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IDENTIFYING AND STRUCTURING OBJECTIVES FOR A CORAL REEF PROTECTION PLAN AT THE U.S. ENVIRONMENTAL PROTECTION AGENCY

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Abstract

Region 2 of the U.S. Environmental Protection Agency initiated a Coral Reef Protection Plan (CRPP) in 2014 to reduce anthropogenic stress on Caribbean coral reefs. The CRPP is intended to foster institutional practices that improve reef condition and focus regulatory and nonregulatory decision making on minimizing pollutant release to coastal systems. A framework incorporating two sets of objectives was constructed to examine the short- and long-term costs and benefits of tasks. The first set of objectives was derived from existing tasks in the CRPP and was intended to support an update of the CRPP for 2015. Fundamental objectives were constructed to communicate the end objectives across tasks and means objectives were constructed to communicate the means for achieving them. The second set of objectives was created to reflect costs and benefits of the CRPP beyond 2015. These objectives contained fundamental objectives comprising broad social, economic, learning and governance topics. The means objectives included tasks such as building capacity, providing regulatory oversight, and learning and reducing uncertainties. The second set of objectives also included strategic objectives that identify long-range benefits such as coral reef integrity and reef ecosystem services. The process of defining objectives helped to ascertain and better elucidate the important consequences for the CRPP. Understanding objectives not only provides a roadmap for coral reef protection but can help Region 2 communicate internally and externally with other agencies, industry, and the public.

Keywords

Objectives; Decision analysis; Coral reef protection; Coastal pollution; Sustainable practices; Regulatory fulfillment

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Introduction

Coral reefs throughout the world are threatened by human activities occurring at both the local and global scales. Local threats include pollutants in watershed runoff, coastal development, marine-based pollution, overfishing and destructive fishing practices (WRI 2011). Global threats to coral reefs include ocean warming, rising sea level, increased storm activity and acidification of coastal waters (WMO 2010). As these pressures continue and expand, they are expected to override the resiliency of many coral reef ecosystems (WMO 2010). Concerns about degradation of reef systems have been corroborated worldwide, including the Caribbean where coral reefs have suffered historic declines. A 1998–99 global bleaching event caused by high ocean temperatures resulted in significant losses of live coral cover across the Caribbean Sea, and this was subsequently compounded by severe hurricanes and another high-temperature bleaching event in 2005 (Whelan et al. 2007; Woody et al. 2008; Wilkinson 2008; Smith et al. 2013).

Resiliency is a particularly important factor in the capacity for coral reefs to regenerate from chronic and episodic disturbances. Managing reefs for resiliency requires knowledge about susceptibility to numerous stressors as well as reef capacity for regeneration, both of which have large uncertainties (Browne et al. 2012). Localized stressors arising from forest clearance, land development, wetland losses, and fishing could have jointly played a role in lowering resilience of coral reefs over time (Spalding et al. 2001). However, pinpointing the contribution of any source or individual stressor is difficult. This is exemplified by pollutants in watershed runoff, which include sediment, contaminants, nutrients and pathogens (Ramos-Scharrón et al. 2015). Uncertainties exist over the relative magnitude of these pollutants as well as their impacts on coral reef inhabitants (Jackson et al. 2014; Ramos-Scharrón et al. 2015). Nonetheless, cumulative stress to nearshore reefs might be expected near areas of intensified human activities; this hypothesis has been supported by at least two studies in the U.S. Virgin Islands (Oliver et al. 2011; Smith et al. 2008).

The United States Environmental Protection Agency (EPA), established in 1970, is charged with protecting environmental systems and human health from anthropogenic stressors. It was organized to include Program Offices that generate policies and procedures and Regional Offices that implement programs in States and Territories. The Office of Research and Development (ORD) supports the Regional and Program Offices by addressing EPA science needs and simultaneously contributes to national and international environmental science research. One of the key Federal statutes pertaining to coral reef protection, the Clean Water Act (CWA), is administered by EPA. The CWA is a comprehensive legislation enacted in 1972 (33 U.S.C. §1251 et seq.) to protect water bodies of the U.S. and maintain or restore their uses. It employs a variety of regulatory and non-regulatory tools to reduce direct pollutant discharges into waterways, finance municipal wastewater treatment facilities, and manage polluted runoff. These tools are employed to achieve the broader goal of restoring and maintaining the chemical, physical, and biological integrity of the nation's waters so that they can support "the protection and propagation of fish, shellfish, and wildlife and recreation in and on the water." For coral reef ecosystems, the CWA has been used to prevent degradation and removal of coral structures, reduce pollutant loadings, and

designate protective status to maintain resources in a ‘natural’ condition now and into the future.

Implementation of the CWA and other regulatory laws throughout the U.S. and its Territories is the responsibility of States with the backing and guidance of ten EPA Regional offices. The U.S. Environmental Protection Agency’s Region 2 (R2) oversees EPA’s activities in New York, New Jersey and the Caribbean Territories, U.S. Virgin Islands (USVI) and the Commonwealth of Puerto Rico (PR). Region 2 has partnered with jurisdictional governments to develop and implement environmental standards and protections, prosecute violations of environmental laws and mandates, oversee the cleanup of hazardous waste sites, and identify and oversee federally protected estuaries in the National Estuary Program. Highly-valued coral reefs are distributed widely along the coasts of PR and USVI, and R2 has been involved with protecting these reef systems since enactment of the CWA. Nonetheless, a Regional Administrator for R2 has voiced an increasing concern for the future of reef ecosystems in these two jurisdictions and throughout the Caribbean. Consequently, for the fiscal year (FY) 2014, R2 initiated a Coral Reef Protection Plan (CRPP) to outline and better communicate ongoing actions and to identify future actions that would improve protection. The CRPP represents a dynamic program intended to evolve and respond to protection needs into the foreseeable future. Tasks included in the FY 2014 CRPP vary in type and scope and include some with definitive endpoints and others that are continuous through time.

Also in 2014, ORD engaged CRPP project leads to collaboratively prepare a strategy that would improve future CRPP actions using structured planning procedures. Using different elicitation methods, fundamental and means objectives were identified (specified) and candidate attributes (also commonly known as performance measures, evaluation measures, criteria, indicators, etc.) generated to better define and characterize existing and future objectives. Specifying objectives shifts the focus of the plan from alternatives to values (i.e., from considering actions to considering different aspirations and ideals), which are the ultimate endpoints of concern (Keeney 1992). This approach of value-focused thinking defines the objectives first, which can then be used to generate new alternatives, and modify existing ones, to achieve the objectives.

