Adaptive Management Applications in U.S. Fisheries and Approaches to Analysis of Adaptive Management Programs Under the National Environmental Policy Act With Example Applications in Terrestrial Resource Management Scenarios

By

Kate Michie
National Marine Fisheries Service
St. Petersburg, Florida
August 2012

Capstone paper submitted in partial fulfillment of the

requirements for the Certificate in NEPA

Duke Environmental Leadership Program

Nicholas School of the Environment at

Duke University

2012

I. Introduction

The ever-changing conditions of U.S. fisheries require dynamic and adaptive management measures to ensure sustainability of target species and the industries which rely on them. Challenges of implementing such measures, as they relate to the National Environmental Policy Act (NEPA) process, often revolve around a need to fully analyze any number of predictable alternative outcomes in a thorough and thoughtful manner while avoiding the production of truly encyclopedic supporting documents. In fisheries management such outcomes may evolve within varying temporal boundaries, as is the case for species-specific rebuilding plans. Compounding issues may arise when: there is a lack of economic or biological data; there are uncertainties in data that do exist; or many complex regulations for the same fishery/species are implemented in quick succession limiting the amount of data carried forward from one regulation to inform the development of another.

The term "adaptive management" (AM) can take on various meanings depending upon its application. In fisheries management, AM could be defined as a useful management tool in situations where current and future biological and management uncertainties exist. Using AM strategies in this application can have many benefits; however, it can also create a very high number of permutations of reasonable alternatives making the associated NEPA analysis complex and lengthy. The objective of this report is to explore the biological and socioeconomic advantages of using AM strategies in fisheries management, outline potential difficulties of building a strong NEPA analysis for AM actions, and explore how other federal and state agencies are using AM.

I.I. Fisheries Management in the United States

United States fisheries are managed by the National Marine Fisheries Service (NOAA Fisheries), which is a line office of the National Oceanographic and Atmospheric Administration, under the Department of Commerce. Federal fisheries management is governed by the Magnuson-Stevens Fishery Conservation and Management Act (Magnuson-Stevens Act), which was reauthorized in 2006. NOAA Fisheries consists of six Regional Offices, six Science Centers, and eight Regional Fishery Management Councils. Each Regional Office is responsible for the administrative elements of fisheries management, and for the development of supporting

NEPA documents for management actions. Councils develop fishery management plans and recommend management measures for fisheries within their area of responsibility. NOAA Fisheries approves and implements these plans and measures. The Science Centers conduct multi-disciplinary research programs to provide scientific information to support national and regional management programs of NOAA Fisheries; and to respond to the needs of regional Fishery Management Councils, Commissions, fishery development foundations, government agencies, and the general public.[1]

To establish management strategies for federally managed fisheries, managers typically use stock assessments, which provide decision makers with the information necessary to make reasoned choices.[2] Stock assessments are a comprehensive review of a fish stock including its population status, a characterization of the fishery itself including recent changes in effort, species biology, natural mortality rates, fishing related mortality rates, population trends, and recent research findings. In the Southeast Region, the development of stock assessments is guided by the Southeast, Data, Assessment, and Review (SEDAR) process. SEDAR is a cooperative Fishery Management Council process initiated to improve the quality and reliability of stock assessments.[3] SEDAR emphasizes constituent and stakeholder participation in assessment development, transparency in the assessment process, and a rigorous and independent scientific review of completed stock assessments. SEDAR is organized around three workshops. The first is a data workshop where datasets are documented, analyzed, and reviewed and data for conducting assessment analyses are compiled. The second is an assessment workshop where quantitative population analyses are developed and refined and population parameters are estimated. The third is a review workshop where a panel of independent experts reviews the data and assessment and recommends the most appropriate values of critical population and management quantities. All SEDAR workshops are open to the public. Public testimony is accepted in accordance with each Council's Standard Operating Procedures. Workshop times and locations are noticed in advance through the *Federal Register*.[4] The SEDAR process can be quite lengthy and typically requires one year to complete.

II. Advantages of Adaptive Management Strategies in Fisheries Management

AM has the potential to be successfully applied to fisheries management for several reasons. An AM approach to managing the harvest of fish species could be especially beneficial for data poor stocks, in situations where a high degree of scientific or management uncertainty exists, and in the nationwide movement toward an ecosystem-based management (EBM) approach for fisheries.

