

NOAA COASTAL SERVICES CENTER

COASTAL CHANGE ANALYSIS PROGRAM EFFECTIVENESS REVIEW

Summary Report

June 27, 2000

ACKNOWLEDGMENTS

The Coastal Change Analysis Program Effectiveness Review was conducted through the efforts of NOAA Coastal Services Center staff and external advisors. A primary aim was to ensure strong internal participation, as well as provide the basis for a comprehensive examination of the program by independent experts.

I am indebted to key Center staff for their contributions, including Tina Drayton, Ellis Godfrey, Don Field, Mark Finkbeiner, Andrea Langley, Donna McCaskill, Anne Hale Miglarese, Gale Peek, and Miki Schmidt. Lawrence Friedl, a presidential management intern, was instrumental in crafting the initial review proposal. Nina Petrovich led the development of the survey instrument and assembled the initial survey findings. Dr. Dorsey Worthy, manager of the C-CAP program, assisted strongly in the coordination of the review process and worked closely with C-CAP technical and management staff to ensure the completion of milestones. Dr. Bud Cross, recently retired as director of NOAA's Beaufort Laboratory, provided expert analysis of materials and participated in the panel review.

To the seven external advisors, I offer special thanks. It was clear from the beginning that the integrity and legitimacy of this effort would depend strongly on an objective voice. I believe that the findings and recommendations of the external advisors in this report are in fact unbiased. Ken Haddad chaired the panel, and was assisted by Thomas Bigford, Dr. Cassandra Coombs, Bryan Logan, Dr. Warren Pulich, C. Dianne Stephan, and Dr. Katherine Taylor.

The C-CAP Effectiveness Review process has been one of significant learning for the Center. The Center is committed to undertaking such program level evaluations to ensure the relevance and impact of activities, and the appropriate utilization of federal funds.

Jeffrey L. Payne, Ph.D.
Deputy Director and
Leader, Center Review Team

U.S. Department of Commerce
National Oceanic and Atmospheric Administration
Coastal Services Center
2234 South Hobson Avenue
Charleston, SC 29405-2413
Phone: 843-740-1200
FAX: 843-740-1297

TABLE OF CONTENTS

ACKNOWLEDGMENTS..... 2

RECOMMENDATIONS AT-A-GLANCE..... 4

I. PURPOSE, GOAL, AND OBJECTIVES OF THE REVIEW 6

PURPOSE 6

GOAL 6

OBJECTIVES 6

II. PROGRAM BACKGROUND 6

HISTORICAL OVERVIEW..... 6

ROLE OF C-CAP 7

DEVELOPING USER CAPACITY 8

C-CAP PRODUCTS 8

CURRENT STATUS 8

III. METHODOLOGY 9

STEP 1 9

STEP 2 9

STEP 3 10

STEP 4 11

IV. CUSTOMER SURVEY RESULTS – C-CAP COMMUNITY: COMPOSITION, USES, AND NEEDS 11

INTRODUCTION AND METHODOLOGY..... 11

NATURE OF COMMUNITY AND AWARENESS OF C-CAP..... 12

PARTICIPATION WITH AND USE OF C-CAP PROCESS, DATA, AND PRODUCTS 13

EXPECTATIONS AND NEEDS FOR HABITAT INFORMATION 16

CUSTOMER EXPERIENCES AND EXPECTATIONS WITH C-CAP 17

V. OBSERVATIONS AND RECOMMENDATIONS OF THE EXTERNAL PANEL..... 20

 A) OBSERVATIONS 20

C-CAP Mission..... 20

C-CAP Approach and Customer Focus..... 21

Outreach..... 22

Program Performance..... 23

Project Selection 23

Research 24

 B) SUMMARY RECOMMENDATIONS..... 24

First Order..... 24

Second Order..... 26

Third Order 26

VI. SELECTED DEFINITIONS AND AVAILABLE DOCUMENTS 27

VII. APPENDIX A..... 28

RECOMMENDATIONS AT-A-GLANCE

The following summary recommendations of the Coastal Change Analysis Program (C-CAP) external review panel result from a cross-comparison and weighting of all input from the panelists in order to determine the areas of strongest agreement. Section V of this report contains a more thorough description of each of the program recommendations, as well as extensive documentation of the observations of the panelists recorded both during the review and subsequent to the review via final written reports. The placement of the recommendations into first, second, and third order reflects a strong demarcation among sets of recommendations.

First Order:

1. ***Determine mission priorities*** – Determine whether the mission is to a) develop a national database of land cover and change information; b) analyze areas of high priority based on management issues or significant rates of change; or c) do both.
2. ***Develop a business plan for the C-CAP program based upon the mission, a clear understanding of the customer base, and the Center’s management objectives*** – A business plan will help define the nature and capacity of the market for C-CAP, the ability of customers to use the information, and the requisite goals, activities, timelines and resources. C-CAP must invest in outreach and user education to better characterize and build the customer base and certify uses. A broad and diverse set of users and collaborators is important for program advocacy and stability. Increasing user community awareness and demonstrating the relevance of C-CAP is essential.
3. ***Standardize and clearly communicate the project selection process*** – Project selection requirements should be clear, unbiased, and consistent to ensure sustainable engagement with collaborators and users. Collaborators are an important link to users.
4. ***Fully define partnership roles*** – Define the respective roles and interrelationships of the Center, data collectors, data providers, data developers, data users, and the private sector. The private sector, in particular, should be involved in business planning development given its wide range of expertise and the rapidly changing nature of remote sensing technology and data streams.
5. ***Support tutorials and applications*** – Expand the user base by documenting and effectively conveying the process, products, and utility of C-CAP. Develop application prototypes and best-practices CD-ROMs, market end-user applications, and provide training focused on management, and technical and non-technical themes.
6. ***Leverage other national efforts*** – Work with other national programs to identify common needs and opportunities for resources.
7. ***Develop program performance measures*** – Develop metrics to assess program processes, outputs and impacts, including techniques for measuring the effectiveness of land use policies. Verify the benefits of capacity building in terms of enhancements to

technical expertise, as well as the use and application of C-CAP information for decision making.

Second Order:

8. *Promote NOAA line office participation* – Encourage broader understanding and support within NOAA of C-CAP data assets and uses.
9. *Describe the future role of the academic community* – Consider cooperative agreements for short-term research to develop creative applications. Support relationships that enable student projects, internships, ship use, and competitive research.

Third Order:

10. *Assess the research needs of the program* – Assess research needs including sensor development, change detection algorithms, scale issues, process modeling, input to ecosystem health assessments and changes to the protocol.
11. *Evaluate Small Business Innovation Research (SBIR) grants as a vehicle to enhance resources*
12. *Participate in the identification and development of new processes and technologies* – Educate customers about new technologies, methodologies, and uses. Work with other agencies and the private sector to explore and validate technical options.

Important Note: Section IV of this report deals with the results from the C-CAP customer survey. In addition to the survey findings, the survey section includes analyses with suggested next steps. This information complements the recommendations of the external panel and should be used by the Center and its Coastal Remote Sensing program to help guide the implementation of the overall program recommendations.

I. PURPOSE, GOAL, AND OBJECTIVES OF THE REVIEW

Purpose

The NOAA Coastal Services Center is committed to evaluating its programs, projects, and processes to ensure customer relevance and impact, internal efficiency, the wise utilization of funds, and continuous improvement. During 1999, the Center conducted its first comprehensive program-level evaluation, focusing on the Coastal Change Analysis Program (C-CAP).

C-CAP is designed to monitor change in terrestrial land cover and nearshore benthic resources within coastal environments, using remote sensing and in-situ techniques. C-CAP seeks to develop the capacities of state and local coastal and marine resource managers to more effectively develop and apply this information.

C-CAP is the Center's most mature program, having originated as a federal research effort. It is now funded as an operational program within the Center. In commissioning the review, Center management was interested in acquiring the information needed to assess C-CAP's effectiveness and, if warranted, consider changes to the program's mission, strategic approach, user base, product line, or funding.