Methods

Coral reef protection issues identified by R2 staff and CRPP leaders were characterized as fundamental, strategic or means objectives. Fundamental objectives were end objectives that could be directly achieved by R2 decisions in the immediate to foreseeable future. Strategic objectives were also end objectives, but were not directly achievable by R2 activities in the foreseeable future. Outcomes for the strategic objectives reflect important values and services from coral reefs but would be expected to occur in the long-term from current decisions, would be difficult to accurately predict and evaluate, are beyond the current considerations of the CRPP, and/or would have high uncertainty due to a variety of potential intervening factors. For example, R2 could reasonably expect that their actions could reduce exposure of chemical pollutants to coastal coral reef systems (a fundamental objective), but could not reasonably expect that their actions would restore coral reef integrity (a strategic

objective). Means objectives were those objectives considered important for achieving the fundamental and the strategic objectives.

Both top-down and bottom-up approaches were used to identify objectives (von Winterfeldt and Edwards 1986). The bottom-up approach was initiated by R2 staff to extract objectives from existing FY 2014 CRPP tasks. These objectives were categorized into fundamental and means objectives as described above. The resulting framework became a vehicle for communicating internally and with outside partners and stakeholders and served as the basis for FY 2015 CRPP planning.

A top-down approach was used to identify a second set of objectives for coral reef protection. These objectives were derived from broader values embodied by the CRPP and not just from existing tasks or planned actions. Although intended to be greater in breadth and scope, the construction of multiple-year objectives was informed by the results from the bottom-up approach. Initial discussions between R2 project leaders and ORD staff focused on the scope of the CRPP and the likely outcomes of successfully completed tasks. A concurrent review by ORD of the 2014 CRPP was used to construct preliminary influence diagram sketches. These framed the causal thinking behind tasks, interventions and anticipated outcomes.

Further phone interviews were conducted with CRPP program leaders, using open-ended questions (Gregory and Keeney 2002) to elicit broader objectives, aspirations and values, and to uncover any additional unstated objectives. Questions given to R2 personnel included thinking about the best possible outcomes from the plan, the worst possible outcomes, the purpose of the CRPP, and desired changes to the CRPP. After these initial phone interviews, a preliminary set of fundamental, strategic and means objectives were developed by ORD personnel. Hierarchical structuring was used to define the fundamental and strategic objectives and a means-ends network was used to link them to means objectives. The objectives hierarchy and a concurrent list of means objectives were sent to the CRPP project leaders for evaluation and consideration. A questionnaire was also sent to R2 staff members in New York, PR and USVI and the responses were incorporated into the objectives hierarchy and means-ends networks.

These draft products were then provided to CRPP project leaders and staff members for feedback and critical analysis. In this process, individual meetings were held with twelve R2 staff members and supervisors to discuss key elements in the tasks that were most relevant to their personal responsibilities and to review and revise the draft objectives. Follow-up consultations with the CRPP program leaders were used to better define objectives, differentiate means from ends, and develop attributes for the fundamental objectives. For the latter, an initial set of potential attributes were provided by ORD for review and modification by the CRPP project leaders. When a natural and in-use attribute could not be identified, a constructed scale for the attribute was chosen. Constructed scales are ones that are not standard or in common usage but are reasonable attributes of the objectives. Often the constructed scales contain uniquely defined levels representing potential impacts on the objective, and can consist of simple or complex multivariate outcomes (Merkhofer and Keeney 1987). For example, aesthetics and beauty measurements for ecosystems could

consist of a constructed scale of paintings by artists depicting different potential outcomes on scenery (Gregory et al. 2012). The constructed scales used here included some that could be used primarily for screening (e.g., yes-no answers) and some that might require answers at multiple levels to reflect multiple degrees and types of concerns. An example constructed scale for the (qualitative) health of a coral reef from visual census is given in Table 1. As utilized in Espinosa-Romero et al. (2011), the constructed scales currently contain placeholder questions that the attribute for the objective would address if further developed.

Region 2 staff plan to continually revisit and update the objectives and attributes as the CRPP evolves and is amended with additional information. For example, the potential effects of micro-plastics on corals (Hall et al. 2015) and compensatory mitigation for planned and unplanned impacts (USCRTF 2016) might be new areas of investment for developing objectives, tasks, and attributes.

Results

The process described above resulted in two sets of objectives; one set was generated with a bottom-up approach and within the context of planning 2015 actions; and the other represented a broader, multi-year perspective derived through a top-down approach. The latter included both fundamental and strategic objectives.

Annual (2015) Fundamental and Means Objectives for the Coral Reef Protection Plan

Based on the 2014 CRPP, eleven tasks were identified for 2015, each relating to one or more fundamental objectives (Fig. 1). The first three fundamental objectives derived from the tasks represent regulatory (point-source and sewage pollution) and non-regulatory (nonpoint source pollution) responsibilities of R2 under the CWA and other Federal legislation. Pollution refers to all types of man-induced release of toxicants, contaminants, sediment, nutrients and pathogens. The other three fundamental objectives focus on exposure of endangered coral species to wastewater, sustainable activities at marinas, and improved decision making.

The tasks encompass several means objectives that contribute to achieving the fundamental objectives. Some tasks in the 2015 CRPP are regulatory actions and some rely on actions by parties outside of EPA (e.g., USVI No Discharge Zone). Other tasks have a combination of regulatory activities in combination with voluntary behaviors on the part of industries and external agencies (e.g., Green Marinas). Several tasks were initiated by R2 before the 2014 CRPP was developed and are at different stages of completion. The 2015 CRPP describes the next-step activities for these tasks and a relatively near-term expectation of achievement. For example, the USVI Rum Plant task (Fig. 1) relates to a permitting schedule to halt wastewater discharge from a rum plant into USVI coastal waters. The schedule is currently in the implementation phase and the focus for 2015 is to enforce and monitor compliance; completion of the discharge treatment system is still in the future.

Reduce point source pollution discharge in coastal waters

Pollutants from a single origin such as industrial plants are point sources and regulated under the CWA National Pollutant Discharge Elimination System (NPDES). Control of point source discharges includes multiple industrial sectors (e.g., manufacturers, feed lot operators, dry cleaners) from across the watershed. Many of the regulatory tasks are enforced using the NPDES permitting process that regulates pollutant discharge to water bodies. Inspections and enforcement are critical to addressing concerns about runoff to storm waters and further minimizing discharge to water bodies or to sewage systems that drain to coastal waters. The R2 objective to minimize point-source discharge (Fig. 1) was identified in USVI through the rum plant task and in PR by a task to reduce storm water runoff from municipalities, large construction sites, and other point sources. Municipalities are required to develop storm water runoff prevention plans that include control measures for conventional pollutants (e.g., pH, fecal coliforms).