Some commercially valuable fish species are considered data-poor, by the scientists and administrators who manage them. The term data-poor generally refers to an overall lack of biological or population dynamics data for any one federally-managed fish species and/or species group. A lack of data may be the result of insufficient resources in the form of funding, equipment, or personnel. Or the species in question may be rarely encountered inhibiting the data collection process. Predicting the outcome or overall potential for effectiveness of new fishing regulations for any data-poor species can be extremely difficult to do even with an acceptable level of uncertainty. Using an AM approach to managing data-poor species could eliminate the need to predict long-term impacts of management measures and circumvent issues sometimes caused by high levels of uncertainty.

Another obstacle facing fishery managers is data uncertainty. In some cases data that are available are associated with a high or moderate degree of uncertainty. This uncertainty may originate from known errors in the data collection process, a lack of data extending over long periods of time, conflicting research, anecdotal information, and/or scientific models. Data uncertainty not only makes fishery management decisions more difficult to analyze under NEPA, it also creates an added layer of public mistrust in the decisions that are made. Because of the negative public perception that fisheries managers use “flawed science”, it is especially important that robust NEPA analysis be performed including a certification by the regions’ Science Center stating the data used is the “best available science” at the time the decision is made.

II.I. Adaptive Management for Data-Poor Fish Species

For the purposes of this report, fish species targeted by commercial fisheries in the South Atlantic region of the United States will be used as examples. Several species in the South Atlantic are considered to be data-poor. Some of these species include gray triggerfish, wreckfish, yellowedge grouper, coney, graysby, white grunt, blueline tilefish, and golden crab. In an effort to manage these commercially important, yet data-poor stocks, vulnerability [to overfishing] indices are being developed to establish appropriate allowable biological catch levels required under the Magnuson-Stevens Act.

Implementing a system of AM for the above mentioned fisheries may alleviate the tendency to assign the ultra precautionary "highly vulnerable" label to fish species simply because they are considered data-poor. Relatively data-poor stocks highlight the need to develop a flexible semi-quantitative methodology for assessing risk of overfishing that can be applied broadly to many fisheries and regions.[5] Through a well-designed AM system, harvest levels could be established based on what *is* known about a species' life history, habitat utilization, and constant shifting of fishing pressure fueled by the regulatory environment. An AM approach to managing data-poor species would allow for timely adjustments to harvest restrictions should some new information become available, without restricting harvest unnecessarily.

A form of this type of AM is currently employed in the snapper-grouper fishery whereby a framework procedure allows for the regular adjustment of specific harvest parameters when new data becomes available. Framework procedures set forth a list of items that the Regional Administrator has the authority to adjust (without having to go through the time consuming fishery management plan amendment process), such as bag limits, quotas, area closures etc., in response to new scientific information. The frameworks themselves are typically analyzed under NEPA through an EIS. Often the subsequent adjustments made under the framework procedures, if determined to not be significant, are supported by an EA. However, framework actions could also be included in an EIS or grouped with other non-framework actions if deemed appropriate.

The example application of AM for data-poor fish species, above, would utilize the most important aspects of AM outlined in a webinar presentation given by Larry Canter[6] entitled "Adaptive Management Within the NEPA Process", where it is stated that:

> AM promotes flexible decision making that can be adjusted in the face of uncertainties as outcomes from management actions and other events become better understood. Careful monitoring of these outcomes both advanced scientific understanding and helps adjust policies or operations as part of an interactive learning process…It is not a "trial and error" process, but rather emphasizes learning while doing. AM does not represent an end in itself, but rather a means to more effective decisions and enhanced benefits... [7]

One can easily see that the primary tenants of AM are ideally suited to fisheries management applications. The ever-changing regulatory, physical, and human environments require fisheries management regimes incorporate a commensurate level of flexibility.

