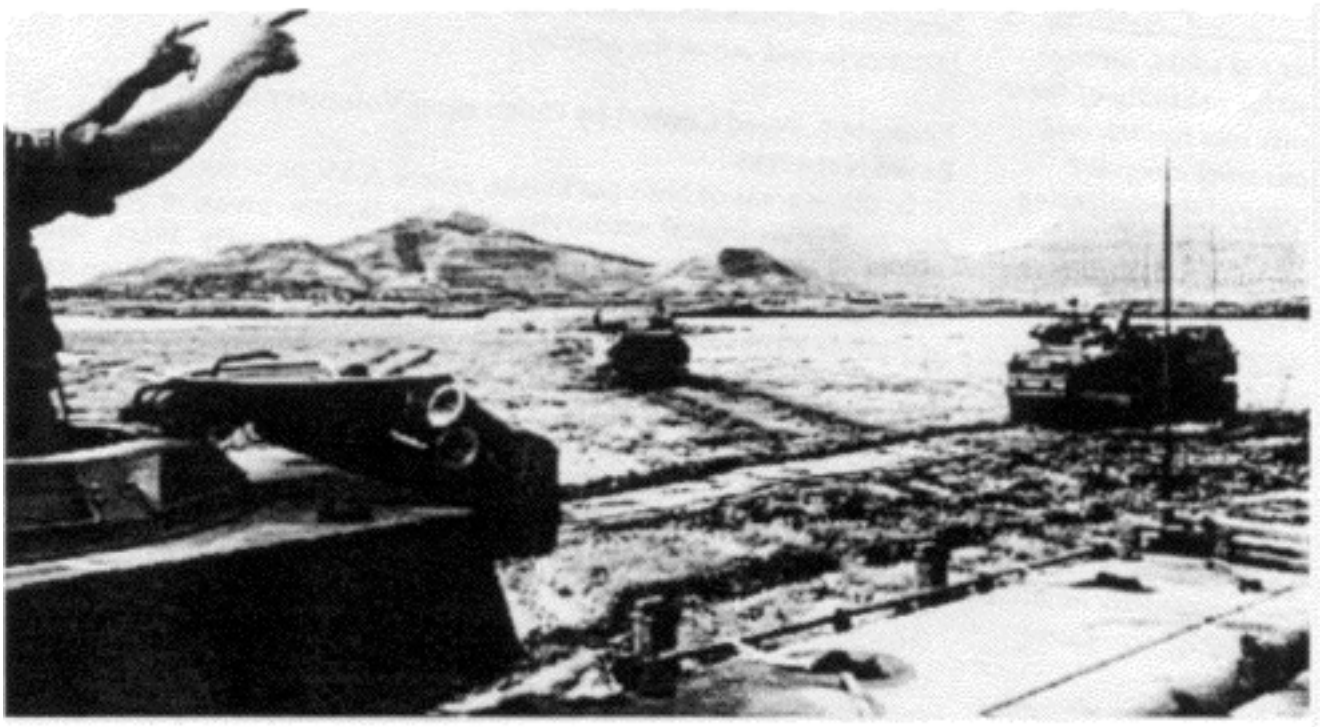


Photo by D.C. Drigot.

mally restricted from their access during the rest of the year. This practice represents a "win-win" balancing of seemingly incompatible wildlife and military training objectives. The Marines have become an integral part of the "working landscape" of this protected wetland, both providing and receiving a valuable service. Without their help, habitat available to the birds would rapidly diminish through aggressive weed regrowth.

In terms of the watershed health framework described earlier, such an approach to invasive weed control is very effective in that it not only enhances the biophysical "capital" of the area (e.g., a documented doubling of endangered stilts counted in the ponds over the last 18 years),[20] but the "social capital" of the military community is also enhanced. Thus, the environmentally friendly use of AAVs has been recognized in wide media coverage and national awards, enhancing the

Over the years, through positive publicity of these events and results, and sponsoring a regular routine of weed-clearing voluntary service opportunities, MCBH has prevented further mangrove encroachment, served the mission of countless civic-minded volunteer organizations, and fostered a regional perception of the sustained commitment and camaraderie involved in restoring ecosystem health.

Marines' reputation as responsible environmental stewards.[21] Such recognition enhances the "civic culture" of the Marine Corps—their sense of pride in doing what is right and being protectors. Marines now refer to this event as their annual "Mud Ops" ritual, reflecting a growing sense of attachment to this place and the restoration mission they serve.[22] Both natural and social capital of the affected community have been enhanced, and this activity is more likely to be sustained so long as these beneficial impacts accrue, and regardless of the rotation of individual Marines in and out of the activity.