Reduce the amount of untreated sewage discharged to coastal waters

Pathogens and nutrients are the focus of regulations to control wastewater release from sewage under CWA §303(d) for impaired waters. Land-based sewage discharge regulations focus on onsite and sewage treatment systems. At the municipal level, there are six wastewater treatment plants that discharge primary effluents (only solids are removed) into the ocean using 301(h) permitted discharges. A priority action for USVI is to ensure improvements to the St. Croix sewage collection and pumping systems through compliance inspections and monitoring. For PR, domestic onsite sewage releases are a major concern because a large percentage of homes are not connected to sewage treatment systems. The 2015 CRPP task for PR seeks to improve existing un-sewered onsite systems and promulgate regulatory changes to improve sewage infrastructure.

Control of untreated sewage discharge from coastal boats and other vessels is also important for coral reef protection. The No Discharge Zone (NDZ) program is a federal initiative that allows a state or jurisdiction to submit a permit designating NDZ water bodies, and grant and technical assistance programs are available through R2 for developing NDZ proposals. Grants can be used to provide new pump-out systems for vessels as well as to support enforcement and infrastructure. Discharges from cruise ships are not covered under the NDZ designation. Cruise ships have sophisticated treatment onboard and are required to discharge treated sewage at least three miles offshore. Recreational crafts also have marine sanitation devices, but waste materials could still be discharged to sensitive coastal areas. The proposed NDZ program would provide more stringent controls for recreational craft.

Reduce nonpoint source pollution discharged to coastal waters

Pollutants from non-point sources such as agriculture or municipal development are not regulated, but EPA assists States and Territories through CWA §319 funding allocations for watershed management. Funding is contingent on addressing nine elements of a watershed management plan, which includes reducing nonpoint discharges. In USVI, the Earth Change Program is a permit process that influences every major land-disturbing activity, including new home construction. The USVI Environmental Handbook is being redesigned by the National Oceanic and Atmospheric Administration to provide advice for controlling storm

water releases from smaller (<1 acre) construction sites. Region 2 personnel have provided best practice expertise to assist in developing the handbook. Additional nonpoint work is collaborative and focuses on stabilization of important sources of nonpoint sediment pollution such as land debris removal from ephemeral streams. Marinas also provide potential risks to coral reef ecosystems through nonpoint discharges and are discussed below.

Reduce exposure of threatened and endangered species to wastewater pollutants

The Endangered Species Act was passed in 1973 to protect and recover imperiled species in the United States and the ecosystems upon which they depend. Threatened and endangered marine species are under the aegis of the Commerce Department's National Marine Fisheries Service. There are currently seven threatened stony coral species in U.S. Caribbean waters. A particular concern highlighted in the 2015 CRPP is threatened elkhorn coral (*Acropora palmata*) colonies near Vega Baja (PR) and their potential exposure to wastewater discharges (Fig. 1). Currently, R2 is working with the Puerto Rican sewage authority and the Vega Baja municipality to reduce these discharges through confirming source abatement and engaging the Vega Baja municipality regarding the transport of the discharges through its municipal storm water sewer system (MS4).

Foster sustainable operations at all marinas

Routine and non-routine maintenance activities for boats (e.g., cleaning, painting, blasting, scraping, antifouling, fueling, fish-cleaning, waste disposal) and for ports (e.g., dredging, landscaping, building and development) can directly contaminate coastal water bodies. A combination of enforcement and voluntary activities are being applied through the development of best management practices (BMPs) and a potential certification program for Green Marinas to promote stewardship in marinas. A guidance document for marinas has also been developed by R2 personnel that provides recommendations on BMPs for pollution reduction and release prevention (USEPA 2012). The document covers numerous activities at marinas, including those mentioned above, and provides recommendations on water and energy efficiency. If regulatory violations occur, enforcement is possible under storm water discharge requirements.

Foster more refined decision making regarding restoration of coral reefs

Good governance is an important objective for any plan because it fosters interactive rulemaking and sets the groundwork for future collaborative decisions (Keeney et al. 1996). Currently, R2 emphasis for refining its decision making is on interactions with jurisdictional governments and the broader public. For agencies such as the Puerto Rico Environmental Quality Board, R2 is supporting the development of monitoring and water quality criteria (CWA §304(a)) that are protective of coral reefs (Fore et al. 2008, 2009). Developing useful narrative biological criteria is the first goal in this process which could evolve into numerical biological criteria and quantitative thresholds for coral reef protection (Bradley et al. 2010). Education is also a key component of developing more refined decision making and community involvement initiatives are being implemented through volunteer monitoring activities. The monitoring program involves citizen monitoring of sewage indicators with hopes of building greater awareness and capacity for public sanitation.

Objectives for Multiple Years

The fundamental objectives for multiple years, generated from the top-down approach, were categorized to reflect six general categories (Table 2). Each category has more than one fundamental objective, several sub-objectives and multiple potential attributes identified through discussion with R2 personnel.

Fundamental Objectives

Fundamental objectives reflect important outcomes directly related to CRPP activities. Their specification clarifies what the CRPP hopes to achieve or avoid. Having a broad initial list of well-defined objectives and attributes is a helpful step towards developing a proactive management approach responsive to potential costs and benefits arising from environmental decisions. Sub-objectives were used to further define what is meant by the fundamental objective if the initial objective was too broad for establishing attributes. A description of fundamental objectives, in the sequence displayed in Table 2, follows. Categories listed in the first column of Table 2 are used for organization and display purposes but should not be viewed as part of the hierarchical structure.

Exposure of reefs to stressors—Reef integrity depends on minimizing exposure of reefs to point, nonpoint, and sewage stressors. This objective includes reducing or halting exposures to individual colonies, coral reef communities, and hardbottom substrate without reefs but with potential for supporting them. It also includes minimizing exposure to other habitats such as wetlands, mangroves, and submerged aquatic vegetation that provide connectivity for mobile reef species such as fish and provides beneficial regulation of nutrient, material and energy flows. Elimination or diversion of point source, nonpoint source, and sewage pollution is the core of the CRPP. Measures for this objective should represent the amount of pollution eliminated or diverted from the source. The focus is on pollutant sources because individual chemicals are too numerous and too difficult to identify at each habitat. Future work might gauge the relative potency of different sources for toxicity or eutrophication.

Damage to coral reefs—Although not currently part of the existing tasks in the CRPP, section 404 of the CWA places special emphasis on protecting coral reefs from dredge and fill activities in aquatic systems. Disposal activities under section 404 could damage coral reefs directly or indirectly through such threats as physical breakage and burial/smothering of reefs. The resulting damages from dredge and fill disposal are encompassed by this objective and are considered distinct from exposure to point, nonpoint and sewage sources discussed above. The attributes are based on the USCRTF (2016) definition of impacts as “loss of ecological functions or services” and their differentiation of temporary and permanent impacts based on the anticipation of recovery.