Goal

Identify and implement actions to ensure C-CAP is relevant and responsive to the needs of users

Objectives

- 1) Examine the mission and effectiveness of C-CAP
- 2) Develop a strategic view
- 3) Ensure C-CAP pursues appropriate government functions and partnerships

II. PROGRAM BACKGROUND

Historical Overview

The concept of using the archive of civilian satellite imagery for large area coastal change analysis that was eventually to become C-CAP began in the 1980s. The initial prototype was a land cover classification extending from Cape Cod to the Chesapeake Bay, derived from Landsat Multi-Spectral Scanner (MSS) satellite imagery, focused on emergent wetlands and uplands.

In 1990 the effort was named C-CAP (originally the Coastwatch Change Analysis Project, now the Coastal Change Analysis Program) and received its first substantial funding from NOAA's Coastal Ocean Program (COP) under Dr. Donald Scavia. Dr. Ford Cross, formerly director of the NOAA Beaufort Laboratory, became the C-CAP manager. An initial task was to prepare a

standardized set of protocols that could be used throughout the U.S. to develop consistent and reliable coastal change information. This was accomplished through a series of regional workshops and prototype projects. The resulting peer-reviewed document, “NOAA Coastal Change Analysis Program (C-CAP): Guidance for Regional Implementation” (Dobson et al., 1995) is a cornerstone of the C-CAP effort.

In 1994, C-CAP was included as a program of the newly established NOAA Coastal Services Center in Charleston, South Carolina. Dr. Dorsey Worthy, formerly manager of the Environmental Protection Agency’s Digital Remote Sensing Research Program, was given the charge to establish an operational C-CAP program at the Center. From 1995 through 1997, the operational component of C-CAP worked closely with the Beaufort Laboratory and Oak Ridge National Laboratory to complete projects in Alaska, the Columbia River Estuary, and central California. The first land cover change detection effort fully funded and managed by the Center, a cooperative effort with the South Carolina Department of Natural Resources, was initiated in 1995. Since that time, C-CAP has initiated new projects, including benthic mapping, in Massachusetts, Virginia, Oregon, Washington, Hawaii, Florida, and the U.S. Virgin Islands. Overall management of the program was formally transferred to the Center in 1997.

The following table lists C-CAP funding levels and sources since project inception in 1981.

Time Interval	Source	Funding Level
1981-1989	NOAA NMFS	\$ 189K
1990-1994	NOAA COP & OCRM	\$3,771K
1995-2000	NOAA CSC, NIMA	\$5,210K

Role of C-CAP

Satellite and aerial imagery provides coastal resource managers with the ability to monitor large expanses of land and near shore habitat. C-CAP harvests the information within the archive of imagery from the Landsat satellites and combines this with air photo- and in-situ-based inventories of benthic habitat to document baseline conditions. By comparing images over time, users can determine trends and develop a correlation between changes in land cover and changes in estuarine and marine ecosystems. The combination of land and near shore maps, developed in accordance with the C-CAP protocol, makes C-CAP arguably the nation's most directed, consistent, and accurate developer of satellite and aerial imagery to characterize coastal resources.

C-CAP serves to collect, document, analyze, and transfer this information, and produce useful products for coastal decision making. Image-derived land cover data provide a broad spatial context to inform land use planning, permitting, and monitoring decisions. This type of synoptic information is becoming more important within coastal areas as populations and the pressures of development increase. Some organizations use C-CAP data as a base map to determine the extent of various habitats in an area of interest. Others use the data for management applications, such as the U.S. Fish and Wildlife Service in Portland, Maine, which incorporates the data into models to examine the effects of forestry on salmon spawning habitat. C-CAP data also serves

to complement other data sets to support resource management decisions. Due to the limitations of scale and the preferred rate of repetition, C-CAP land cover data may not be as useful for some local applications, where more detailed and timely information is often needed.

Developing User Capacity

During C-CAP's history, a user community has developed with a wide range of technical expertise. With the first land cover products, only academic institutions and a few state agencies had the geographic information system (GIS) expertise or computer capabilities to handle the large databases. With the proliferation of fast computers, user-friendly software and a more extensive pool of personnel trained in the spatial technology sciences, many county-level agencies can now utilize these data.

There is a two-fold value in developing C-CAP data products for the coastal community. The information itself is important for mapping coastal landscapes and seascapes, and examining dynamic change. But the process of C-CAP data development also involves fostering an understanding of spatial data within state, regional, and local resource management agencies. C-CAP typically strives to identify states with critical landscape habitat or living marine resource issues, then identifies individuals within appropriate organizations with the abilities to perform the image and spatial analysis tasks involved in creating land cover and benthic habitat maps. Working directly with organizations and individuals at the state or similar organizational levels promotes the transfer of remote sensing understanding and technology skills. Partners are able to access, work with, and derive value from the great range of remote sensing imagery and other spatial information that is becoming available.

C-CAP Products

C-CAP has produced a variety of products targeted at a wide range of users. One of the most widely distributed products is the C-CAP protocol. This document summarizes C-CAP procedures that are used by scientists throughout the U.S. to develop consistent and reliable coastal change information. The most advanced C-CAP products to date are CD-ROMs that have been produced in cooperation with other program areas at the Center. These CD-ROMs contain the C-CAP land cover change data along with other remotely sensed data, GIS information, and scenarios showing potential use of these data. Another product that the program is beginning to employ is the data CD. These products contain the C-CAP data sets (including field observations) and a very limited set of reference raster, vector, and textual data sets to provide context for the C-CAP data. Other C-CAP products include land cover and benthic maps (digital), and land cover and benthic change maps.

Current Status

Based on the results of a recent Center-wide management review, the Center has consolidated its two primary remote sensing programs. C-CAP and the Coastal Remote Sensing Program are now combined under a single management structure. This action is designed to result in management and administrative efficiencies, improved collaboration between the two former programs and with other Center programs, and the general strengthening of the scientific and

technical resource base for conducting a focused remote sensing activity. The changes will enable the Center to be more flexible and responsive to the remote sensing needs of the coastal management community. The combined program is termed Coastal Remote Sensing (CRS).

The Center and the Coastal Remote Sensing program will continue working to develop baseline land cover and benthic habitat information for coastal areas of the U.S., and develop trend information in certain geographies. C-CAP, as a part of CRS, is supporting the development of this information at the state and local level by conducting data analysis, developing protocols and applications, and helping partners incorporate information into the decision-making process. The program is evaluating the technical and resource implications posed by the availability of new commercial data streams and the growth of service-based remote sensing companies. The Center and the program are also examining means to ensure both a consistent funding base and the necessary partnerships for long-term success.

III. METHODOLOGY

The C-CAP review process involved four key steps:

- ❑ Step 1: Certification of goals, objectives, and methodology
- ❑ Step 2: Survey of user community and collection of background information
- ❑ Step 3: Convening of an independent expert review panel to examine the program and provide recommendations on future directions
- ❑ Step 4: Synthesis of information for final management decisions and implementation

Step 1

A “Proposal of Plan and Activities” (March 1999) was developed to document goals and the process for the entire review. This activity was conducted through an internal review team with leadership from the Center’s deputy director and the C-CAP program manager. The team was selected for experience in management, policy, evaluation, and the C-CAP program. The proposal included information and guidance on the purpose and structure of the review, proposed goals and objectives, information collection requirements and techniques, schedule of activities, purpose and composition of the Review Panel, and required fiscal and staff resources.

Step 2

Information was collected from a variety of sources to address specific goals of the review. An Office of Management and Budget (OMB) approved survey was conducted to solicit input from the current user community. In addition, information was collected from a broader audience of coastal resource management organizations through a related Center-level survey to contribute to an assessment of the needs of potential clients. Other categories of background information were developed by the internal review team: C-CAP history; C-CAP strategic view; authorizing language and directives; state and territory coastal program emphases; interagency activities; public and private partnerships; and C-CAP project summaries.

Step 3

An independent external panel was assembled. Panel membership was designed to achieve a balance of perspectives, expertise, and diversity. The panel included knowledge of national and state remote sensing directions, technologies, and information sources; state and local capabilities and needs; coastal science and management issues; technology policy; commercial sector capabilities; and strategic management. An extensive briefing book was prepared for the panel, and a formal review was conducted at the NOAA Coastal Services Center on December 14 and 15, 1999, in Charleston, SC. The panel prepared an initial set of observations during the review, and then followed up with individual reports of their final findings and recommendations, in January 2000.