II.II. Use of Adaptive Management in Ecosystem-Based Fisheries Management

As NOAA Fisheries' movement toward EBM evolves, AM programs and associated framework procedures will become increasingly important management tools. According to the South Atlantic Fishery Ecosystem Plan,[8] the South Atlantic Fishery Management Council adopted three broad goals to support the move to EBM in the South Atlantic Region. Those goals include maintaining/improving: ecosystem structure and function; economic, social, and cultural benefits from resources; and biological, economic, and cultural diversity. [9] Although data on some specific species and specific habitats are available, much of the information needed to implement EBM, such as benthic maps, ecosystem models, and detailed information on fishing fleet dynamics is lacking. Despite the data gaps considered here, it has been possible to proceed with some aspects EBM through the first Comprehensive Ecosystem-Based Amendment of the South Atlantic Region. This amendment used an ecosystem-based approach to analyzing and implementing protective measures for a series of deepwater coral habitat areas of particular concern in federal waters of the South Atlantic.

Due to a plethora of information yet to be uncovered and analyzed in a meaningful way, future EBM actions would likely benefit from the flexibility that could be built into an applied AM program. In doing so, ecosystem managers would have the ability to respond to changes in ecosystem impacts, utilization, and planning. As EBM evolves through time, so will the technology used to capture and measures regulatory impacts, as well as overall ecosystem health. Therefore, it would be prudent to build in a system of AM that could grow and evolve along with the EBM approach to managing fisheries and related ecosystems.

III. Analyzing Adaptive Management Programs Under NEPA

Predicting the long-term impacts of any fishery management decision under NEPA can be challenging even for regulations affecting species with the most robust data sets supporting them, much less for data-poor stocks. However, AM is not only for data-poor species. Because of the innate flexibility of AM and the continually changing fisheries environment and pressures imposed upon it, AM has the potential to be successfully applied to virtually all federally managed fish stocks across the U.S. in addition to those associated with a lack of data or with management and/or scientific uncertainty. AM recognizes that knowledge about natural resource systems is sometimes uncertain and may be the preferred method of management in these cases.[10] Using an AM approach to fisheries management provides the opportunity to perform a NEPA analysis for every regulatory change as needed, i.e., when some threshold is reached or some form of new data becomes available.

Analyzing smaller incremental changes made within a broader AM regime circumvents the need to predict potential impacts too far into the future to be modeled with any true certainty. Such NEPA analysis could take the form of one large programmatic Environmental Impact Statement (EIS) that would cover the entire snapper-grouper fishery for example, within which the entire AM system is analyzed in mostly qualitative terms. This programmatic EIS could then be followed by smaller more specific NEPA documents, Environmental Assessments (EA) or EISs, which would support smaller adjustment/incremental-type actions under the larger programmatic AM umbrella. For example, an EA could contain the NEPA analysis for environmental impacts of a bag limit reduction for black sea bass, a species within the fishery management unit of the snapper-grouper fishery. This EA could be designed in such a way as to be tiered off the larger programmatic EIS and include a focused quantitative analysis specific to the action to reduce the bag limit.

Fisheries managers currently employ the EIS tiering approach referenced above in the form of a framework action carried out within the scope of a previously analyzed framework process. Many fishery management plans include some form of framework process, whereby certain fishery regulations may be added or adjusted if new science suggests a change is necessary for successful management of a species or species complex. Actions implemented using a previously established framework procedure are typically completed in a more timely fashion relative to standard fishery management plan amendment actions since they require one less mandatory comment period (the 60-day comment period for the notice of availability of the amendment) under the Magnuson-Stevens Act because their NEPA analysis for framework procedure was previously completed at the time the framework procedure was developed.[11] The use of framework procedures and actions are themselves a form of AM in that their purpose is to facilitate an expeditious regulatory response to some environmental or scientific change.

III.I. Public Involvement and Adaptive Management

Most NEPA practitioners are familiar with the scoping process and the overall need to facilitate public review and input for actions being analyzed under NEPA. Actions utilizing an AM approach to managing natural recourses are no different in that they too would require the requisite early and open public involvement process. Scoping for an action that includes a long-term AM plan would likely require more work and explanation on the part of those presenting the information to the public, than would be required for a typical federal action. This is because AM programs are often wider in scope than a typical single focus action, which would only require an analysis of direct and indirect impacts within the one dimensional boundaries of a "one time" action.