Ancillary damage—It was recognized by R2 personnel that environmental damage can sometimes occur to terrestrial and aquatic habitats from implementation of tasks intended to benefit the environment. An example of this would be constructing a treatment system in a location with sensitive habitat. This objective requires that R2 consider and minimize any

possible collateral damage before task implementation. The measure for ancillary damage, acres of lost or degraded habitat, can be weighted to account for differences in quality and quantity.

Cost savings—Every activity has a cost to government, industry, or residents. Cost-savings represents the ability to achieve the same environmental goals while reducing the financial burden to achieve them. This can include promoting tasks that accommodate infrastructure capabilities for restoring water quality and establishing water treatment systems that minimize corrosion. Attributes should integrate costs and benefits to calculate the net value of the cost savings.

Public resources—It is important to R2 that tasks are implemented effectively while minimizing use of staff time and effort and ensuring that any distribution of funds is appropriate and judicious. For the latter, a constructed scale addressing concerns about optimal fund distribution was suggested. Although this objective could be considered a governance objective, it was categorized as economic because it concerns the use of public dollars.

Exposure of reefs important for human uses—A related objective is to protect reef systems that have recreational and contact importance to humans from exposure to coastal and land-based sources of pollution. The recreational quality can be assessed using categories of reefs from CWA designated use classifications used in PR and USVI; i.e., reefs of exceptional quality, reefs intended for primary or secondary contact, and reefs intended for boating, fishing, and wading. Diversion of pollutants or reduction of loadings to reefs is expected to reduce impacts and further degradation to their recreational and contact value.

Adverse recreational impacts from poor water quality—An ancillary benefit identified by R2 personnel was prevention of water quality impacts (separate from reef impacts described above) that could lead to degraded recreational experiences both on reefs and elsewhere. Recreational impacts from poor water quality could arise from beach closures or from the knowledge or perception that water in a particular region is polluted. Visitation could be impacted by turbidity, harmful algal blooms and other unappealing aspects of pollution. Noncontact recreation impacts could be measured solely from lost person-days of recreation from water quality degradation while contact recreation could additionally be measured by person-days in unappealing water bodies.

Social benefits from stewardship—Stewardship provides broad, long-lasting benefits to communities. Region 2 has initiated many community-based protection activities to foster participation and independent initiatives to support coral reef protection. Moreover, activities such as the NDZ create awareness and cultivate responsible behaviors that could have a multiplying effect on stewardship in individuals and communities. Positive outside perceptions of community stewardship, also noted by Gregory and Keeney (1994) was identified as a sub-objective. If perceptions of poor stewardship are compounded by degraded reef systems or water quality, local communities could be stigmatized. Conversely, perceptions could be positive in cases where communities are known to actively protect coral reef and aquatic resources. Members of communities can often feel a strong

attachment to local environmental resources through stewardship activities. Protection of community resources can lead to greater bonding, empowerment and other social benefits. At the individual level, positive emotional benefits can accrue from stewardship and participation (Koss and Kingsley 2010). Constructed scales were suggested for measurement of all stewardship objectives except where volunteer person-days was an adequate proxy.

Knowledge and education—Improved understanding and knowledge provides stakeholders insight to coral reef ecosystem ecology, the benefits of coral reefs to their economy and culture, connections between water quality and coral reefs, and opportunities for protecting them. Region 2 personnel actively partner with organizations to offer education opportunities and develop tools and BMPs that aid in protecting reefs. Attributes to capture the knowledge benefits of this objective would be person-days spent in educational activities for stakeholders and stakeholder groups.

Equitable outcomes—Keeney et al. (1996) emphasize the importance of equitable procedures and outcomes in the context of policy. The R2 equity objective centered on fairness and impartiality when dealing with different regulated communities, ensuring equitable outcomes for environmental justice and intergenerational parity. As discussed above, much of the CRPP consists of protecting reefs from harmful inputs that could damage their condition in the future. Thus, costs of enhancing coral reef protection in the present are expected to bring benefits to future generations from environmental improvements. Equity attributes were each given constructed scales that would consider the distribution of costs and benefits from decision making.

Public nuisances—Region 2 personnel also identified an objective to reduce social disruptions (nuisances, inconveniences) from task implementation. This objective initially arose out of a discussion about perceived inconvenience to boaters from one task but was generalized to consider additional disruptions that might be significant to task development in the future. Person-days of inconvenience could be used to measure this objective if a task under consideration might cause a disruption or significant inconvenience to residents or visitors.

Health threats from degraded water quality—Reducing exposure to pathogenic bacteria or chemical contaminants would reduce adverse human health effects from water contact and seafood consumption. It is currently listed as an ancillary objective, meaning that it might be useful to consider in some situations or to track additional benefits beyond coral reef protection. The amount of pollutants removed or diverted was considered a reasonable measure of a reduction in water-borne health threats.

EPA mandates—It is important to R2 that activities in the CRPP contribute to non-legislative EPA mandates including mission requirements and the vision statements of EPA and Regional Administrators. Because administrations change, it is expected that broad mission requirements will have greater permanency than Administrator visions. This distinction could affect the weighting and evaluation of attributes. Constructed scales can be developed measuring the degree to which the CRPP will conform and contribute to mission and vision statements.

Regulatory mandates—Legislated mandates, such as the CWA, would serve to protect and restore coral reefs, but must be met regardless of this benefit. Non-legislated mandates such as political commitments and executive orders were also considered important objectives. A proxy measure for this objective focused on the activities initiated within the CRPP for achieving regulatory mandates.

Inclusivity in development and implementation—Good governance depends on open dialog and inclusion of ideas and concerns from both internal and external parties. Externally, R2 considers the input of federal, jurisdictional, and local agencies, including non-governmental stakeholders, academics, and experts relevant to the CRPP and whose input would be valuable for its success. The measure for internal inclusivity could be a constructed scale examining the opportunities available to R2 personnel to contribute to the CRPP.

Alternatives and responses for future needs—An important part of any plan is the ability to learn and incorporate new knowledge into effective alternatives for the future. Whereas education benefits for stakeholders were specified in the ‘social objectives’ category, this and the next fundamental objective emphasizes benefits from management learning both for the CRPP and for the broader technical community of environmental scientists. Developing alternatives for future needs and priorities was defined as the development of new actions and improvement of existing actions. Keeney and McDaniels (2001) identified a similarly useful objective for climate change policies. This objective emerges from the dynamic nature of the plan and the benefits from learning and reducing uncertainties for coral reef protection decisions. A constructed scale based on the capabilities to improve and design new actions was considered a viable attribute.