C-CAP Effectiveness Review External Panel:

- ❑ *Thomas Bigford*, chief, Habitat Protection Division, National Marine Fisheries Service
- ❑ *Dr. Cassandra Coombs*, Department of Geology, College of Charleston
- ❑ *Ken Haddad* - panel chair, Director, Florida Marine Research Institute
- ❑ *Bryan J. Logan*, chairman and CEO, Earth Data International of Maryland, L.L.C.
- ❑ *Dr. Warren Pulich*, Resource Protection Division, Texas Parks and Wildlife Department
- ❑ *C. Dianne Stephan*, habitat coordinator, Atlantic States Marine Fisheries Commission
- ❑ *Dr. Katherine L. Taylor*, director, Columbia River Estuary Study Taskforce

In preparation for the review, and in support of the primary objectives, the panel was asked to consider the following questions that are key to the Center's interests:

1. How should the mission, key goals, and implementation strategies of C-CAP be adjusted to meet user needs?
2. How can products and services be improved, including the framework for project selection, outreach and communications with partners, and delivery? What criteria should the Center use to select new C-CAP projects, and what issues should be considered in establishing priorities? Is there a new potential customer base that C-CAP is missing?
3. How can the Center better inform the public about C-CAP?
4. What research emphases are needed to extend the C-CAP protocol? What are the opportunities for new remote sensing techniques that may aid C-CAP in fulfilling its mission?
5. How can C-CAP work effectively with states to develop their capacities, and with the federal, private, academic, and nongovernmental organization communities to increase

support? What are the proper government roles and activities for C-CAP, and what is the appropriate relationship with the private sector?

6. What targets of opportunity exist for C-CAP to partner with other agencies to leverage resources, reduce overlap, and support mutual objectives?
7. What performance measurement techniques can be used to evaluate objectively the relevance and impact of C-CAP? Should NOAA use C-CAP as a major tool to judge the effectiveness of coastal land use policies as required by the coastal zone management program?
8. Should C-CAP invest sufficient resources to complete a nationwide baseline classification of land cover and submerged habitats, or prioritize efforts in key watersheds and geographies to accomplish more timely change analysis and process understanding? How can the Center foster the use of C-CAP land cover and benthic data for ecological process modeling?
9. According to the survey results, there appears to be a gap between the customer's need for change information to support management decisions and their use of that information for decision making: Is this an issue of targeting a different audience? Or, should C-CAP invest resources in developing applications of the data and tutorials to illustrate how the data can be used?

Step 4

A synthesis of all information was prepared. Initial observations of the panel during the two-day review were combined with individual written reports from each panel member, and other information collected during the review to produce a final set of recommendations for approval by Center senior management. Much of the basic information collection and analysis in support of the review can be found in the panel briefing book, "C-CAP Effectiveness Review: Briefing for External Panel," including the detailed results of customer surveys. The minutes from the two-day panel review are available in the document "C-CAP Panel Consolidated Minutes." Final written reports from each panelist also are available, with the permission of the author.

IV. CUSTOMER SURVEY RESULTS – C-CAP COMMUNITY: COMPOSITION, USES, AND NEEDS

Note: The following narrative is based on the results of the 1999 C-CAP Customer Survey. For direct information on the tabular data results for each of the twelve questions in the C-CAP survey, see Appendix A of this report.

Introduction and Methodology

Questionnaires for the C-CAP Customer Survey were distributed to 168 individuals representing a variety of organizations. Individuals were selected based on either their participation in the development of C-CAP data and products or their receipt of a CD-ROM or other product. In

accordance with the Paperwork Reduction Act, the C-CAP Customer Survey underwent review by OMB to ensure redundancy was avoided and the burden of response for clients was minimized. Eighty-seven (52%) usable responses were received from the C-CAP survey. These responses form the majority of the following findings and analysis.

In addition to input from direct users of C-CAP, independent information was collected from a broader audience of coastal zone management programs through a separate Center-level Coastal Resource Management survey. Questions addressed by the Center-level survey contribute to the assessment of needs of potential clients, and help identify gaps between the current and potential uses of C-CAP products. Selected information from the Center-level survey is included in this section, but is clearly identified as such.

The C-CAP customer survey was developed as an evaluation tool with four objectives:

- Define the nature of the C-CAP user community and how the community develops an awareness of C-CAP
- Understand how the user community participates with and uses C-CAP processes, data, and products
- Document user community expectations and needs for habitat information
- Document customer experiences and expectations with C-CAP

The following subsections include both findings and analyses in support of these four objectives. The analyses include recommended follow-up actions. This information complements the recommendations of the external panel, and should be used by the Center and the Coastal Remote Sensing program to help guide the implementation of the recommendations.

Nature of Community and Awareness of C-CAP

Findings

All C-CAP customer survey results are broken into six categories (customer groups) representing the respondent's affiliation: 1) academic institutions; 2) federal offices; 3) state offices (including coastal zone offices, resource agencies, and protected areas operating at the state level); 4) local offices (including county and regional planning offices); 5) nongovernmental organizations (NGO); and 6) private companies. The percentage breakout for each group follows: academic (32%); federal (14%); state (35%); NGO (2%); local (9%); and private (8%). NGOs, due to their low response, are not included in the following results. Note as well that direct comparisons of tendencies among groups cannot be conducted with any statistical relevance, due to the skewed nature of the respondent profiles.

With the exception of academics, the majority of respondents indicate that they participate in resource management either as a resource manager, support staff, or technical specialist. Awareness of C-CAP is largely gained through user education efforts such as workshops and Center staff presentations (presentations are a highly consistent means for building awareness across all customer groups). With the exception of federal offices, participation with a protected area such as a National Estuary Program or National Estuarine Research Reserve is also an

effective way to facilitate awareness and involvement (13% to 25%). Participation with a state office is useful for building awareness among state and local offices and private companies. Academics show the highest level of involvement with C-CAP through partnering with universities. Advertising through the *Federal Register* and the Internet, or partnering with the private sector or an NGO, are not as effective in promoting awareness.

Analysis

The C-CAP survey was delivered to users who either were substantially involved in the development of C-CAP data and products or received a product. As a result, information was not solicited from a larger community of potential users that might be served by C-CAP. As indicated above, the majority of respondents fall into the academic, and federal and state resource agency categories (total of 81%). This indicates groups such as NGOs, local offices, and the private sector have not been as involved with C-CAP, suggesting a potential for expanded collaboration.

Information from the Center-level Coastal Resource Management survey should be integrated with the focused results of the C-CAP survey to gain an improved understanding of the broader potential customer base. Given the way respondents describe their positions in the C-CAP survey, the roles of policy maker, planner, and local resource agency staff appear underrepresented. This constitutes a potential target audience.

In addition to proven means of building user awareness of C-CAP through presentations and workshops, the Center should seek to increase awareness and involvement through a comprehensive plan that stresses multimedia, user education, partnerships, and customer focus groups. Given the current low value of the Internet in creating awareness, the Center should explore ways to develop additional audience exposure to C-CAP through this mechanism, perhaps with enhanced profiles of products, applications, and services. Collaborators are also an important mechanism for educating potential users.

Participation with and Use of C-CAP Process, Data, and Products

Findings

Participation with C-CAP varies considerably between groups. Academics tend to be more involved in the use of C-CAP data and the protocol than in data development. State, federal, and local offices tend to be as involved in the development of C-CAP information (by providing GIS and field support) as in applying the data and protocol. Local offices and private companies have slightly more involvement in creating benthic habitat maps than other groups. Private companies provide the least field support among groups, but have more involvement in using C-CAP data and creating land cover maps. Local, state, and federal offices have the highest involvement with C-CAP for facilitating resource management applications.

Land cover maps are the most consistently and frequently used information product across all customer groups. The protocol is used frequently by all groups except local offices. Benthic habitat maps are most commonly used by local offices—at two to three times the rate of any other

customer group. Change images are in highest demand by federal, private, and state groups. Tabular summaries are used rarely by any group, with the exception of local offices.

