

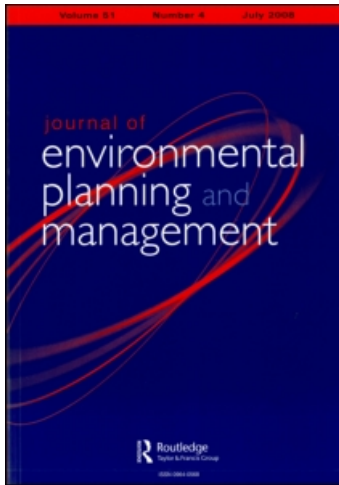
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Incorporating ecosystem-based management into urban environmental policy: a case study from western Washington

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The worldwide growth of urban settlements affects the management of natural resources and has prompted scholars in the natural and social sciences to call for ecosystem-based approaches to the management of human settlements. While considerable literature exists on the definition, theoretical underpinnings and methods for applying ecosystem-based management (EBM), few studies have examined whether urban and regional planners consider elements of EBM when developing environmental policy. This study assesses the extent to which planners apply EBM principles when reviewing scientific information for environmental policies in western Washington State. Using a working definition of EBM based on existing literature, the study conducts a content analysis of interview data from 42 environmental planners working for cities in western Washington, and asks what elements of EBM are considered as they review scientific information. The results suggest that elements related to monitoring, inter-agency co-operation, ecological boundaries, values and to a limited extent, adaptive management, are considered when planners review scientific literature for environmental policy development. However, urban and regional planners struggle with, or do not explicitly consider, the elements of scale, ecological integrity and organisational change when developing local environmental policy. The paper concludes with a description of why some elements of EBM are considered and why others are not, and offers suggestions for improving urban environmental policy development through application of EBM principles.

Keywords: ecosystem-based management; urban planning; science and policy; Washington State

1. Introduction

The widespread and increasingly rapid pace of change in Earth's ecosystems induced by human activities is evident in the transformation of multiple landscapes associated with urbanisation (Vitousek *et al.* 1997, Foley *et al.* 2005). Urban settlements significantly impact ecosystem services and functions through increased fragmentation and degradation of natural habitats, simplification of species composition, disruption of hydrological systems and modifications of energy flow and nutrient cycling (Pickett *et al.* 2001, Grimm and Redman 2004). In turn, changing ecological conditions resulting from urbanisation

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affect human health and well being (Patz *et al.* 2005, Corburn 2005). Evidence is mounting that current approaches to urban development are unsustainable and that the value systems and underlying processes of urban governance and planning need to be reformed to reduce the ecological impacts of human activities (Millennium Ecosystem Assessment 2005, Najaf *et al.* 2007).

Attempting to reduce human impacts on ecosystems, many scholars have called for ecosystem-based approaches to manage human settlements. Broadly speaking, an ecosystem-based approach is the process of managing and understanding the interaction between biophysical and socio-economic dimensions of landscapes within regional or larger systems (Slocombe 1998). Management of human settlements using ecological and social principles has been central to arguments made by ecologists (e.g. Naiman and Bilby 1998, Dale *et al.* 2006), planners (e.g. Beatley 1994, Alberti and Marzluff 2004), and social scientists (e.g. Cortner and Moote 1999, Dolšak and Ostrom 2003, Berkes *et al.* 2003). These scholars recommend identifying scientific, institutional and administrative approaches to managing *whole* ecosystems. As such, one goal of the ecosystem-based approach is to link explicitly knowledge of the human impacts on ecosystems to urban and regional planning policies that may work to reduce the unintended consequences of urban development on ecosystems.

Ecosystem-based management (EBM) attempts to integrate biophysical and social dimensions of human activities with scientifically informed management systems. While considerable literature exists on the definition, theoretical underpinnings and methods for applying ecosystem-based management, few studies have examined whether urban and regional planners consider EBM when developing environmental policy. Urban and regional planners (hereafter referred to simply as planners) are pivotal decision makers in the implementation of ecosystem protection measures. Knowing which tools they use to mitigate impacts of urbanisation is central to understanding the effectiveness of EBM in environmental policy.