Technical advancements and innovations—External funding opportunities for improving the science of environmental protection are available from the CRPP and have direct benefits to many of the coral reef protection objectives. However, research outcomes also have broader benefits in supporting and accelerating the science of environmental protection and monitoring. This is measured by the number of improvement grants for environmental protection and monitoring supported by R2. While a useful proxy, it is recognized that not every research proposal will generate new technical advancements and innovations.

Strategic Objectives

Several objectives were identified that were also considered end objectives related to coral reef benefits but were too uncertain for inclusion in the list of fundamental objectives. These were designated strategic objectives (Table 3) because they reflect important long-term aspirations in coral reef protection but are currently difficult to attribute directly to actions in the CRPP and lack good information for tracking and/or evaluation. Candidate attributes were generated for these objectives to examine their definition and potential quantification. Some strategic objectives are supported by fundamental objectives which can be useful as measurable proxies but do not directly specify the strategic objective (e.g., decrease exposure to coral reef systems). The strategic objectives (Table 3) should be regarded as an

initial list to be refined and modified as needed by the CRPP over time; however, their initial specification can help guide future efforts to develop related fundamental and means objectives.

The first strategic objective is to protect, restore and enhance the ecological integrity of coral reef ecosystems in R2 jurisdictions. Reef integrity is recognized as a long-term (strategic) objective, important for tracking progress but not entirely within the control of the CRPP. The sub-objectives further define ecological integrity as the condition of individual coral colonies and of coral communities, which include reef building stony coral species and water column species such as fish. An attribute that was immediately discussed by R2 as important for ecological integrity in coral reef communities is the biological condition gradient which is currently under development by ORD (Bradley et al. 2014). The BCG uses expert knowledge to assign biological condition categories at a community level and is being developed to cover numerous structural and functional aspects of coral reefs. Individual coral colonies include threatened and nonthreatened colonies that are measured by their abundance, size, and condition (e.g., Fisher 2007). These components could be further defined and used to develop an index.

Additional strategic objectives that were identified focused more on human benefits from coral reefs including cultural, social, and economic benefits. Reef structures reduce the strength of storm-induced waves and provide opportunities for economic benefit from tourism, recreation and commercial fishing (Principe et al. 2012). Storm wave protection can be reflected by the reduction of property damages through a cost or value function tied to the value of the property or could be reflected by the properties of coral reefs in reducing wave runoff to shore. Economic benefits from tourism and visitation can also be important and can have attributes related to coral reef condition and desirability of different uses (Johns et al. 2003). Economic benefits to individuals can also accrue through changes in employment from reef condition. Both long-term employment and short-term employment such as seasonal work in reef-related industries might provide useful attributes for this objective.

Ensuring social benefits provided by coral reefs was another long-term objective. Social benefits included cultural uses of reef resources (e.g., festivals, fish markets), availability of reef resources for traditional harvesting, and recreational use of the reefs for snorkeling, diving and fishing. Passing along fishing traditions can be important for artisanal fishers and is dependent on numerous threats to resources as well as factors outside the purview of R2 (e.g., availability of low cost imported fish; Griffith et al. 2013). Potential attributes for traditional fishing include constructed scales for availability of targeted species and for the ability to continue cultural fishing practices (McDaniels et al. 2006) under changes in coral reef condition. Recreation could be measured by changes in visitor days caused by changes in coral reef condition.

Human health benefits from coral reefs include protection from storm waves, sustenance from fisheries products and potential for pharmaceutical discovery. As noted above, the physical structure of reefs dampens the strength of waves and surge from storms before they reach coastal communities, reducing injuries and fatalities. Consequently, the reduction in numbers of deaths and injuries from storm waves was considered a useful and direct

measure for this objective. Reefs also provide critical food sources in fish, lobsters, crabs, conchs and urchins, which can be measured as biomass of fisheries species. Pharmaceuticals have been and will continue to be discovered at coral reefs (Principe et al. 2012), particularly from sessile species (e.g., sponges) that have evolved to survive through production and secretion of secondary metabolites for nutrition and defense. The density and diversity of sessile species was considered a proxy measurement because of this relation to bioactive compounds.

A final strategic objective was fostering long-term public support and trust. This was the only strategic objective that did not pertain to direct benefits from coral reef systems but was focused on aspects of governance. Good governance requires sustained trust and support among stakeholders. Communication personnel within R2 work to promote awareness of the CRPP and garner support for achieving its objectives. A key governance related outcome from this is the public support of the objectives of the CRPP. Other activities are expected to influence the outcome of this objective through community participation initiatives and partnerships. The measure for this objective focuses on a broad consensus for and active support of plans in the CRPP.

Means Objectives

For clarity, the means objectives for multiple years were condensed into five broad interactive categories that support the fundamental objectives—fostering sustainable practices, achieving regulatory compliance, learning and reducing uncertainties, building capacity, and improving coastal water quality (Fig. 2). Each of these categories contributes to the fundamental objectives and each category encompasses several different causally-related means objectives (Figs. 3, 4, 5, 6 and 7).

Improving coastal water quality—Means to improve coastal water quality include minimizing the discharge of pollutants from land- and marine-based sources, strengthening shorelines and coastal regions from erosion by increasing and protecting mangroves, seagrasses, wetlands, forests, and other natural features; nutrient sink enhancement; and promoting and supporting green infrastructure (Fig. 3). This is the core of the work envisioned by R2 and captured in the CRPP. Both regulatory and non-regulatory alternatives are captured by the means objectives. This category of means objectives is influenced by the achievement of all other categories of means objectives (see Fig. 2 and described below) including some that directly influence coastal water quality improvements (e.g., achieving regulatory compliance, fostering sustainable practices) and some that indirectly influence coastal water quality improvements (e.g., learning and reducing uncertainties).

Achieving regulatory compliance—Means to achieve regulatory compliance include capable oversight of the numerous regulated communities such as marinas and municipal facilities (Fig. 4). Activities include permitting, surveillance and inspections, and enforcement actions. Compliance assistance is also a key component and EPA has often worked with jurisdictions, municipalities, and industries on the best ways to achieve regulatory compliance. Providing guidance to jurisdictions on how to exercise authority with regulated communities and to set up protective programs are key benefits of federal

involvement in pollution prevention actions. Transparency and accountability in regulated communities could be further achieved through emerging tools like e-reporting, which would aid in task oversight and would likely strengthen voluntary compliance.