For CD-ROM products, the Columbia River CD-ROM and San Francisco Bay CD-ROM are more commonly used than any others, with the highest use occurring among state, local, and private groups (15% to 23%). The combined use of CD-ROMs by federal offices and academics is relatively low (averaging 4% and 7%, respectively).

Some interesting trends emerge from a review of the use and application of C-CAP data and products. Use can be divided into three general categories: 1) *direct use* such as for baseline benthic and land cover data and monitoring changes over time; 2) *applied use* such as for teaching or outreach; and 3) *management use* such as for measuring development, assessing resource health, planning land use, and making resource management or permit decisions.

For example, although most respondents categorize themselves as resource managers and staff supporting management offices, the groups ranked the use of C-CAP data and products for resource management decisions very low (zero to 5%, with the exception of local offices which responded at 13%). The use of C-CAP for measuring development, land use planning, assessing fish and wildlife health, and assessing watershed health ranges from zero to 13% across all groups. The use of C-CAP information for permit decisions, with the exception of federal offices, is uniformly low. The highest and most consistent management use across all groups (excluding private companies) is for assessing watershed health, an average of 10%. The survey data indicate that private groups do not use C-CAP for any management purpose, except land use planning.

Overall, C-CAP information is used most frequently for direct purposes, such as establishing baseline benthic and land cover information and to monitor changes in cover. Federal, state, and private offices are the highest users of baseline land cover information. Private companies and local offices use C-CAP proportionally more for baseline benthic habitat information than other groups. With the exception of the private sector, consistently strong use of C-CAP information across all groups occurs for monitoring changes in cover.

Academics use C-CAP for teaching purposes more than any other group (the private sector is the second most frequent user). Local offices use C-CAP as an outreach tool for local government and for resource agency staff more than any other group. State and federal offices use the information for these purposes at about half this rate. C-CAP information is not used for marketing by any of the customer groups.

Analysis

The Center should seek to understand why some customer groups report low rates of participation with, and use of, certain C-CAP components and products. For example, the survey data indicate that federal and state offices are rarely involved in creating land cover and benthic habitat maps, and rarely use benthic habitat maps. However, it is a historical fact that every C-CAP land cover and benthic habitat project has had state-level participation. Respondents representing local offices do not create land cover maps, have a very low rate of participation

with C-CAP through the use of the protocol, and are infrequent users of change imagery. CD-ROM use by customers appears to be influenced by population density in the geographic area of coverage. There are consistently few federal users across the range of CD-ROM products. These results could be influenced by several factors, including how the different groups approach the use of C-CAP data, their need for the products, the scale at which C-CAP products are useful, the general volume and geography of available products, or the underlying capabilities to work with the data. Currently, there are no benthic habitat data products, and there is no Web-based dissemination mechanism for either land cover or benthic data. These factors, compounded by the lack of sufficient funding to fully establish a national baseline and make the product more visible, might explain the low use of the data and products. These are all areas of opportunity for further Center investigation.

According to the data on how groups apply products, C-CAP information is being used more often to develop baselines and monitor changes than to make resource management decisions, plan land use activities, or assess watershed and fish and wildlife health. The very low use of C-CAP for land use planning, measuring development, and permitting is of interest given that C-CAP would be expected to be a significant resource for these needs. The results for permitting, in particular, are puzzling due to the fact that three out of seven benthic projects incorporate the data directly in various permitting processes, such as Clean Water Act Section 404 regulations and shellfish lease management. Part of this broader issue of management use may be a function of how easily or effectively the customer can interrogate C-CAP information. For example, past Center survey results show that ArcView® is the most common GIS technology in use by the coastal management community. However, users cannot even query the screen with a C-CAP product in ArcView® (i.e., it is not possible to tell if one pixel is pine forest or salt marsh). Such a query can be accomplished with ArcView Image Analyst by converting the data to a grid format, but this significantly increases the cost to the user, and not all offices are so equipped. Thus, a real constraint may be that the coastal management community does not have all of the necessary tools or image processing skills to use C-CAP information effectively.

The relatively low use of C-CAP as an outreach tool by all except local government suggests an unfilled potential public education niche. It could be that those responsible for making decisions are not primary users of C-CAP, or that there currently is an insufficient understanding of how C-CAP information can be applied for management needs.

All of these findings are especially relevant given information from the Center-level survey indicating that state and coastal zone management agencies manage habitat through two principal means: 1) permit authority and land use planning; and 2) interagency coordination and public education. From this same survey, respondents were asked what information or technical resources contribute to decision making. Fifty percent of coastal zone management agencies and forty percent of state agencies rank as highly important an enhanced ability to interpret and apply spatial data and imagery for decision making. The seeming divergence between the actual use of C-CAP information for management purposes and the results of the Center-level survey suggests that more information is needed to understand how C-CAP can be applied to address an apparent market need.

Expectations and Needs for Habitat Information

Findings

The second section of the C-CAP customer survey addressed user needs. Questions were asked to determine what habitat cover information is being used, the preferred scale of this information, and the preferred time frame of the change analysis.

In addition to C-CAP data, each group uses several other sources of data to measure land cover—largely existing state and federal databases. Academics, federal offices, and private companies commonly use other federal data sets. State offices use other state data most often and federal and university data at a lesser rate. Local offices proportionally use more existing commercial data and distribute their use of alternate data more evenly than any other group. A clear feature of these results is that very few groups use C-CAP exclusively as their source of land cover data.

The results shift in the case of benthic habitat data. Much larger proportions of each group use no other source of data than C-CAP. When other sources are available, private companies exclusively use commercial, state, and university databases. Compared with the utilization of other sources of land cover data by respondents, the relative incidence of nonresponse in the use of benthic data is higher among academics and federal and state offices, indicating that a number of the respondents likely have had no involvement in benthic projects. Federal offices use state, federal, and academic data sets most commonly. Local offices use the most diverse sources of benthic cover data of all groups, although the sources are mostly private and state databases.

All groups rank the watershed as the preferred geographic scale for habitat cover and change data, although several other boundaries are recommended depending on user group—especially state and county scales. In general, the user's range of preferred scales appears to conform to the particular scope of authority or interest. For example, federal groups, with a desire to assess impacts on a national and regional level, prefer watershed, state, and satellite scene scales. Local offices, with requirements for more detail, prefer watershed, county, and municipality scales. Overall, the frequency of additional responses beyond the watershed scale, in addition to some written responses, suggests that customers want local political boundaries included at all scales.

The clear preference among users for a temporal scale for change detection data is five-year intervals, with the exception that local offices prefer a one-year interval.

There is significant interest in C-CAP-related training, particularly in field verification (33% to 86%) and the interpretation of aerial photography (42% to 88%). State and local offices and private companies want training in ArcView® GIS (57% to 63%) and image processing techniques (50% to 63%). Basic GIS is least desired among all groups, except academics.

Analysis

According to results from the Center-level survey, of a range of spatial data sets used by state and coastal zone management organizations, land cover/land use maps and change maps rank the

highest in terms of those data sets considered very useful. This seems to affirm the potential usefulness of C-CAP. However, an important question concerning the use of land cover data sets other than C-CAP by customer groups is how these data sets are applied. Are the data used as a complement to C-CAP to deal with gaps or problems of resolution, or as an exclusive data source for addressing certain issues? Although the C-CAP survey reveals that very few groups use C-CAP exclusively as their source of land cover data analysis, this is not surprising considering both the limited coverage of C-CAP, and the fact that managers would be expected to reach out to multiple sources of information to make decisions.

For benthic habitat data, the discovery that larger proportions of each group use no other source of data suggests that C-CAP is filling a market need, or that few other sources of data exist. As with land cover data, local offices reach out to alternate sources, implying their needs and authorities are perhaps different than federal and state resource managers. It would be useful to have information on how customer groups are using other benthic data sources, and their nature.