Example 2. Weed Control by Cultivating Volunteer Community-Based Networks

In other areas of Nu'upia Ponds, where AAV plowing is infeasible due to archaeological sensitivity or other factors, invasive weed removal is accomplished by manual labor. In the early 1980s, base resource managers began to remove weed mangrove trees in these less accessible areas with voluntary help. Through the process of involving diverse groups of volunteers in weed removal, modest viewplains were cleared into the pond habitat. In so doing, a collaboratively created vision of what is possible evolved as more people were literally drawn into the landscape to directly connect to the resource.

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Example 3. Watershed and Community Health Restoration

With the recent federal emphasis on ecosystem management and watershed enhancement, MCBH has expanded its resource management perspective from focus on wetlands to enhancing the health of entire watershed ecosystems within which these wetlands are situated. MCBH has also expanded its activities to enhance host community support upon which continuing training use of MCBH lands depends. A

Mokpau: Manualfor Watershed Health and Water Quality was developed to provide technical guidance in this regard.[24]

Evolving from this foundation, a MCBH Watershed Health Restoration project was begun in 1999, aimed at enhancing collaborative community involvement as well as the "natural capital" of the watersheds affected.[25] A key project element developed several demonstration riparian (streamside) native plant gardens along dramatically altered stream channels in the military base community on Mokapu peninsula, and in the adjacent Waimanalo watershed, on Marine Corps Training Area-Bellows.

Teachers from nearby elementary schools (serving both on- and off-base students) located in these two watersheds were recruited as part of the community's "social capital" resources through which to help implement this project. They provided a critical role in linking military children and their parents with the larger host community and surrounding environment. A customized graduate-level credit, environmental education course was offered to them through the University of Hawaii Outreach College, and was endorsed by the State Department of Education toward teacher career advancement. The teachers who registered in the course were those who already use or were motivated to start using watershed health and related concepts in their lesson plans. The course provided them with knowledge, skills, and tools about watershed health, with specific applications to MCBH watersheds.

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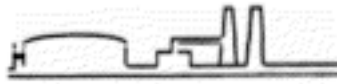
The design of the course drew upon a community problem-solving "environmental encounter" approach to environmental education pioneered by Dr. William B. Stapp, a noted international leader in environmental education.[26] As a result of completing this course, 16 State Department of Education-employed teachers have acquired basic training in watershed management science and how their students can play a role to enhance watershed health. They have begun to develop and apply customized lesson plans in their classrooms and the field, including but not limited to assistance to MCBH in planning, planting, and maintaining the riparian native plant gardens supported by the MCBH watershed project.[27] Moreover, they are helping enhance community awareness that the watershed is a living resource needing care and stewardship and that all its occupants play a critical role in the restoration process. Their actions are resonant with the vision of many government and citizen groups described earlier, to revive elements of the ancient ahupua'a management system (e.g., the ethic of *malama* and ***pono).***

Community interaction linkages among stakeholders in the region are also being expanded in the process. For example, teachers from Aikahi and Mokapu elementary school in the Mokapu watershed who took the watershed environmental education course have shared their knowledge and support with teachers in the neighboring Waimanalo watershed also engaged in environmental education curriculum development and application. Together they have assisted in launching student involvement in watershed issue investigations including, but not limited to, development and maintenance of a demonstration ripar-

ian native plant garden at the Marine Corps Training Area-Bellows. To date, over a hundred students from Waimanalo elementary school have been involved there as well as scores of military volunteers. Enhanced cooperation among services within the military has also been catalyzed. Thus, the military volunteers have included Air Force and Hawaii Army National Guard personnel, as well as MCBH Marines, Sailors, and their families. A number of community-based organizations and plant nurseries in Waimanalo have also been involved.[28]



In return for this investment, the host community is more likely to understand and support continuing military training activities in these watersheds.

In sum, after the first year of this MCBH project, three streambank areas are being recovered with native ripanan vegetation, two on Mokapu Peninsula and one on Marine Corps Training Area-Bellows, with community help, from both on- and off-base. Cooperation among community stakeholders and state, federal, and private agencies in applying watershed science and environmental education concepts has been enhanced, while a collective community vision of improved watershed health has evolved.

Although this is a "work in progress," the level of sustained enthusiasm and participation thus far suggests that this community-based watershed improvement effort will be self-sustaining as is the community-based invasive vegetation control program efforts at Nu'upia Ponds, described earlier. This is because the "social capital" of the teaching and volunteer community has been tapped and enhanced as well as the "natural capital" of the streams in the affected watersheds.