This study assesses whether planners consider EBM and the extent to which jurisdictions use EBM when reviewing scientific information for environmental policies. Using data from interviews with planners working for 42 cities in western Washington State, the study asked what elements of EBM are considered by planners when they review scientific information. Understanding how planners review and use scientific information aids our understanding of the benefits and challenges of EBM strategies, their potential effectiveness, and how we can improve the links between science and policy to achieve more sustainable urban forms.

2. Defining ecosystem-based management

The concept of EBM was introduced in the late 1940s (Leopold 1949). In the 1990s, EBM became commonplace in the environmental management literature, particularly following the Rio de Janeiro Earth Summit in 1992. EBM is discussed widely in the literature, each author providing their own rubric for understanding the central defining themes of an EBM approach to environmental management. In a seminal work on the foundations for ecosystem management, Christensen *et al.* (1996) describe several components integral to creating a scientifically-based approach to terrestrial landscape management. These include considering spatial and temporal scales, complexity and adaptability of ecosystems, the soundness of ecological models, humans as components of the ecosystem and establishing clear and measurable goals focused on sustainability. Slocombe (1993a, 1993b, 1998) articulates the basis for using EBM themes in environmental management

and distinguishes ecosystem-based management from ecosystem management by describing EBM's origin as a management tool operating at multiple scales and engaging an integrative, transdisciplinary approach to pressing ecological problems. Others characterise EBM by examining its implementation in terrestrial (Sinclair and Knuth 2000, Belin *et al.* 2005) and marine (Fluharty and Cyr 2001, Nicholson and Jennings 2004, Hooker and Gerber 2004, O'Boyle and Jamieson 2006) environments.

To date, most researchers have assumed that through an explicit characterisation of EBM, planners and policy makers will be able to employ its principles more effectively. The understanding of EBM principles by policy makers has rarely been tested, but in one comparison of how scientists and management agencies define EBM, Arkema *et al.* (2006) found extensive disparity between scientific definitions of EBM and the process by which it was implemented. As a result, while EBM is increasingly called for in environmental management, little is known about how regional decision makers employ EBM principles.

Only recently have scholars begun to identify the importance of using ecological principles in managing urban development (Zipper *et al.* 2000, Marcotullio and Boyle 2003). Indeed, urban applications of ecosystem-based approaches have focused on only a few EBM themes. Common foci are the role of spatial scale of urban development (Wu and Loucks 2001, Cumming *et al.* 2005, Borgström *et al.* 2006); the coupling of human-natural systems (Elmqvist *et al.* 2004, Grimm and Redman 2004, Lui *et al.* 2007); and adaptive management (Angelstam *et al.* 2005). Other EBM themes in the environmental management literature include: ecological boundaries (Gunderson 1999); ecological integrity (Karr and Chu 1999); inter-agency co-operation (Doremus 2001, Stankey *et al.* 2005); monitoring (Ringold *et al.* 1996); organisational change (Danter *et al.* 2000) and human values (Cortner and Moote 1999). These themes explicitly address the integration of management concepts (e.g. adaptive management, inter-agency co-operation, and organisational change), human dimensions (e.g. values, agents of change) and scientific understanding (e.g. monitoring, scale dependency, ecological integrity). Through a systematic review of the environmental management literature, eight themes were derived that describe the essential components of an EBM approach to managing urban landscapes (Table 1). The eight themes are used as the framework for the evaluation of which EBM concepts are employed in urban environmental policy development.

Consideration of these ecological principles when siting new developments or restoring existing ones supports existing planning processes by integrating science and politics in developing effective strategies for land development and conservation. In addition, consideration of ecological principles affects the planning process by including a wider range of stakeholders – namely urban ecologists – to participate in decisions about the use and protection of the land. Recognising the legal and political framework that planners operate within can help urban ecologists participate in the systematic evaluation of ecological principles relevant to local environmental policy.