Fostering sustainable practices—Means to foster sustainable practices include support of voluntary public actions to affect pollution reduction, encouraging community vigilance, developing outside protective programs and building certifications for positive behaviors such as BMP implementation (Fig. 5). Building political and cultural will for coral protection is a key bridge from building capacity to fostering sustainable practices. Rewarding positive environmental behaviors from voluntary activities, while supporting community vigilance, protection opportunities and engagement reinforces sustainable practices now and in the future. An involved and educated public can generate protective programs and support regulatory programs for reef protection. Such activities could have a lasting effect on protecting reefs and solidifying institutionalized best practices. Tools that support sustainable practices include the Green Marinas Handbook (USEPA 2012) and the USVI Environmental Handbook (UVICES 2002), which provides guidance on all construction activities in the Virgin Islands.

Community involvement is important for engendering sustainable practices. Community activities include volunteer monitoring and citizen science, education, and best practices for protecting reefs. Vulnerable and resource-driven communities, such as low-income and traditional fishing communities, can be targeted for participation in the plan's development and for accruing its benefits. Acceptance and awareness of coral reef protection efforts are critical to participation along with political relations, public outreach, and communicating opportunities for engagement. Sustaining meaningful outreach includes promoting participatory opportunities and generating public awareness of the plan—what it is working towards, and what it is accomplishing for the environment and for communities.

Building procedural capacity—Procedural capacity refers to the ability to implement and develop tasks that benefit both regulatory and non-regulatory aspects of coral reef protection. It has a direct influence on fundamental objectives like inclusivity and efficiently managing public resources. Procedural capacity relies upon external and internal coordination efforts (Fig. 6). Coordination will lead to greater procedural capacity by aligning objectives and leveraging capabilities to address current and future regulatory and non-regulatory tasks. Engagement with outside groups can help build capacity and generate improvements from pooling of knowledge and resources. Strengthening partnerships and relationships can benefit protection efforts, educational opportunities, and development of tools and BMPs. Sound coordination across programs and stakeholders can avoid costs, disruptions, and burdens, both externally and internally, that can hamper effective protection. Minimizing conflicts early in the process will support coordination initiatives.

Some of the anticipated benefits of the CRPP were the improvement of procedural capacity with outside parties and within R2. Sustaining manageable growth of plans and activities in the CRPP will allow for new initiatives in the future. This means that R2 must support the CRPP through effective and successful application of the existing tasks and plan future tasks that are within their capabilities. While recognizing the value of initiative and creative ideas,

the CRPP was developed around the strengths and capabilities of existing personnel and should not move into actions that cannot be properly completed.

Communities, other agencies, and additional EPA personnel are more likely to partner with the CRPP when they learn about the benefits of the program and how CRPP resources can contribute to solving mutual problems. They are also more likely to collaborate if R2 demonstrates that they are reliable and credible in their process and achievements. Outside initiatives, efforts, and groups will be open to aligning their own activities with the CRPP if they perceive the program to be credible and reliable. These means objectives are supported by communicating the benefits of current and future tasks to coral reef systems and by a transparent decision process. Maintaining focus will help ensure that actions are generated and incorporated for coral protection efforts and not creep into other concerns and delay achieving more important CRPP goals.

Learning and reducing uncertainties—Given the numerous uncertainties associated with coral reef protection, the CRPP is intended to have a strong learning component (Fig. 7). Learning can support coral protection by improving the knowledge base for future plans, documenting performance, and identifying threats and issues for improved response. Developing, identifying and defining priorities and objectives, as well as links among water quality, ecosystem services and ecological integrity, should benefit from this aspect of the plan. Part of these efforts would include improved monitoring of water quality and biological condition and exchanging and sharing this information with research institutions and stakeholders. Surveillance includes identifying the sources of degradation including landscape impairments, unpermitted construction, and pollutant emission factors. Learning from ‘cutting-edge’ science through tailored grants and using this science in protection efforts will inform the plan now and in the future. Keeping the plan’s focus at a local level will provide insight to emerging issues.

Discussion

Information obtained through elicitations of R2 personnel who were involved in developing and implementing a coral reef protection program was incorporated into a framework of fundamental and means objectives for a short-term ‘annual’ plan (Fig. 1) and a longer-term ‘multiple-year’ plan (Tables 2 and 3, Figs. 2, 3, 4, 5, 6 and 7). The process generated useful discussion within EPA concerning current and future coral reef protection, and the resulting framework provided greater clarity and transparency to their goals and actions. The process led to a framework at the level of problem identification and structuring (Linkov and Moberg 2012), which is a key step that influences subsequent analysis and development. Defining objectives is a common step in responsible decision making, important because objectives are statements of the ultimate rationale for making a decision. It is a critical step for the complex decisions faced in environmental management where social, economic and environmental issues often intersect. Frameworks, such as objectives hierarchies and means-ends networks, lead all parties to a better understanding of the decision context and goals, the uncertainties between means and ends, and the trade-offs that will emerge.

Initial interviews with R2 personnel revealed multiple perceptions of coral reef protection for both near- and long-term issues. Ideas and objectives that were clear to one member were not always clear to others. Subsequent discussions about objectives, means and attributes helped to reveal the different perceptions and to uncover hidden objectives. Clear statements of objectives, especially objectives sharpened by the initial development of attributes, led to a common interpretation and improved communication among R2 personnel, and a better ability to communicate the goals of the CRPP to other agencies and stakeholders. Defining the objectives on an annual and multi-year basis can improve communication efforts with the public while increasing efficiency in task development and implementation through improved prediction and monitoring (Seager et al. 2007).

Identifying candidate attributes for each objective serves multiple purposes; the most obvious is that their measurement will allow R2 to predict and gauge progress in achieving the objectives. But attributes also serve to refine and clarify the objectives. Once an attribute is proposed, all stakeholders can determine whether the measure truly reflects what they intended for a particular objective. For example, an objective to protect property from storm waves could be measured by reduced repair costs for damaged buildings (Table 3). Yet, some stakeholders may have been specifically interested in protecting irreplaceable cultural artifacts. In the fundamental objectives of Table 2, constructed scales were described for many objectives where clear or standard measurements were unknown. Questions were developed to guide future characterization of the constructed scales and can be expanded or modified in future iterations. Seager et al. (2007) and Linkov and Moberg (2012) provide additional considerations for developing attributes including typologies and characterizations.

Examination of proposed actions by R2 personnel in the 2015 CRPP revealed several common purposes that were captured as fundamental objectives (Fig. 1). As an example, several actions were proposed to eliminate or reduce sewage discharge in USVI and PR; these were combined into a common objective to ‘minimize sewage discharge in coastal waters’. In general, the 2015 CRPP listed short-term action items that fell within the abilities of existing staff and resources. Nonetheless, there were some actions clearly intended to improve future decision making. These included a stronger partnership between R2 and ORD to support citizen science projects relevant to coral reef protection, and to support development and implementation of biological water quality standards (Bradley et al. 2010; Fore et al. 2008).