As noted in the findings, the scope of authority of each user group appears to correlate with a preferred range of geographic scales. However, all groups identify the watershed as the single most useful scale. In part, the watershed may serve as a commonly desired framework data set or basis for conceptual management. This seems especially apparent with local offices, which prefer the watershed scale (at a higher rate than any other customer group), but also have a considerable interest in the county and municipal scales; and with private companies, which have no regulatory authority yet prefer the watershed scale. It is important for C-CAP to understand how differences in geographic or political scale affect user interests. This information should be helpful in determining how to address multiple user needs most effectively, and is essential to the development of partnerships that may transcend geopolitical boundaries.

C-CAP should also seek to understand better how user needs are affected by the temporal scale. Although the majority of respondents prefer a five-year interval, the finding that local offices prefer a one-year interval, and private companies have some interest in a single date within three years, suggests that these groups have different requirements for the timeliness of information as compared to academic, federal, and state users. These different requirements indicate that these groups may be dealing with different management issues or approaches as well.

The data on training interests reveal that the Center should focus training on state and local offices, where there is highest demand. For just these customer groups combined, the relative interest in training (average from high to low) is for interpretation of aerial photography, ArcView® GIS, image processing techniques, field verification techniques, and basic GIS.

Customer Experiences and Expectations with C-CAP

Findings

The last set of questions in the survey pertain to the user's experience with the C-CAP process—accuracy, use of the protocol, expectations, guidance from staff, and application to coastal resource management. The responses provide further information about the use of C-CAP data and products, and information to guide potential future services.

The rates of those respondents indicating that they do not know the relative accuracy of C-CAP products is relatively high (25% to 43%, with the exception of federal offices at 8%). However, no one surveyed said that results were inaccurate. Of those who did respond, the relative accuracy ranks predominantly as generally accurate (29% to 42%). Compared with other groups, local offices rate C-CAP products as very accurate (25%). Federal, state, and local offices respond most frequently that accuracy varies with product.

The level of nonresponse for the series of questions dealing with customer needs and expectations increased significantly: an average of 32% for academics, 32% for federal offices, 27% for state offices, 38% for local offices, and 59% for private companies. These figures, combined with the fact that “not applicable” also was frequently marked, may indicate that either these respondents had not extensively used C-CAP products or have not been involved in product development. For all groups, the number of individuals opting not to respond changed from question to question, indicating either an unwillingness to respond or the need to have more options than “agree,” “neutral,” “disagree,” and “not applicable.”

Overall, those who did respond to this series of questions agree with the statements made—some more strongly than others. Most notable is that all groups strongly agree that partnerships are an effective means for building capacity. Federal and state offices hold this opinion most strongly (75% and 53%, respectively). Agreement with statements about C-CAP meeting needs, expectations, guidance, timeliness, and contribution to resource management responsibilities vary from group to group.

There is good agreement across all groups that the protocol is easy to follow (23% to 54%). However, there is variability among respondents concerning whether they will be able to apply the protocol without additional assistance. Academics and private companies agree most strongly that additional assistance is not needed (32% and 29%, respectively). Within local offices, there is zero agreement that additional assistance is not needed, and federal and state offices are neutral on the subject (25% and 17%, respectively). A number of written suggestions for improvement relate to the need and process for modifications to the protocol.

Of those who responded, there is general agreement that customers receive sufficient guidance from C-CAP staff. This opinion is strongest among academic and federal users. Local offices are evenly divided between agreeing or disagreeing that staff assistance is sufficient. The level of nonresponse for this question ranges from 30% for state offices, to 57% for private companies.

Among the groups, overall agreement that C-CAP meets needs ranges from 30% to 43%, while agreement that products meet expectations has a much broader range (14% to 50%). Only academics and state offices express an opinion that C-CAP does not meet needs (7% and 3%, respectively), and 17% of federal respondents are neutral on this subject. The highest level of disagreement with the statement that products meet expectations is from federal offices (8%) and academics (7%). The level of nonresponse for both these questions ranges from 27% to 71%.

There is agreement that products are produced on a timely basis among federal, state, and private groups. The most disagreement concerning timeliness occurs among academic and local users, although those that disagree are about half the number that agree.

Most offices are in general agreement that C-CAP helps them meet their resource management responsibilities (range of 14% to 38%). Federal offices show the highest level of neutrality on this subject (25%). Local and state offices have the highest rate of agreement (38% and 37%, respectively). Only local offices record any disagreement that C-CAP products contribute to resource management responsibilities (13%).

Additional written comments and suggestions from respondents for improvements to C-CAP address availability and uses or applications of data (8); integration of specific types of data (7); changes in resolution to meet local needs (7); need to increase or better manage local partnerships (5); timeliness of product completion (4); accuracy of data (3); consistency in funding (3); updating the protocol (3); and the coverage or extent of C-CAP projects (3).

Analysis

A clear strength of the C-CAP program, both real and advertised, is its accuracy. However, as the survey data indicate, a high percentage of respondents are unable to rate product accuracy. This result could signify that the respondents are unfamiliar with other methods of assessing land cover and therefore have no way to determine relative accuracy, or may indicate an unwillingness or inability to rate the accuracy of C-CAP for other reasons. For example, in a national program such as C-CAP, the majority of program participants and respondents may have little ability to comment on the accuracy of any given product unless it is in their area. Further, some users may simply use the data without considering accuracy. C-CAP might investigate how the improved documentation of accuracy could be achieved and communicated to all users, such as through a metadata record. In terms of building a stronger and more diverse market for C-CAP, the program should understand how customers value the higher accuracy that C-CAP provides in comparison with other mapping efforts.

The protocol is a critical component of the C-CAP process. Although most customer groups agree that the protocol is easy to follow, state offices rank lowest in this assessment (only 23% agree, with 10% disagreeing). C-CAP should clarify the concerns this particular customer group has with the protocol, considering that states have been a primary target audience and partner. In addition, C-CAP must understand why there is less agreement among all user groups that the protocol can be applied without further assistance, especially with local offices (this is an important issue, given that local offices agree strongly that C-CAP meets their needs and expectations). In general, it seems that the groups in strongest agreement that the protocol can be applied without additional help are those with perhaps the greatest resources and experience—academics and the private sector. Consistent with this result is the finding that both local and state offices, compared with other customer groups, agree less strongly that they receive sufficient guidance from C-CAP staff. If this is indeed a resource and expertise limitation, C-CAP should consider targeting these user groups in capacity building efforts.

It is encouraging that, for those who responded, C-CAP strongly meets customer needs. Although there is greater variability in how well C-CAP products meet expectations, the generally good level of agreement suggests that C-CAP is performing well. For these two questions, the Center should gain insight on why there are high levels of nonresponse across all user groups, as well as moderately high opinions of neutrality among academics, federal offices, and private companies.

Another measure of effectiveness is timeliness of production. Written comments from a number of survey respondents include the need for C-CAP to be clearer about the resource commitment necessary to complete projects, and more prompt with the delivery of products. Based on experience to date, C-CAP should attempt to document the time needed to produce basic products, as well as identify and estimate the impact of external factors that may affect product delivery. These actions will enhance partners' understanding of the requirements involved in coordinating with the program.

The finding that most offices agree that C-CAP helps them meet their resource management responsibilities seems inconsistent with earlier results concerning how respondents use C-CAP data (recall that only 13% of local offices claim to use the data for resource management decisions; all other offices report even less or zero use in this category). In order to understand better how C-CAP products contribute to resource management, the Center and C-CAP should ensure that outreach and user education efforts distinguish the nature and extent of users' resource management authorities and responsibilities. For example, the fact that 25% of federal respondents expressed a neutral opinion on this question may reflect the degree to which federal offices directly manage resources compared to state and local offices.

V. OBSERVATIONS AND RECOMMENDATIONS OF THE EXTERNAL PANEL

This section combines the findings of the panel recorded during the review with the written reports of the panelists submitted following the review. It is important to note that the *observations* represent both individual panelists' opinions, as well as more commonly held views among the group. Thus, the observations reflect direct comments, and are not biased toward either majority or minority views (i.e., all comments are recorded). For the *recommendations*, however, the Center has performed a cross-comparison and weighting of all input from the panelists in order to determine the areas of strongest agreement.