Since AM in fisheries management would likely involve several tiered or step-wise levels of implementation triggered by knowledge gained over time, the entire process of building in proactive management measures, and the potential effects thereof, would need to be disclosed in as much detail as necessary for public consumption. Projecting quantitative impacts of actions that may or may not be triggered by some far-into-the-future information gathering effort is not practical, and could probably not be done with a high degree of certainty. Therefore, it is imperative the public understand the overall AM concept, and how it will be applied to a specific situation. Though explaining AM, as it could be related a specific fishery management decision could be difficult and would require tactful presentation. The benefits of doing so could be realized in the form of improved public perception of a more flexible and adaptive fishery management process.

Typically, constituents are presented with short and long-term impacts of a single action in an "if this, then that" type of scenario. Often, public opposition to a proposed fishery management action is fueled by the seemingly permanent nature of the action and its impacts. Employing a more flexible AM approach could ease public apprehension related to this perception of permanency. If constituents are informed that actions within a subject AM plan can be revisited and modified under certain pre-determined circumstances, the fear associated with a final/permanent set of negative impacts may be mitigated. It is also more likely that the general public would offer greater support for fishery management actions based on a system of flexible decision-making designed to evolve along with societal and biological changes. Under this type of AM plan, constituents could be given a much larger range of possible actions and impacts based on whatever outline is established for the proposed AM. In essence, the "if this, then that" scenario could be extended into infinity allowing the public to see that the current action under consideration is not as finite as they once believed, but rather is open to constant adjustment within the bounds established by the AM program. An AM plan presented effectively to constituents could ease the emotional reaction to potential adverse economic impacts by illustrating that those impacts may not be permanent and the actions that may cause them could be re-addressed and adjusted as needed. AM has been used successfully to quell public misconceptions and discontent in other non-fisheries related situations, an example of which appears in section IV of this report.

III.II. Potential Difficulties in Drafting a NEPA Document For an Adaptive Management Program

AM programs are often developed with the intent of functioning well into the future as a systemic approach to implementing modifications to a particular management regime on an "as needed" or pre-scheduled basis. Quantitative analysis of biological, economic, social, and administrative impacts of such a network of planned, but not yet implemented, actions may be extremely difficult under the NEPA umbrella, given the ever-changing nature of the economic and biological parameters such as gas prices and anomalous events like hurricanes. However, it is likely that effects of the most immediate action to be taken under a new AM program could be quantified to some degree. Beyond the immediate action, the AM plan and possible impacts thereof could be analyzed in a qualitative fashion with an emphasis on the overarching intent of a given AM system. As previously stated, this type of NEPA analysis could take the form of a programmatic EIS that would analyze the entire AM program. Then, as subsequent actions are needed under the subject AM program, smaller action-specific NEPA documents could be developed and tiered off the larger programmatic EIS. This system of one large "parent" NEPA document supporting subsequent "children" NEPA documents on an as-need basis would ensure that the AM program is adequately analyzed under NEPA, as well as any related actions falling within the scope of the establish AM system.

It is important to note that the type of NEPA document used is not necessarily as important as how well the issue is scoped, and how well the NEPA document is written. Regardless of whether a CE, EA, or EIS is used to support an AM plan, the document should serve the general public equally as well as the decisions makers. This means great effort should to be paid to constructing a clear, concise, and meaningful analysis of potential impacts on the human environment. The NEPA process is intended to give the public ownership in actions that will potentially affect them, while providing the best information available to resource managers to base their decisions on.

IV. Examples of Successful Adaptive Management Programs in Alternate Applications.

AM has been successfully applied to several different natural resource management issues, several of which contain parallel elements found in the fishery management world. AM has been applied to both large and small scale projects. The following summarizes several situations where AM has lead to successful resources management and similarities of how different agencies have utilized AM compared to NOAA Fisheries.