The multiple-year CRPP required hard thinking about broader, long-term aspects of decisions to protect coral reefs, including effects of actions not only on environmental, but social and economic concerns of stakeholders. This ‘top-down’ approach included consideration of topics such as ecosystem services and economic benefits of coral reefs, human health and other social benefits from water quality improvements, stewardship and intergovernmental cooperation for long-term protection, learning and education for improved decision-making, and real and ancillary costs of management actions. These are issues that cannot all be addressed by one-year action plans but reveal the overall intent of R2 personnel for implementing coral reef protection. Although these were not completely independent processes, the top-down approach captured many of the objectives that were

also identified in the bottom-up approach. In this case at least, top-down and bottom-up approaches for developing objectives were not mutually exclusive. Belton (1999) note that developing objectives with both approaches can provide greater insights. As demonstrated here, the top-down approach can help identify objectives that are not apparent or currently under consideration and the bottom-up approach is useful for identifying measurable objectives that are important to immediate tasks.

By its nature, the multiple-year CRPP will necessarily require a high level of stakeholder involvement, not only to ascertain community values and concerns over sustainable outcomes, but as partners and stewards for implementing change into the future. Most of the tasks in the CRPP require some outside facilitation or voluntary support to succeed. This was viewed by R2 personnel as an opportunity to collaborate with stakeholders to generate effective programs (Gregory et al. 2012). As the CRPP is updated over time, it will increasingly engage stakeholders into the planning process and, as a result, will increasingly incorporate stakeholder objectives.

Certain objectives were better described as strategic, or long-term objectives. These objectives are important but have too many uncertainties, are too long-term, or lack data or robust modeling capabilities for direct attribution to R2 actions. Nonetheless, the strategic objectives are important to specify and retain in the CRPP. Their specification helped characterize key long-term aspirations for the CRPP which include environmental and socioeconomic benefits directly related to coral reefs and the importance of achieving broad public support from developing and implementing policies. The strategic objectives provide a basis for working towards long-term beneficial outcomes in protection and outreach tasks. They will continuously define and focus shorter-term objectives and will spur creation of additional objectives that contribute to the overall vision.

Differentiating means and ends is a useful organizing tool. Some means objectives were not captured in existing 2015 CRPP tasks but were important to consider for future tasks. The development of community-based green infrastructure programs, for example, could support many of the fundamental objectives by reducing runoff to coral reefs from diffuse sources of pollution. This would also benefit community stewardship initiatives. Green infrastructure could affect other important values outside of coral reef protection, including community beautification and livability, air quality, storm drainage, and water retention and protection. As the CRPP develops over time, the scope and definition of objectives may include these co-benefits.

The process initiated here was intended to allow responsiveness to issues and emerging threats that fit with the dynamic nature of the CRPP. Growth capabilities are built into the process. The objectives can be carried from year to year and modified, subtracted or expanded depending on their relevance and importance. In this process, the means-ends network in Fig. 1 can continue to serve as an organization platform on the fundamental objectives for the task plans and the means of achieving them. As the CRPP continues to be updated with new tasks or modifications to existing tasks, the means-ends network in Fig. 1 can be used to communicate the task objectives and means objectives. The additional work on the multi-year objectives can also be used to inform the fundamental objectives for the

tasks, including unanticipated consequences and trade-offs. The objectives provide a tool to track progress by defining what is important to the program and, combined with attributes, will guide data collection efforts in ways that could also benefit the construction and modification of future tasks (Keeney 1992). Although these objectives were developed to encompass the vision of the CRPP as a whole, they can be adapted to location-specific risk assessments for coral reef sustainability. This will allow actions to be modified and resources directed towards achieving the objectives. Likewise, the objectives and attributes can be a useful starting point for tasks that require prioritizing or targeting resources (e.g., prioritizing an area to establish a NDZ, targeting assistance grants to communities, scheduling compliance inspections for sewer overflows). For these activities, objectives should be identified that are specific to these contexts to ensure that sensitive and important indicators are not overlooked. Attributes should also reflect the spatial and temporal aspects of the problem scenario. However, understanding the broader context and objectives of the CRPP provided a useful basis for informing task development and prioritizing activities in the future.

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Fig. 1.

Means-ends network for 2015 objectives for the U.S. Environmental Protection Agency Coral Reef Protection Plan (CRPP). Tasks and their specific means objectives are enclosed in boxes and fundamental (ends) objectives are in the center box. USVI = United States Virgin Islands, PR = Puerto Rico, WW = wastewater, ESA = Endangered Species Act, MS4 = Municipal separate storm sewer system, R2 = Region 2, ORD = Office of Research and Development, NDZ = No discharge zone, BMP = Best management practices, CWA = Clean Water Act, WQ = water quality

Fig. 2. Means-ends network for multiple years of the United States Environmental Protection Agency's Coral Reef Protection Plan. The means objectives are on the left and fundamental (ends) objectives on the right. Each means objective is detailed in the text

Fig. 3. Means objectives for improving coastal water quality, which is one means to achieving fundamental objectives for the multi-year approach (see Fig. 2)

Fig. 4. Means objectives for achieving regulatory compliance, which is one means to achieving fundamental objectives for the multi-year approach (see Fig. 2)

Fig. 5. Means objectives for fostering sustainable practices, which is one means to achieving fundamental objectives for the multi-year approach (see Fig. 2)

Fig. 6. Means objectives for building procedural capacity, which is one means to achieving fundamental objectives for the multi-year approach (see Fig. 2)

Fig. 7.
Means objectives for learning and reducing uncertainties, which is one means to achieving fundamental objectives for the multi-year approach (see Fig. 2)

Table 1

Example of a constructed scale related to coral reef health within a delineated spatial region. As the levels increase from 0 to 5, the preferability also increases so that the least preferred scale level is 0 and the most preferred is 5

Scale levels	Description
0	Seafloor surface is barren of benthic biota or completely dominated by algal species
1	No stony corals, sporadic sponges and sporadic gorgonians, seafloor is largely dominated by benthic algae
2	Region is dominated by sponges or gorgonians, sporadic or no stony corals, visible aggregations of algal colonies
3	Region is dominated by coral species, some sponges and gorgonians, small patches of benthic algae, stony corals absent or sporadic
4	Region is dominated by stony coral species but with visible indicators of stress such as bleaching or diseases in greater than 10% of the colony, healthy gorgonian or sponge colonies could be present, benthic algae is sporadic
5	High stony coral species dominance interspersed with other coral species, and sponges or gorgonians. Diseases and bleaching are negligible

Table 2

Fundamental objectives, sub-objectives, and attributes for the United States Environmental Protection Agency's Region 2 Coral Reef Protection Plan (CRPP). CS = constructed scale for the attribute