A) Observations

C-CAP Mission

- ❑ Currently, C-CAP has a two-fold mission: develop a national database of benthic habitat, land cover and land change, and analyze areas of high priority based on resource management issues or significant rates of change. These missions require separate approaches, and attempting to do both without sufficient resources disadvantages both. Which mission is the priority?

- ❑ If the mission is to complete a national database, C-CAP must develop a business plan, schedule, and resources for accomplishing the mission. The business plan should be based on an understanding of the market for C-CAP—both existing and potential. Planning will either reveal that there is no need for C-CAP and it should be terminated, or highlight an approach to reach the full user community, including any necessary changes to the protocol. In this scenario, methods and incentives for partnering with states and others need to be re-evaluated. Partnerships with the private sector and academia must be explored. The Center should consider retaining a planning consultant to guide this document to completion.
- ❑ If the mission is to support priority projects based on management issues or high rates of change, available resources, and technical capability, C-CAP can continue its current approach, but should modify the project selection procedure. In this scenario, methods for developing the capacity to use the information need to be incorporated, not just for developing the technical data processing capability within an agency.
- ❑ It is important to consider the benthic and the land cover categories individually. The land cover data is very useful at a regional and national scale. It would be ideal to have national benthic coverage as well, but there is good reason to consider targeted areas for submerged lands analysis.

C-CAP Approach and Customer Focus

- ❑ There is a difference between collaborators and users. C-CAP has worked primarily with collaborators, focusing on data development. There has been little emphasis on the end uses of information, so data development is dictating outcomes. Ideally, use should drive the parameters of development. Users provide a value-added set of requirements and ensure relevance.
- ❑ Change information is important at local, regional, and national levels. No one else provides it at the scale, accuracy, and cost of C-CAP. Benthic characterizations are very useful; the fishery management councils need such information for essential fish habitat identification. However, despite enthusiasm and potential, a significant user base is lacking. Potential users may include a large range of people, including nontechnical. For example, NGOs are decision makers at the local level, yet are largely untapped as customers or partners. They influence government to make choices by affecting public opinion. To strengthen awareness and impact, the C-CAP data sets, products, and applications already developed should be shared with a much broader audience for new uses. The Center can tap the power of diverse partnerships and develop mechanisms to ensure that collaborators have the information they need to educate local users.
- ❑ C-CAP should focus more attention on product type. C-CAP products should be integrated with other products of the Center, and applications developed that demonstrate uses. In addition, the current emphasis on states is too narrow. While C-CAP cannot be responsible for developing products for all users, the Center should have the capability to understand potential applications for different client needs and consider these during data development. It may be necessary to re-evaluate the classification and nomenclature currently being used.

- ❑ The Center should promote partnerships with private sector collaborators to enhance data development and accelerate the completion of the national baseline. The Center can coordinate, package, and market C-CAP data and applications, but should not necessarily develop all data. In this role, the Center can ensure that the user community (existing and yet to be established) understands the program's value and decision-making potential. These types of partnerships can create advocacy for the program. As it stands, the private sector has no incentive to support C-CAP because it receives no return on investment.
- ❑ The development of capacities within states should focus on using and applying C-CAP data for decision making, not just for building technical expertise. C-CAP needs to develop an effective tool or filter to discriminate the customer's need for change information in decision making versus their actual use of that information for decision making. Integrating C-CAP data with management decisions is not as common as would be expected. Part of the answer may lie in the current approaches to land management at state levels, such as the lack of state synoptic view land management plans or strategies. Partnerships with networked coastal management programs could greatly facilitate information flow within a state.
- ❑ The utility of C-CAP will benefit from an approach that identifies, articulates, and is responsive to the needs of its users. Due to the client base it targets, the C-CAP customer survey does not provide conclusive information on how C-CAP is, or can be, used within a community. The survey respondents are a limited group. The Center must use additional information to identify the C-CAP potential users before completely establishing the direction of C-CAP.

Outreach

- ❑ There are two levels of outreach that C-CAP lacks—educating users about products and building awareness about value. In terms of user education, more work should be done on the development of applications and understanding the nontechnical uses of C-CAP information. This would not necessarily have to be done within C-CAP, but does need to be a focus of the Center. C-CAP also needs more assistance from the Center in building awareness with potential client groups. Technical staff should be free to focus on the technical vision.
- ❑ Active documentation is also important for establishing use patterns. In some cases, users of the data have obtained it either directly from the CD-ROM or through secondary sources and have no contact with C-CAP or the Center. Data partners in each region should be able to help identify these other users of the data who have likely had little contact with the program. This requires active outreach and sustainable partnerships.
- ❑ An increased understanding of the uses and applications of C-CAP for decision making should result in more support from user groups. Options include holding applied workshops; presenting products and applications at major conferences (such as the NOAA Office of Ocean and Coastal Resource Management's program manager and regional meetings and the National Marine Fisheries Service's habitat managers meetings); increasing product visibility

(place mats of change maps); developing best practices CD-ROMs; and sponsoring a low-cost student competition within universities for the development of creative applications. In addition, new tutorials that exhibit, for example, management applications should be developed by the Center and built into the CD-ROMs.

- ❑ C-CAP is producing change analysis maps that are useful for the general public, not just state agencies. Put these maps and data sets in schools, museums, libraries, and on the Web to let the public see what is happening in the environment. Share these very visible analysis tools with the media (*National Geographic*, *Weekly Reader*, and the *New York Times*). Highlight the program for a month on the NOAA Web page. All of the data generated for and by the C-CAP/Center team would be very beneficial to science and geography classes nationwide, if not worldwide, particularly when combined with a brief tutorial.

Program Performance

- ❑ C-CAP performance should not necessarily be measured by timeliness of completion; instead it should be measured by how its outputs are used and demonstrated as relevant to resource management decisions.
- ❑ The CD-ROMs put out by the Center showing C-CAP data are good products, but a lot of the use within the resource management community appears to be not very technically sophisticated. It is important to be able to show trends on a regional scale, on a map with reputable data, to show reasons for management decisions in a public and political context.
- ❑ The customer survey shows the need for standardized coastal data sets in all states by coastal resource management programs. C-CAP is an excellent tool with which to judge the effectiveness of coastal land use policies. C-CAP should pursue a more formal link with coastal zone management programs and supporting agencies in states to assess how the data can be used to improve the documentation of environmental change.
- ❑ The community at large feels that C-CAP is a research-based program with no particular goals or timelines. If goals are set through the planning process, and goal-specific timelines can be met, the Center will see a ground swell of support in the user community.

Project Selection

- ❑ The process for project selection is neither effective for completing the C-CAP mission, nor for developing lasting partnerships. The grant process is biased given the current approach of working only with organizations that already have some capability to perform the necessary image and spatial analysis tasks. Project selection should also be weighted toward users that have a true management plan and purpose for the data and information.
- ❑ Any consideration of a revised process for project selection must be linked to the mission and the user. If the mission is to develop a consistent national database, then areas are selected geographically and the onus is on the federal government to fund and complete projects. If the mission is to conduct baseline and change analysis to address pressing resource issues,

the project selection process needs to be more open and flexible, and not linked necessarily to a state agency.

- ❑ Requirements for collaboration, outreach, user education, and data distribution should be built into the project selection process. Clear definitions of partnership roles are especially critical where grants are the funding vehicle. Projects should be linked to C-CAP's business plan, once it is developed.

Research

- ❑ There is no research plan associated with the protocol to determine what the research needs should be. This is a first step. Research does not have to be conducted by C-CAP or the Center. There is a significant role for the private sector and academia in research. The private sector continues to develop new technologies, such as sensors to improve resolution. The Center's role is to educate people about new uses, not develop the technologies or solely test the methodologies.
- ❑ Applied work is needed via already proven techniques. The protocol should be continuously evaluated to consider its effectiveness in light of technology change. Concerns about the ecological level of detail in the C-CAP habitat types should be addressed. If C-CAP were more reliant on the academic and private sectors, these sectors would in turn become advocates of the program. Small grants might be authorized to expand the development side.
- ❑ The National Centers for Coastal Ocean Science (NCCOS) can partner with C-CAP to continue research and development. While the Center should be cooperating in the development of process models using C-CAP data, it should not necessarily be developing these models. NCCOS could partner with C-CAP to evaluate the use of C-CAP data in process modeling.