IV.I. U.S Fish and Wildlife Service (duck harvest regulation)

The U.S. Fish and Wildlife Service (USFWS) is responsible for managing the yearly allowable harvest of recreationally hunted waterfowl in the United States. The USFWS adopted the concept of adaptive management for regulating duck harvests in 1995.[12] Like fisheries managers, duck harvest managers face several sources of uncertainty including, variation in the environment, limited management control, sampling error, and biological uncertainty.[13] To deal with these uncertainties USFWS adopted an adaptive harvest management system whereby each year, an optimal regulatory choice is identified based on resources and environmental conditions, and current model weights are assigned; after which, model-specific predictions for subsequent breeding population size are determined. When data becomes available, model weights are increased to the extent that observations of population size agree with predictions, and decreased to the extent that they disagree. Finally, the new model weights are used to start another iteration of the process.[14] According to USFWS, this yearly cycle of accounting for changes in overall population abundance provides the regulatory choice each year necessary to maximize management performance.

According to the USFWS Adaptive Waterfowl Harvest Management Report found at http://www.doi.gov/initiatives/AdaptiveManagement/documents/adaptiveharvestmanagement.pd f, public notice was given that an EIS was going to be prepared for the consideration of a range of management approaches for sport hunting of migratory birds including the current AM approach. At this time, there is no record of the EIS having been completed. Previously, in 1977, a programmatic EIS for the migratory bird harvest program was developed, and was supplemented in 1988.[15] The implementation of an AM approach to regulating migratory bird harvest in 1995 has been supported by the development of an annual EA with well defined alternatives based on a public rulemaking process (U.S. Fish and Wildlife Service 2012). The USFWS states in its report on the effectiveness of its AM program that "the AM process is by its very nature a systematic, coherent, and open process for decision-making; these features have great potential to enhance the annual EA process further". In the proposed EIS the USFWS will include their AM program as an alternative that will "institutionalize an adaptive approach for setting annual regulations, as well as a protocol for application of AM concepts, within the NEPA framework."[16]

The same adaptive approach to building in a routine response to regularly acquired knowledge could also be applied to fishery management decisions, thereby fostering an environment of predictability that would benefit fishing-related businesses. Currently, in fisheries management, stock assessments are conducted on a species specific basis and do not occur on a very regular schedule. Additionally, there is typically a large time lag between actual harvest and reporting of the harvest, which often precludes the use of real time data. It should be noted; however, that this is not the case in all instances. Some fisheries such as king and Spanish mackerel do have a system in place where landings are tracked throughout the fishing season, and actions are routinely taken to close the fishery when the quota is projected to be met. But in some areas this is rare, especially in the Caribbean where there are many fisheries monitoring obstacles. In those cases, management actions tend to be more reactive, and based on intermittent stock assessments that could reveal a fish stock is being overfished, setting off chain of events, including, but not limited to, sometimes severe expedited regulatory responses required by management statutes.

IV.II. Glen Canyon Dam

Glen Canyon Dam was built on the Colorado River in Arizona by the U.S. Bureau of Reclamation in the late 1950's and early 1960's. The dam stores and releases water from Lake

Powell, and provides electricity to the states of Arizona, Colorado, Nevada, Utah, New Mexico, and Wyoming.[17] In 1997, the Glen Canyon Adaptive Management Program was established to provide long-term research and monitoring of downstream resources.[18] Information gleaned from monitoring efforts is used to guide overall dam operations. The Glen Canyon Dam Adaptive Management Program utilizes a work group, which functions very much like the regional Fishery Management Councils. The Glen Canyon Dam Adaptive Management Work Group is a Federal Advisory Committee that makes recommendations to the Secretary of the Interior on actions affecting the management of Glen Canyon Dam resources.[19] Just like the nation's Fishery Management Councils, the Glen Canyon Dam Adaptive Management Work Group consists of an interdisciplinary group of stakeholders that work together to formulate appropriate resource management strategies.