In return for this investment, the host community is more likely to understand and support continuing military training activities in these watersheds. Evidence of this likelihood is presented, for example, in a 1999 Ko'olaupoko Community Coalition Development plan which states that "it is more in the community's interest to have these areas (e.g., Mokapu and MCTAB) remain in military control rather than be released to civilian ownership." Earthjustice Defense Fund (often one of the military's strongest critics) has stated that MCBH's conservation program is "enlightened."[29]

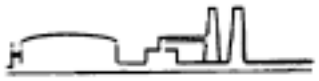
SUMMARY, RECOMMENDATIONS, AND CONCLUSIONS

What these MCBH examples of wetland and watershed health recovery initiatives share in common is that the activities tapped into and enhanced the "social capital" of the communities involved, as well as the "natural capital" of the biophysical environment. The following recommendations are offered to other agencies and organizations faced with similar ecosystem management and watershed restoration objectives:

1. Do not perpetuate "top-down" programs that attempt to "do for" rather than "do through" the affected communities. Especially in the area of watershed restoration, "watershed" has become a buzzword and major source of funding. Sometimes, state, university, paragovernmental, and consultant projects initiate top-down efforts with little community involvement. As a result, much effort is expended by community-based advocates to

deflect the intrusive, fragmenting effects of such externally driven programs.

2. Seek to deliberately work through the "civic culture" of affected communities to enhance the social capital of these communities
(e.g., their routines, informal caretaking networks, and inherent stewardship values) while seeking also to restore the "natural capital" of the affected biophysical environment.



The post-cold war years have brought a shift in public attitudes toward being more skeptical of military presence in neighborhoods and communities.

3. Work collaboratively with informal as well as formal networks and informal as well as formal elected leaders in a community.
Examples of informal leaders vary from community to community and from project to project. In the MCBH project, key roles have been played by informal leaders such as a retired military officer, a sports coach, and kupuna (respected Native Hawaiian elders), as well as personnel from more formal organizations such as school teachers, school principals, and scouting leaders.

4. Facilitate horizontal community-to-community linkages so as to encourage development of a collaborative regional vision of
resource recovery possibilities.

CONCLUSIONS

In closing, the conceptual framework, examples, and recommendations in this article are offered to other agencies and organizations considering watershed health or other ecosystem-based management initiatives. For military installations, in particular, it is becoming increasingly critical to apply such approaches to support continued combat readiness of our military forces. The post-cold war years have brought a shift in public attitudes toward being more skeptical of military presence in neighborhoods and communities.[30] Military commanders are beginning to realize that new approaches to working with host communities to sustain their support are necessary.[31] Working collaboratively, through host-community channels, to enhance bothnatural and social capital, comprises a sustainable approach to ecosystem management. It also provides promising potential to military installations for helping sustain public support of the peacetime presence of military training activities in their communities. +

NOTES

1. Memorandum of Understanding to Foster an Ecosystem. Approach signed on December 15, 1995 by the President's Council on Environmental Quality and 14 federal land management agencies: US Departments of Agriculture, Army, Commerce, Defense, Energy, Housing and Urban Development, the Interior, Justice, Labor, State, Transportation, Environmental Protection Agency, and Office of Science and Technology Policy. (Distributed within DOD in an attachment to Memorandum of the Undersecretary of Defense, Environmental Security IES]/EQ-CO) Letter of January 231996, prepared by Office of the Under Secretary of Defense, ES. Pentagon, Washington D.C.)

2. Rapport, D. (1998). Defining ecosystem health. In D. Rapport, R. Costanza, P.R. Epstein, C. Gaudet, & R. Levins (Eds.), Ecosystem health (Chap. 2, pp.18-33). Oxford,

England: Blackwell Science, Inc.

3. Memorandum from U.S. Department of Agriculture and U.S. Environmental Protection Agency and attached Final Framework for Unified Watershed Assessments, Restoration Priorities, and Restoration Action Strategies, June 9, 1998.

4. O'Conner, K.A. (1997). Clean Water Act problems and watershed solutions. In Watershed '96 Proceedings, June 8-12,1996, Baltimore, MD and posted at US EPA's website: http: / /www.epa.gov /owowwtrl/watershed /Proceed.

5. The Federal Clean Water Act defines a "best management practice" as "a practice or combination of practices that is determined by a state to be the most effective means of preventing or reducing the amount of pollution generated by nonpoint sources to a level compatible with water quality goals."