3. EBM in western Washington State

The discipline of urban planning has long attempted to provide systematic approaches for managing urban development. A recent development in this field is a policy known as growth management. Washington State's Growth Management Act (GMA), enacted in 1990, contains 13 specific planning goals (Revised Code of Washington (RCW), 36.70A). These goals can be broadly summarised as aimed at focusing new growth in existing urban areas; encouraging citizen participation in the planning process; preserving historically significant lands, sites and structures; maintaining and enhancing natural resource-based

Table 1. Ecosystem-based management themes derived from literature.

Item	Theme	Relevant citations	Description	Examples identified
1	Adaptive management	Walters 1986, Christensen <i>et al.</i> 1996, Marcotullio and Boyle 2003	The consideration of uncertainty in information and the use of an iterative process for meeting the goals of policies.	Plans and procedures for assessing monitored data
2	Ecological boundaries	Gunderson 1999, Johnson <i>et al.</i> 1999	The use of ecosystems to define management boundaries	Biomes, watersheds, wetlands, etc.
3	Ecological integrity	Karr and Chu 1999, Sample, 1994	The presence of native diversity and the resiliency of organisms in the environment	Species abundance and diversity
4	Inter-agency cooperation	Yaffee 1996	The involvement of multiple agencies when developing environmental management plans	Shared full-time equivalents, multi-agency memorandum of understanding
5	Monitoring	Ringold <i>et al.</i> 1996, Szaro <i>et al.</i> 1999	The collection of ecological data of relevance to stated management goals.	Total number of juvenile salmon over time, pollution levels, etc.
6	Scale dependence	Wu and Loucks 1995, Cumming <i>et al.</i> 2005, Borgström <i>et al.</i> 2006	The interaction of ecological functions across spatial and temporal regimes	Hydrological flows, nutrient cycles, landscape 'legacies', etc.
7	Organizational change	Danter <i>et al.</i> 2000	The level to which an environmental management organization can adapt to new information	Employee flexibility
8	Values	Cortner and Moote 1999	The consideration of human values and preferences when developing an environmental management plan	Human preference for vegetation

industries; protecting the environment; and enhancing the state's high quality of life (Ousley 2003).

Of particular relevance to this study is the formulation of planning goal number 9, which states that the GMA aims to "retain open space, enhance recreational opportunities, conserve fish and wildlife habitat, increase access to natural resource lands and water, and develop parks and recreation facilities". This goal was amended in 1995 with the passage of RCW 36.70A.030, requiring municipalities to consider the 'best available science' (BAS) when designating critical (or environmentally sensitive) areas in the state by a specific date (most by December 2004). Critical areas include wetlands, fish and wildlife habitat conservation areas, aquifer recharge areas, geologically hazardous areas and frequently flooded areas (Ousley 2003). They are protected by Critical Areas

Ordinances (CAOs) created by individual jurisdictions working within the guidelines of the GMA, which requires, that these areas are protected before other planning requirements are fulfilled, but acknowledges that other considerations (e.g. economic or private property rights concerns) are part of the land use decision-making process (Copsey 1999). The BAS amendment is unusual within the US because it compels local environmental planners (and their consultants) to assess the best scientific information for their jurisdiction, rather than relying on the contest of opposing experts to evaluate the reliability and validity of scientific information (a standard practice in the United States).

Much like the recommendations for employing an EBM framework to manage urban development, the BAS amendment also attempts to infuse a systematic approach to developing scientifically-informed environmental policy. However, while the BAS amendment regulates the process of review, the content of the scientific review is largely determined by individual jurisdictions. As a result, the requirement for jurisdictions in Washington State to consider BAS when developing CAOs provides an ideal opportunity to assess the extent to which EBM concepts are considered in the process of developing locally relevant environmental policy.