Though the interdisciplinary approach to recommending management actions is not without flaws and can often be prolonged by lively debate, it does provide an avenue for multi-stakeholder participation on the decision making process. Allowing such participation fosters a sense of ownership in the resultant recommendations made by the advisory groups and could serve to temper mistrust of the federal government. Much like the USFWS AM model in section IV.I, the Glen Canyon Dam Adaptive Management Program is very prescriptive in nature and follows a well defined step-wise process for administering the management of the dam's resources. First, models are developed to reveal potential effects of policies, activities, or practices that are being considered for implementation; then hypotheses are formulated regarding the expected responses of the Colorado River ecosystem to dam operations and other management actions. Experiments are then conducted to test the hypotheses, and monitoring and evaluation reveal the accuracy or completeness of earlier predictions. Lastly, new information produced through experimentation is incorporated into management options and recommendation to the Secretary of Interior.[20]

The Glen Canyon Dam AM project itself was not supported by a specific NEPA document; however, the Bureau of Reclamation and the National Park Service is in the process of developing an EIS that will cover long-term management of the dam system and will include AM components. Details including an EIS schedule and projected contents of the EIS can be found at the project web site: http://ltempeis.anl.gov/eis/who/index.cfm. A notice of intent to prepare the EIS was published in the *Federal Register* on July 6, 2012, and scoping meetings were held thereafter. The agencies prepared a scoping report and are currently compiling the range of reasonable alternatives for the document.

One parallel that can be drawn between the management of Glen Canyon Dam and United States fisheries is that they are both required to implement management measures pursuant to federal resources management acts. The Magnuson-Stevens Act governs management of the nation's federal fisheries, while the Gran Canyon Protection Act governs management of natural resources within the Grand Canyon Region. Therefore, all resource management decisions must not only fall within the scope of the applicable AM plan, but must also comply with the overarching federal statutes governing them.

Thus far, the AM approach has been shown to work well for managing the Glen Canyon Dam. Specific improvements due to the use of an adaptive approach to management have been seen in two areas: 1) Working relationships among diverse groups of stakeholders have been established as well as a collaborative program for using the best scientific data to make recommendations to the Secretary of the Interior on satisfying the directives of the Grand Canyon Protection Act; and 2) a functional science center is in place capable of delivering the latest and most relevant scientific information for management decisions.[21]

Like the Glen Canyon Dam management agencies, NOAA Fisheries also utilizes separate Science Centers that operate independently of the regional fishery management councils and the Regional Offices where policy decisions on fishing regulations are made. The fisheries Science Centers are charged with providing data to fisheries managers, and deeming the data used in the decision making process as being the best available science. Similar to the SEDAR peer review process, the Glen Canyon Adaptive Management Program utilizes an independent, external, peer review process, which draws from a pool of external peer reviewers to ensure scientific integrity of data.

Another parallel element of fisheries management and resource management downstream of the Glen Canyon Dam system is the constant need to balance health of the ecosystem and impacts to the economic environment. In fisheries, an overfished species could require very significant harvest reductions, which may in turn result in significant economic hardship for the fishing communities that rely on its harvest. Managers of Glen Canyon Dam also have to consider hydropower production in their AM program. The main focus of the Glen Canyon Dam Adaptive Management Program is to improve the downstream ecosystem; however, they must do so while recognizing that the dam's production of electricity is a very important part of the southwestern United States economy. In order to address environmental concerns downstream of the dam, electricity generation was decreased by approximately one third, forcing some areas to purchase power from alternate source.[22]

Because of the extensive similarities between this and other federally managed natural resources, it may be advantageous for NOAA Fisheries to open a line of communication to agencies dealing with such parallel situations. It is likely that there is much to be gained in the way of shared information if those agencies currently involved in AM programs are brought together in some meaningful way to discuss methods and problems they may have encountered during the planning and implementation process.

IV.III. Kissimmee River Restoration

According to the Kissimmee River Restoration case study,[23] the project is designed to restore 70 kilometers of river channel and approximately more than 10,000 hectares of wetland to reverse degradation caused by channelization of the river for flood control in the 1960's. Public outcry regarding the loss of floodplain, wildlife habitat, and ecological structure, spurned initiation of the Kissimmee River restoration effort. Though resource managers did not realize it at the time (around 1972), the restoration project would eventually incorporate an AM approach to restoring the natural flow of the Kissimmee River. Over the course of the 10 to 15 year restoration planning process, it became apparent that a piecemeal approach of conducting hydrologic studies, analyzing the results, and debating a permanent plan to utilize a variety of restoration techniques was not going to result in a cohesive, effective, and publicly palatable long term solution. From this dire situation "a fundamentally new approach evolved-from impoundments, water-control structures, and regulation schedules to a full-scale restoration of at least a minimum-sized footprint at an adequate scale to restore a functioning and sustainable portion of original river and floodplain that returned the natural hydrology and physical form of the river".[24] By systematically filling data gaps and designing an approach to restoration that was agile enough to respond to questions and situations as they arose, the project was able to move forward with significant public support. The AM program for the Kissimmee River restoration project, though never actually defined as an "AM" program, built in the ability to adapt to new information. Therefore, as the scientific data improved so did the management decisions.