6. In addition to the Ecosystem Health textbook cited in note 2, another useful reference in this area is Ecosystem Health, the quarterly Journal of the International Society for Ecosystem Health, Blackwell Science, Inc., ISBN 1076-2825

7. See, for example, Karr, J.R., Fausch, K.D., Angermeier, P.L., Yany, P.R., & Schiosser, I.J. (1986). Assessment of biological integrity in running water. A method and rationale. Illinois Natural History Survey Special Publication 5.28 pages; and Karr,J. R. (1994). Landscapes and management for ecological integrity. In K.C. Kim, & R. D. Weaver (Eds.), Biodiversity and landscape: A paradox for humanity. New York: Cambridge University Press.

8. For more on "natural capital," see, for example, Costanza, R., d'Arge, R., de Groot, R., Farber, S., Grasso, M., Hannon, B., Limberg, I., Naeen, S., O'Neill, R.V., Paruelo, J., Raskin, R.G., Sutton, P., & van den Belt, M. (1997). The value of the world's ecosystem services and natural capital. Nature, 387,253-260.

9. Putnam, R.D. (1995, January). Bowling alone: America's declining social capital. Journal of Democracy, 6(1), 67.

10. Cernea, M.M. (1994). The Sociologist's approach to sustainable development. In I. Seragoldin, & A. Steer (Eds.), 1994. Making development sustainable, from concepts to action. Washington DC: The World Bank, Environmental Sustainable Development Occasional Paper Series No.2, p.8.

11. Preister, K. & Kent, J.A. (1997). Social ecology: A new pathway to watershed restoration. In J.E.Williams, C.A. Wood, & M.P. Dombeck (Eds.), Watershed restoration: Principles and practices (Chap. 3). Bethesda, MD: The American Fisheries Society. Further exposure to applications of this model can be gained in a series of Partnership subject courses offered, such as "Community-Based Partnerships and Ecosystems for a Healthy Environment," codeveloped by US Bureau of Land Management, USDA Forest Service, U.S. Fish and Wildlife Service, USDI National Park Service, and Natural Resources Conservation Service through the Bureau of Land Management National Training Center in Phoenix, Arizona. See BLM website for further details: www.ntc.blm.gov.

12. Caidwell, L. K. (1982) Science and the National Environmental Policy Act, redirecting policy through procedural reform. Alabama: University of Alabama Press.

13. Id., personal contact, 1999.

14. Under the watershed restoration priority setting guidance outlined in the U.S. Environmental Protection Agency's Final Framework for Unified Watershed Assessment, Restoration Priorities, and Restoration Action Strategies, Hawaii submitted a list of watershed restoration priorities in October 1998, reflecting public input. The Ko'olaupoko District was declared through this process to be in Category One priority. For more information, see State of Hawaii, Department of Business, Economic Development and Hawaii Department of Health's Clean Water Branch (Draft of October 1999) Hawaii's Implementation Plan for Polluted Runoff Control.

15. A key vision element of Koolaupoko's future in the City and County of Honolulu (June 1999) Final Draft, Koolaupoko Sustainable Communities Plan is to "adapt the

concept of ahupua'a in land use and natural resources management (p. 2.2). A major coalition of citizen groups in Hawaii working toward watershed restoration objectives has the name "Ahupua'a Alliance," which further signifies the importance of this vision. The Plan can be accessed at the website for City and County of Honolulu homepage at www.co.honolulu.hi.us under Planning and Permits section.

16. Much has been written on the ahupua'a concept and its application. For basic information on the subject see, for example, (1) Handy, E., Craighill, S., &. Handy, E.G. (1972). Native planters in old Hawaii, their life, lore, and environment. Honolulu: Bernice P. Bishop Museum Press, Bernice P. Bishop Museum Bulletin 233, ISBN 0-910240-11-6; and (2) Wise, J. H. (1973). The history of land ownership in Hawaii. In , E. Handy, S. Craighill,K. Emory,E. Bryan, P. Buck,J. Wise,et. al. (Eds.), Ancient Hawaiian civilization, a series of lectures delivered at Kamehameha Schools (Chap. 7). Rutland, VT: Charles E. Tuttle Co.

17. The pre-European contact status of abundance in the Hawaiian's ahupua'a-based land management system of the Ko'olaupoko District is documented in references such as Devaney, D.M., Kelly, M., Lee, P. J., & Motteler, L.S. (1982). Kane'ohe, a history of change. Honolulu, HI: The Bess Press.