Category	Fundamental objective	Sub-objective 1	Sub-objective 2	Attribute
Environmental	Decrease exposure of coral reefs to physical and chemical stressors (point source, nonpoint source, sewage)	Decrease exposure to endangered and threatened coral species		Diversion of measurable quantities of pollution
		Decrease exposure to coral reef communities	Reef communities of varying ecological condition	Diversion of measurable quantities of pollution
		Decrease exposure to regions without coral reef benthic habitats but capability of supporting them		Diversion of measurable quantities of pollution
		Decrease exposure to other benthic habitats that directly benefit coral reef communities	Coastal wetland habitat	Diversion of measurable quantities of pollution
			Mangrove habitat	Diversion of measurable quantities of pollution
			Submerged aquatic vegetation habitat	Diversion of measurable quantities of pollution
	Minimize damage to coral reef habitat from dredge and fill disposal activities	Minimize permanent impacts on coral communities	Reef benthic communities of varying ecological condition	Areal quantity of reef habitat permanently impacted
		Minimize temporary impacts on coral communities	Reef benthic communities of varying ecological condition	Areal quantity of reef habitat temporarily impacted
	Avoid ancillary damage to environmental resources in construction and implementation	Avoid damage to terrestrial habitat		Acres of lost or degraded quality wildlife habitat
		Avoid damage to aquatic habitat		Acres of lost or degraded quality fish habitat
Economic	Decrease external collateral costs/ Increase external cost-savings (including property and infrastructure)	To government agencies		Net value
		To industries		Net value
		To residents		Net value
	Efficiently manage public resources	Time and effort		Full time equivalents (FTEs)
Social	Decrease exposure to reef communities important to humans	Funding management		CS- Will funds be distributed and used appropriately?
		Class A waterbody designated uses		Diversion of measurable quantities of pollution
		Class B waterbody designated uses		Diversion of measurable quantities of pollution
		Class C waterbody designated uses		Diversion of measurable quantities of pollution
	Decrease recreational disruptions from	Primary contact recreation (swimming and wading,	Lost recreational opportunities	Person-days of primary contact recreational activities

Category	Fundamental objective	Sub-objective 1	Sub-objective 2	Attribute
Human health	degraded water quality	snorkeling and diving, skiing, surfing)	Degraded experiences	lost due to physical, chemical or biological pollution
				Person-days spent in unaesthetically pleasing conditions such as turbid waters
	Foster social benefits from stewardship	Noncontact recreation (commercial and recreational fishing, boating, beach shoreline activity)		Person-days of noncontact recreational activity lost due to physical, chemical or biological pollution
		Positive outside perceptions of community vigilance and stewardship		CS- Will community contributions to coral protection be acknowledged in jurisdictional to international venues?
		Ownership and empowerment in coral reef protection		CS- How much ownership for the coral protection tasks will be taken by the communities?
		Pride and feeling of making a contribution in individuals		Person-days spent participating in stewardship and volunteer opportunities directly or indirectly initiated by the CRPP
	Foster improved understanding and knowledge from education initiatives	For the general public		Person-days spent in quality educational opportunities
		For K-12 students and teachers		Person-days spent in quality educational opportunities
		For college students and teachers		Person-days spent in quality educational opportunities
		For business owners		Person-days spent in quality educational opportunities
Human health	Foster equitable outcomes from decisions	For political leaders		Person-days spent in quality educational opportunities
		Foster a level playing field for regulated communities		CS- Will laws be enforced fairly across different industries?
		Foster equitable outcomes for environmental justice communities		CS- Will costs and benefits be distributed equitably across different ethnicities and income levels?
		Foster equitable outcomes among present and future generations		CS- Will costs and benefits be equitably distributed between present and future generations?
	Avoid public nuisances and inconveniences			Person-days of inconvenience
	Decrease health threats from degraded water quality	Exposure to bacteria		Measurable quantity of e coli and fecal coliforms diverted from recreational coastal waters, food sources, potable water sources, and other media directly contacted
		Exposure to chemicals		Measurable quantity of chemical loadings diverted from recreational areas, potable water sources, and fish species used for consumption

Category	Fundamental objective	Sub-objective 1	Sub-objective 2	Attribute
Governance/Political commitments	Contribute to EPA mandates	Contribute to EPA mission requirements		CS- How well will the CRPP contribute to the EPA mission?
		Contribute to the Administrator's vision		CS- How well will the CRPP contribute to the Administrator's vision?
		Contribute to the Regional Administrator's vision		CS- How well will the CRPP contribute to the Regional Administrator's vision?
	Fulfill regulatory mandates to protect coral reefs			# of regulatory activities initiated
	Foster inclusivity in CRPP development and implementation	Internally		CS- Will there be opportunities for managers and staff to contribute to the CRPP? Has new input been received and incorporated?
Learning	Develop alternatives and responses for future needs and priorities	Externally (federal, jurisdictional, and local agencies; non-governmental stakeholders; academics and experts)		CS- Will external stakeholder input advise the development and/or implementation of the CRPP?
		Design new actions		CS- Are there capabilities for designing effective actions to address condition changes, new issues and/or new priorities when required?
	Foster new technical advancements and innovations	Improve existing actions		CS- Will task development and implementation be flexible enough to address condition changes, emerging issues and/or new priorities when required?
		In environmental protection	Source control	# of improvement grants developed and sent out as requests for proposals (RFPs)
			Runoff prevention	# of improvement grants developed and sent out as RFPs
			Wastewater management	# of improvement grants developed and sent out as RFPs
		In monitoring		# of improvement grants developed and sent out as RFPs

Table 3

Strategic objectives for the United States Environmental Protection Agency's Region 2 Coral Reef Protection Plan (CRPP).

Category	Fundamental objective	Sub-objective 1	Sub-objective 2
Environmental	Protect, restore, and enhance ecological integrity of coral reef systems	Individual coral colonies	Endangered or threatened colonies
		Coral reef communities	Non-endangered nor threatened colonies
Economic	Protect, restore, and enhance economic benefits from coral reef systems	Property protection from storm waves	
		Economic benefits from reef-related activities	Tourism/visitation
		Increase employment in reef-related industries	Fisheries
Social	Protect, restore, and enhance social benefits from coral reef systems	Traditional uses of reef resources	Availability of coral fish species and resources for traditional uses (e.g., festivals, local markets)
			Traditional fishing and harvesting of reef resources
Human health	Protect, restore, and enhance human health benefits from coral reef systems	Recreational benefits	
		Protection of human lives from storm waves	Mortality from storm waves
			Morbidity from storm waves
		Sustenance from fisheries species	
Governance/Political commitments	Foster long-term public support and trust	Pharmaceutical discovery	