The AM component of the Kissimmee River Restoration Project was not analyzed in isolation from other project components through the NEPA process. However, the basic ideas of AM are interwoven throughout the EIS and subsequent supplements to the EIS for the restoration project. In 1991 the first EIS for the restoration project was drafted, after which one EIS supplement was completed, once in 1995.[25] The agency did not specify as to why or why not they chose to supplement the earlier EIS rather than tier off the EIS with an EA, which could have also been done in this case.

The ability to seamlessly adapt to a constant influx of changing information is an idea that could ideally be applied to fisheries management, where fishery and species dynamics are constantly changing and data collection and analysis methods are always being improved upon. The Kissimmee River restoration project is similar to several fisheries management actions that have, in essence, applied an AM approach to overseeing natural resource use without actually formally defining them as AM plans. The establishment of framework procedures for setting harvest parameters in specific fisheries is one example that could be considered a type of AM approach since framework procedures set forth a list of relatively minor items that the Regional Administrator has the authority to adjust, such as bag limits, quotas, area closures etc., in response to new scientific information.

Resource managers involved in the Kissimmee River restoration project noted one very important lesson learned during their long process of restoring the original flow of the river. Project participants stated the following:

> Management should expect and plan for inevitable surprises. With large-scale projects especially, the long time periods from goal articulation to project completion make it highly probably that surprises will occur, and mid-course adjustments will be needed. Scientific, understanding, societal goals, or public opinion may shift dramatically over time.[26]

Keeping this lesson in mind, it is important for every NEPA practitioner and project leader to build in the maximum level of flexibility possible into their project design to account for those unexpected issues, and the inevitable shifting of societal needs over time. This may mean focusing on improving data analysis techniques, or building more creative NEPA documents that work well for both the public and decision makers, while including some degree of foresight to acknowledge issues that may or may not arise after the initial action has been taken.

V. Conclusion

The three examples presented in section IV of this report represent only a fraction of the multitude of ways AM can be applied to natural resources management issues. Across the nation and across federal agencies, the potential use for AM as a means to maintain sustainable resources is immense. The organization of some type of forum in which all agencies who use or are interested in implementing AM programs could yield significant benefits by providing opportunities for practitioners to share lessons learned, and successful strategies for NEPA analysis. An AM consortium for federal agencies where AM success stories could be shared may even encourage the use of AM in agencies and applications where it was not previously considered. An open dialogue among agencies may also reveal existing programs that already incorporate the AM concept could further encourage their utilization.

Clearly, AM could be applied to fisheries management and on some levels it already is being employed. As seen in the previously mentioned examples several successful models exist and could be used to guide the development of formal AM plans with fishery-related applications. As fisheries management evolves toward a more inclusive ecosystem based regime, the use of AM could be especially beneficial since a strategically implemented AM program should be able to grow and adapt to the ever-changing world of ecosystem-based management. AM could even be applied to the new catch shares initiative in fisheries management where shares of the total allowable catch would be issued to fishery participants. As fishing mortality rates change with the implementation of new regulations and efforts shifts, an AM program would be able to facilitate regular adjustments to harvest restrictions most appropriate for a stock at a given point in time. An AM plan that incorporates a predictable rhythm of regular adjustments to harvest limits based on regularly acquired data would foster greater trust in resource managers, encourage a more stable economic environment, and fulfill the tenants of NEPA.

<u>Notice:</u> *The material presented in this report represents the opinion and interpretations of a student enrolled in the Duke National Environmental Policy Act Certificate Program. In no way*

is this report considered a representation of the policies and views of the National Marine Fisheries Service.

VI. References

---

[1] NMFS (2010). NOAA Fisheries Service: National Oceanic and Atmospheric Administration Retrieved from www.nmfs.noaa.gov/.