B) Summary Recommendations

First Order

1. ***Determine mission priorities.*** Determine whether the mission is to a) develop a national, contiguous database of land cover and change information; b) analyze areas of high priority based on resource management issues or significant rates of change; or c) do both (address regional issues while the national database is being compiled). Consider the land cover and the benthic categories individually.
2. ***Develop a Business Plan for the C-CAP program based upon the mission, a clear understanding of the customer base, and the Center's management objectives.*** There must be a real and sufficient market for C-CAP, and ability among customers to use it if available. The business plan should articulate program goals and activities; identify existing and potential collaborators and users; specify the utility of C-CAP to an expanded customer base including any necessary changes to the protocol; evaluate strategies to secure funds; and incorporate performance standards,

- a timetable, and budget. Consider retaining a planning consultant to guide this document. Investments in outreach and user education are needed to better characterize and build the customer base, and certify uses. The C-CAP customer survey does not provide conclusive information on how C-CAP can be used. The Center must use additional information to identify potential users before completely establishing new directions. Define how the process and product lines influence coastal management decision making by emphasizing use and value in addition to data development. A broad and diverse set of users and collaborators is essential for advocacy and resource stability. In particular, assess the practical participation of NGOs, conservation organizations, the U.S. Fish and Wildlife Service, the National Marine Fisheries Service's National Habitat Program, Regional Fishery Management Councils, marine and estuarine protection and research programs, coastal zone management programs, and regional and local resource management organizations.
3. ***Standardize and clearly communicate the project selection process.*** Determine the most effective process for sustainable engagement with both collaborators and users. Standardize and convey the criteria for project selection including requirements for outreach, data development and distribution, and end product application. Develop an effective tool to discriminate the customer's need for change information in decision making versus their actual or proposed use of that information for the same.
 4. ***Fully define partnership roles.*** Define the respective roles of the Center, data collectors, data providers, data developers, data users, and the private sector. Consider how these sectors must interrelate to achieve the mission. The private sector, in particular, should be involved in business planning development given its wide range of expertise and the rapidly changing nature of remote sensing technology and data streams.
 5. ***Support tutorials and applications.*** Integrating C-CAP data with management decisions is not as common as would be expected. Expand the user base by documenting and communicating the process, products and utility of C-CAP. Project collaborators should help identify and educate local users. Develop application prototypes and best-practices CD-ROMs, and market end-user applications. C-CAP products should be integrated with other products of the Center, and with other public data sources such as digital soil maps and state-level GAP data. Encourage NMFS to integrate C-CAP data into habitat management activities. Training should encompass both management and technical themes. Build awareness by introducing C-CAP to the nontechnical user. Develop a simple guide on the use of C-CAP for educators.
 6. ***Leverage other national efforts.*** Work with other national programs to identify common needs and opportunities for resources.
 7. ***Develop program performance measures.*** Consider the power of C-CAP to produce standardized change detection algorithms, and a national baseline from which to measure change. Explore how C-CAP information can be used to evaluate the effectiveness of coastal land use policies. The coastal zone management community

is a customer base for this information, but is not necessarily positioned to collaborate in data development. Develop metrics to assess program processes, outputs, and impacts. Routinely solicit customer feedback to evaluate the relevance of products and services. In particular, capacity building should be evaluated not only for enhancements to technical expertise, but for how well customers use and apply C-CAP information for decision making.

Second Order

8. ***Promote NOAA line office participation.*** Encourage a broader understanding within NOAA of C-CAP data assets and uses. Capitalize on NOAA-sponsored meetings to strengthen awareness and develop new relationships for supporting Center and NOAA customers.
9. ***Describe the future role of the academic community.*** Consider cooperative agreements for short-term research to develop creative applications. Support relationships that enable student projects, interns, ship use, and competitive research. Leverage academic strengths in technical assistance, and consider the future role of centers of expertise such as the Oak Ridge National Laboratory.

Third Order

10. ***Assess the research needs of the program.*** Assess research needs including sensor development, applying change detection algorithms, scale and resolution issues, cause and effect relationships, and input to ecosystem health assessments. Partner with NCCOS to evaluate the use of C-CAP data in process modeling. C-CAP data sets, products, and applications already developed can be shared with a much broader audience for new uses. To be more effective, continuously evaluate the classification and nomenclature, including that for technology change and user requirements for different levels of ecological detail.
11. ***Evaluate Small Business Innovation Research (SBIR) grants as a vehicle to enhance resources.***
12. ***Participate in the identification and development of new processes and technologies.*** Although C-CAP is not responsible for instrument design and fabrication, the program can be a test bed for new technologies. The Center has a legitimate role to educate people about new methodologies and uses, and should nurture natural synergies with other agencies (e.g., NASA) and the private sector to permit C-CAP to stay current with technology while still maintaining the database, analysis, and application efforts. However, one caution in adopting new technologies is that major shifts may tend to work against the goal of a standardized national database acquired using one protocol. C-CAP has filled a niche by producing comparable data sets in contrast to the wide variety of data sets that exist among state and federal organizations.

VI. SELECTED DEFINITIONS AND AVAILABLE DOCUMENTS

Selected Definitions

Scale - refers to the ratio between distances and areas in a map and their relative distance and size on the ground. For instance, one inch on a one-to-twenty-four-thousand (1:24,000) scale map represents 24,000 inches or 2,000 feet on the ground.

Accuracy - refers to how well a map or spatial data represents the actual landscape. The proportion of correctly matching observations is what is referred to as "accuracy."

Resolution - refers to the smallest observable detail visible in a photograph or image.

Spatial Extent - refers to the geographic area covered by an image, map, or spatial data set.

NMFS – National Marine Fisheries Service

OCRM – Office of Ocean and Coastal Resource Management

NIMA – National Imagery and Mapping Agency

COP – NOAA Coastal Ocean Program

CSC – NOAA Coastal Services Center (also “Center”)

Available Documents

In addition to this executive summary, the following documentation in support of the C-CAP Effectiveness Review is available from the NOAA Coastal Services Center upon request:

- ❑ Proposal of Plan and Activities
- ❑ C-CAP Effectiveness Review: Briefing Book for External Panel
- ❑ C-CAP Effectiveness Review: Panel Presentations
- ❑ C-CAP Panel Consolidated Minutes
- ❑ C-CAP Customer Survey Results – Combined Narrative, Graphical and Tabular Results
- ❑ Lessons of C-CAP Evaluation

VII. APPENDIX A

The following tabular data is from the C-CAP customer survey.

Question 1. How would you best describe your position?

Academic	Federal Offices	State Offices	NGO	Local Offices	Private Companies
32%	14%	35%	2%	9%	8%

Question 2. How did you become aware of or involved with C-CAP?

A. Marketing Efforts

	Federal register	Located through www:	Requested C-CAP support	Attended C-CAP workshop	Heard C-CAP presentation
Academic	4%	11%	8%	15%	15%
Federal Offices	0%	0%	14%	36%	23%
State Offices	2%	11%	17%	17%	13%
Local Offices	0%	0%	13%	13%	25%
Private Companies	0%	10%	0%	10%	20%

B. Partnerships

	Participated in NERR, NEP, NMS program	Participated with state office	Partnered with university	Partnered with private sector	Partnered with NGO
Academic	13%	4%	17%	0%	2%
Federal Offices	9%	5%	0%	0%	5%
State Offices	13%	11%	2%	0%	4%
Local Offices	25%	13%	0%	0%	0%
Private Companies	20%	10%	0%	0%	0%

Question 3. Which of the following best describes your involvement or participation with C-CAP?

	Use C-CAP data	Use C-CAP protocol	Facilitate resource management	Non response	Provide GIS support	Provide field support	Create benthic habitat maps	Create land cover habitat maps
Academic	22%	19%	7%	12%	9%	10%	9%	12%
Federal Offices	18%	18%	13%	3%	13%	16%	11%	8%
State Offices	20%	14%	13%	9%	19%	11%	5%	9%
Local Offices	20%	7%	20%	7%	20%	13%	13%	0%
Private Companies	21%	7%	7%	14%	14%	7%	14%	14%

Question 4. Which of the following C-CAP products have you used?