18. A history of change induding adverse impacts from increased nonpoint source pollution in Ko'olaupoko District is documented in sources such as Devaney, et. a!., id.; Smith, S. V.,. Chave, K.E, &. Kam, D.T.O (1972). Atlas of Kaneohe Bay: A reef ecosystem under stress. Hawaii: University of Hawaii Sea Grant Program Publication; and Lowe, M. K. (1996). Concerns for coastal and inshore fisheries of Kaneohe Bay and the nearby windward coast if stream flows are restored in Northern Kaneohe Bay. In State of Hawaii, Department of Land and Natural Resources, Division of Aquatic Resources (1996) Will Stream Restoration Benefit Freshwater, Estuarine, and Marine Fisheries? Proceedings of the October 1994 Hawaii Stream Restoration Symposium, pp. 31-56, Technical Report 96-01.

19. The number of Hawaii beach closures due to pollution from nonpoint pollution and sewage spills has generally increased in the 1990s, with an average of 24 closures per year over the most recent five years for which data are available (1994-1998). Warning signs are also posted such as at stream mouth openings to drain nonpoint source polluted water such as at channelized stream mouths in the Ko'olaupoko District. For more information, consult the Environmental Council and the Office of Environmental Quality Control, State of Hawai'i. (1999). Annual report, environmental report card, 1999, an assessment of Hawaii's environmental health. Honolulu, HI.

20. The approximate doubling of endangered Hawaiian Stilt waterbird numbers at the Nu'upia Ponds from 1982 (60 birds) to present (1999) (130 birds) is documented in official waterbird counts coordinated by State of Hawai'i Department of Land and Natural Resources, Division of Forestry and Wildlife.

21. Marine Corps Base Hawaii has most recently received top Secretary of Defense awards in the areas of overall Environmental Quality (FY 99), Pollution Prevention (F? 98) and Natural Resources (FY95). MCBH has also received the top Secretary of the Navy Natural Resources Conservation Award six years in a row (1992—1998). This has been coupled with associated recognition by the Hawaii State legislature, City and County of Honolulu, nonprofit conservation, civic, and commerce groups.

22. Compton, W., Sgt. USMC. (1997, February 13). Annual mud ops, Nu'upia Ponds get torn up. Hawaii Marine, a weekly newspaper of Marine Corps Base Hawaii, A-4.

23. For further details, see Drigot, D.C. (1999). Mangrove removal and related studies at Marine Corps Base Hawaii. In Department of Defense Legacy Resource Management Program Technical Notes: Case studies from the Department of Defense Conservation Program. Conserving natural and cultural resources on Department of Defense Lands:
Case studies from the DOD Conservation Program (Tech Note M-3N). Available on CDROM through the Undersecretary of Defense, Environmental Security Office, ODUSD (ES) EQ-LP, 1225 Jefferson Davis Hwy, Suite 1500, Arlington, VA 22202, (703) 604-1792.

24. Wilcox, B.A., Guinther, E.B, Duin, K. N, & Maybaum, H. (1998). Mokapu: Manual for watershed health and water quality by Institute for Sustainable Development and AECOS, Inc., for Marine Corps Base Hawaii. Found at the DOD Office of Environmental Security Web site www.denix.osd.mil under public menu/library/water.

25. See, for example, Roman, Y. Pfc, USMC. (1999, April29). Community effort improves K-Bay watershed. Hawaii Marine, MCBH's weekly newspaper, A-6.

26. Dr. William B. Stapp, professor emeritus, University of Michigan School of Natural Resources and world-renown leader in Environmental Education (director of first UNESCO international conference on Environmental Education, 1974) also founded the Global Rivers Environmental Education Network (GREEN) which is working with students in over 130 countries on watershed education through water quality monitoring and related activities. For an overview of GREEN's local and global activities, visit its website at green@earthforce.org or read one of numerous publications: For example, Stapp, W. B., Wais, A., Moss, M., & Goodwin, J. (Eds.). (1996). International case studies on watershed education. Dubuque, IO: Kendall/Hunt Publishing Co.

27. See, for example, Roman, Y., LCpl, USMC. (2000, March 23). Base students 'plant a vision.' Hawaii Marine, MCBH's weekly newspaper, 29(12), 1.

28. Salazar, D. Cpl., USMC. (2000, May 18). Children, community gather to restore, improve the Watershed at Waimanalo. Hawaii Marine, B-2, 2.

29. Earthjustice Defense Fund Honolulu-based representative, Margorie Ziegler, quoted in Gordon, M. (1999, July 10). Military becomes eco-friendly. The Honolulu Advertiser,
A-i.

30. See, for example, Curtius, M. (1999, January 9). San Francisco gives Marines' water games plan the boot. Los Angeles Times, 1.

31. See, for example, Richter, P. (2000, 18 May). Military bases work to be good neighbors—land use: Vieques dispute in Puerto Rico underscores problems installations face in increasingly populated areas. Los Angeles Times.