[2] Cooper, Andrew B. (2005). A Guide to fisheries stock assessment: From data recommendations. New Hampshire Sea Grant College Program, Kingman Farm, University of New Hampshire, Durham, NH 03824. www.seagrant.unh.edu.

[3] Carmichael, John. (2007). SEDAR Guidelines: Southeast, Data, Assessment, and Review, A cooperative stock assessment program. SEDAR, South Atlantic Fishery Management Council. 4055 Faber Place Dr. Suite 201, North Charleston, SC 29405.

[4] Ibid.

[5] Patrick, W. S., Spencer, P., Ormseth, O., Cope, J., Field, J., Kobayashi, D., Gedamke, T. (2009). Use of productivity and susceptibility indices to determine the vulnerability of a stock: with example applications to six U.S. fisheries. National Marine Fisheries Service, 1315 East-West Highway, Silver Spring, MD 20910

[6] Canter, L., Atkinson, S. (2007). *Adaptive Management Integrated Decision-making – An Emerging Tool for Cumulative Effects Management.* Retrieved from http://www.eiatraining.com/Adaptive_Management-CEMgmtPaper.pdf

[7] Ibid. p.3

[8] (SAFMC) South Atlantic Fishery Management Council. (2009). Fishery ecosystem plan of the south Atlantic region. 4055 Faber Place, Ste 201, North Charleston, SC 29405

[9] Ibid.

[10] U.S. Department of the Interior. (2004). Environmental impact statements: Departmental manual, part 516 (National Environmental Policy Act of 1969), Chapter 4 (environmental impact statements), section 4.16 (adaptive management), 516 DM, May 27, 2004, Washington, D.C.

[11] (SAFMC) South Atlantic Fishery Management Council. (2010). Amendment 17B to the Fishery Management Plan for the Snapper Grouper Fishery of the South Atlantic Region, Environmental Assessment, Initial Regulatory Flexibility Analysis, Regulatory Impact Review, and Social Impact Assessment/Fishery Impact Statement, 4055 Faber Place, Ste 201, North Charleston, SC 29405.

[12] U.S. Fish and Wildlife Service. (2009). Adaptive harvest management: 2009 hunting season. U.S. Dept. Interior, Washington, D.C. 52pp. Retrieved from http:www.fws.gov/migratorybirds/CurrentBirdissues/Management/AHM/AHM-intro.htm

[13] Flyways.us. (2010). A collaborative effort of waterfowl managers across the continent. Retrieved from http//www.flyways.uw/adaptive-harvest-management-details.

[14] USFWS (2009). Adapive Harvest Management: 2009 hunting season.

[15] U.S. Fish and Wildlife Service. (2012). Adaptive waterfowl harvest management report. Retrieved from www.doi.gov/initiatives/AdaptiveManagement/documents/adaptiveharvestmanagement.pdf

[16] Ibid.

[17] USGS. 2005. United States Geologic Survey western coastal and marine geology Glen Canyon Dam. Retrieved from http://walrus.wr.usgs.gov/grandcan/dam.html.

[18] U.S. Department of Interior. (2010a). Glen Canyon Dam adaptive management program Retrieved from http://www.gcdamp.gov

[19] Ibid.
[20] Ibid.

[21] U.S. Department of Interior. (2010b). Glen Canyon Dam adaptive management program frequently asked questions. Retrieved from http://www.gcdamp.gov/faq.html

[22] Ibid.

[23] CamNet. (2010). Collaborative Adaptive Management Network. CAM programs & projects: Kissimmee River restoration. Retrieved from http://www.sfwmd.gov/portal/page/portal/levelthree/kissimmee%20river

[24] Ibid.

[25] Army Corps of Engineers. (1996). Kissimmee River headwaters revitalization project integrated project modification report and supplement to the final environmental impact statement. Retrieved from http://my.sfwmd.gov/portal/page/portal/xrepository/sfwmd_repository_pdf/3_kiss_headrevit_%2804-1996%29_%28search%29.pdf

[26] Collaborative Adaptive Management Network. (2010). CAM programs & projects: Kissimmee River restoration