	Protocol	Land cover maps	Benthic habitat maps	Change images	Tabular summaries of spatial data	Chesapeake Bay CD-ROM	St Croix River CD-ROM	Columbia River CD-ROM	Yakutat Bay CD-ROM	San Francisco Bay CD-ROM	No response
Academic	16%	18%	9%	13%	4%	8%	1%	11%	3%	13%	5%
Federal Office	21%	21%	5%	21%	5%	8%	3%	3%	3%	5%	5%
State Office	17%	18%	5%	15%	2%	3%	2%	15%	2%	15%	7%
Local Office	8%	15%	15%	8%	8%	0%	0%	15%	0%	23%	8%
Private Companies	18%	18%	0%	18%	0%	0%	0%	18%	0%	18%	9%

Question 5. How have you used C-CAP data?

A. Direct Use

	Baseline land cover	Baseline benthic habitat cover	Monitor changes in cover	Research
Academic	10%	3%	15%	7%
Federal Offices	18%	5%	18%	8%
State Offices	16%	3%	16%	7%
Local Offices	6%	13%	19%	0%
Private Companies	25%	17%	0%	8%

B. Management Use

	Measure development	Assess watershed health	Assess health of fish & wildlife	Land use planning	Resource management decisions	Permit decisions
Academic	7%	9%	6%	7%	4%	1%
Federal Offices	5%	8%	5%	3%	0%	5%
State Offices	5%	8%	8%	5%	5%	3%
Local Offices	6%	13%	0%	0%	13%	0%
Private Companies	0%	0%	0%	8%	0%	0%

C. Applied Use

	Teaching	Outreach tool for local government	Outreach tool for staff	Marketing	No response
Academic	13%	5%	3%	0%	8%
Federal Offices	5%	5%	8%	0%	8%
State Offices	3%	8%	5%	1%	8%
Local Offices	0%	13%	13%	0%	6%
Private Companies	8%	8%	8%	0%	17%

Question 6. What other sources of land cover data have you used to meet your environmental assessment needs?

	No other	Private contractor	University	NGO	Existing commercial database	Existing state database	Existing federal database	Non response
Academic	2%	5%	27%	10%	5%	20%	28%	3%
Federal Offices	0%	12%	8%	4%	12%	27%	35%	4%
State Offices	4%	7%	20%	2%	4%	31%	22%	9%
NGO	0%	33%	0%	0%	17%	33%	17%	0%
Local Offices	5%	19%	14%	10%	14%	19%	14%	5%
Private Companies	0%	10%	10%	0%	10%	20%	30%	20%

Question 7. What other sources of benthic habitat change data have you used to meet your environmental assessment needs?

	No other	Private contractor	University	NGO	Existing commercial database	Existing state database	Existing federal database	Non response
Academic	25%	5%	13%	0%	5%	20%	15%	18%
Federal Offices	16%	5%	11%	5%	0%	26%	21%	16%
State Offices	36%	3%	8%	0%	0%	25%	8%	19%
Local Offices	21%	21%	14%	7%	7%	21%	7%	0%
Private Companies	38%	0%	13%	0%	25%	25%	0%	0%

Question 8. What geographic scale is most useful for your work?

	Municipality	County	Watershed	State	Satellite scene	Non response
Academic	16%	20%	28%	18%	15%	3%
Federal Offices	4%	8%	38%	25%	25%	0%
State Offices	15%	18%	37%	14%	8%	8%
Local Offices	14%	29%	43%	7%	7%	0%
Private Companies	13%	0%	38%	13%	0%	38%

Question 9. Which of the following temporal frames is most appropriate for your needs?

	1-yr intervals	5-yr intervals	10-yr intervals	Single date within 3-yrs	Non response
Academic	19%	56%	14%	8%	3%
Federal Offices	11%	47%	26%	11%	5%
State Offices	14%	51%	19%	16%	0%
Local Offices	40%	27%	13%	13%	7%
Private Companies	18%	36%	9%	27%	9%

Question 10. Based on your knowledge and through field evaluation, how would you rate the relative accuracy of C-CAP products?

	Very accurate	Generally accurate	Results varied with product	Inaccurate	Do not know	Non response
Academic	11%	36%	7%	0%	36%	11%
Federal Offices	8%	42%	25%	0%	8%	17%
State Offices	3%	37%	20%	0%	30%	10%
Local Offices	25%	38%	13%	0%	25%	0%
Private Companies	14%	29%	0%	0%	43%	14%

Question 11. Would you or your staff participate in the following C-CAP-related training if it were made available to your office?

	Academic	Federal Offices	State Offices	NGO	Local Offices	Private Companies
Introduction to GIS	32%	25%	33%	50%	38%	43%
ArcView GIS	43%	25%	60%	50%	63%	57%
Image Processing Techniques	29%	33%	63%	100%	50%	57%
Interpretation of Aerial Photography	46%	42%	63%	100%	88%	71%
Field Verification Techniques	39%	33%	43%	50%	63%	86%

Question 12. If you have been involved in the creation or use of C-CAP data, products, or services, please answer the following:

a) Overall, working with C-CAP met my needs.

	Non response	Not applicable	Agree	Neutral	Disagree
Academic	36%	4%	43%	11%	7%
Federal Offices	33%	8%	42%	17%	0%
State Offices	27%	30%	30%	10%	3%
Local Offices	38%	25%	38%	0%	0%
Private Offices	57%	0%	43%	0%	0%

b) The C-CAP protocol was easy to follow.

	Non response	Not applicable	Agree	Neutral	Disagree
Academic	29%	7%	54%	7%	4%
Federal Offices	25%	25%	42%	8%	0%
State Offices	27%	27%	23%	3%	10%
Local Offices	38%	25%	38%	0%	0%
Private Companies	57%	0%	43%	0%	0%

c) Products were produced on a timely basis.

	Non response	Not applicable	Agree	Neutral	Disagree
Academic	29%	14%	29%	11%	18%
Federal Offices	33%	8%	42%	8%	8%
State Offices	27%	30%	27%	17%	0%
Local Offices	38%	13%	25%	13%	13%
Private Companies	57%	29%	14%	0%	0%

d) Products met my expectations.

	Non response	Not applicable	Agree	Neutral	Disagree
Academic	32%	7%	25%	29%	7%
Federal Offices	33%	0%	42%	17%	8%
State Offices	30%	23%	37%	7%	3%
Local Offices	38%	13%	50%	0%	0%
Private Companies	71%	0%	14%	14%	0%

e) After working with the C-CAP protocol, I will be able to develop future products without additional technical assistance.

	Non response	Not applicable	Agree	Neutral	Disagree
Academic	32%	18%	32%	14%	4%
Federal Offices	42%	17%	17%	25%	0%
State Offices	27%	33%	17%	17%	7%
Local Offices	38%	25%	0%	25%	13%
Private Companies	57%	14%	29%	0%	0%

f) C-CAP staff provided me with the information I needed to collect or process data.

	Non response	Not applicable	Agree	Neutral	Disagree
Academic	32%	18%	39%	7%	4%
Federal Offices	33%	25%	33%	8%	0%
State Offices	30%	30%	27%	10%	3%
Local Offices	38%	38%	13%	0%	13%
Private Companies	57%	14%	29%	0%	0%

g) Partnerships are an effective means for building our capacity.

	Non response	Not applicable	Agree	Neutral	Disagree
Academic	29%	14%	50%	4%	4%
Federal Offices	25%	0%	75%	0%	0%
State Offices	23%	17%	53%	7%	0%
Local Offices	38%	13%	38%	13%	0%
Private Companies	57%	0%	43%	0%	0%

h) C-CAP products have helped our office fulfill our resource management responsibilities.

	Non response	Not applicable	Agree	Neutral	Disagree
Academic	36%	32%	29%	4%	0%
Federal Offices	33%	8%	33%	25%	0%
State Offices	27%	27%	37%	10%	0%
Local Offices	38%	13%	38%	0%	13%
Private Companies	57%	29%	14%	0%	0%

Note: all rows do not necessarily add up to 100% due to rounding.