4. Methods

Cities within nine western Washington counties served as the primary units of analysis for this study, and lead environmental planners were the primary data source. The counties include highly urbanised (e.g. King, Pierce, Snohomish), mixtures of urban and rural (e.g. Kitsap, Thurston, Clark), and predominately rural counties (e.g. Clallam, Jefferson, Whatcom). Semi-structured interviews were conducted with 42 planners during 2003 and 2004. In-person interviews were conducted with all lead environmental planners in all jurisdictions that (1) responded to the telephone invitation for an interview and (2) had existing policies for protecting wetlands and fish and wildlife habitat conservation areas. Because the State of Washington had different deadlines for jurisdictions to complete updates to their Critical Areas Ordinances (including a review of BAS), and jurisdictions varied in the extent to which they had begun the scientific review process, only jurisdictions that had completed more than one-half of the review process by the time of the interview were invited. Half of the review process was defined as having examined the BAS applicable to their jurisdiction, and self-identified defined as having finished one-half or more of the update of the ordinance.

The interviews lasted 60–90 minutes and were taped and transcribed. Interview questions attempted to solicit from each planner the essential elements considered when drafting environmental policy for their jurisdiction. By focusing on the formulation of policy by planners, their considerations in making policy and the expected outcome, the essence of the policy development process was captured. An attempt was made to reduce the probability for biasing responses by avoiding questions specifically about EBM. For example, specific questions were asked about local planning considerations to obtain detailed descriptions of the development process, but planners were also encouraged to discuss all possible elements they considered.

A standard content analysis technique was used (Rubin and Rubin 2005) to analyse the interview data. Words or phrases (mentions) were extracted about the subject of interest together with their contexts and related to an EBM theme. In this manner, it was assessed whether each jurisdiction was considering specific aspects of EBM. Each mention was coded into categories based on a qualitative evaluation of each sentence of each interview. Coding and categorising each mention involved an iterative process, whereby the data

were reduced through a combination of *a priori* and emerging codes. This systematic and thematic approach to the interview data made it possible to compare the application of EBM principles across multiple jurisdictions.

Atlas.TI was used (Muhur 1997), a qualitative data analysis software package to organise and code interview data. Each transcript was coded with primary and secondary themes (Table 1), where the secondary themes are related to the primary themes through the context in which each were mentioned. For example, one planner stated that his/her jurisdiction was part of a larger watershed and that upstream and downstream effects were considered when developing critical area policies. The primary theme was coded as 'ecological boundaries' and the secondary theme as 'watershed effects'. Because a multiple coding protocol (primary and secondary) was used, the number of mentions may represent more than one thematic category. For example, when one planner said "we've attempted to monitor our streams but we've faced some challenges associated to getting the State Department of Ecology to co-operate", two primary themes were coded (monitoring and inter-agency co-operation) and two secondary themes (stream monitoring and plan oversight). Preserving this rich detail by using a qualitative analytical process was valuable to maintain the integrity of the planners' thoughts as well as providing as much insight as possible into the process of urban environmental policy formation. This analysis allowed the general EBM themes to emerge (primary codes), but also captured location-specific and planner-specific details of the application and context (with secondary codes).

5. Results

Planners in the study considered scientific information from one of three sources when developing environmental policy: from (1) reviews by scientists employed within the jurisdiction; (2) a bibliography of Best Available Science literature provided by the Washington State Office of Community, Trade and Economic Development (CTED); and (3) external consultants. The level to which jurisdictions relied on internal versus external reviews of scientific information was largely based on the population and economic status of the jurisdiction (for detailed breakdown of the relationship between population and type of review see Francis *et al.* 2004). Moreover, the process for reviewing scientific information generally consisted of a policy directive to review the BAS, evaluating whether existing ordinances complied with the BAS review, and amending existing ordinances as necessary. CTED also provided guidance for the process environmental planners should follow when considering scientific studies.

5.1. Using EBM in developing local environmental policy

Planners in all jurisdictions mentioned several of the EBM themes at least once during the interview (Figure 1). The most commonly mentioned EBM themes were monitoring, inter-agency co-operation, values, and ecological boundaries. However, there was considerable variation in how planners elaborated on each of the most often mentioned themes. Specific aspects of each EBM theme are described in more detail below.

5.1.1. Monitoring

All planners in the study mentioned that monitoring, in one form or another, was an essential part of their policy development process. Almost all jurisdictions were actively engaged in some form of ecological monitoring, and the few that did not have an active

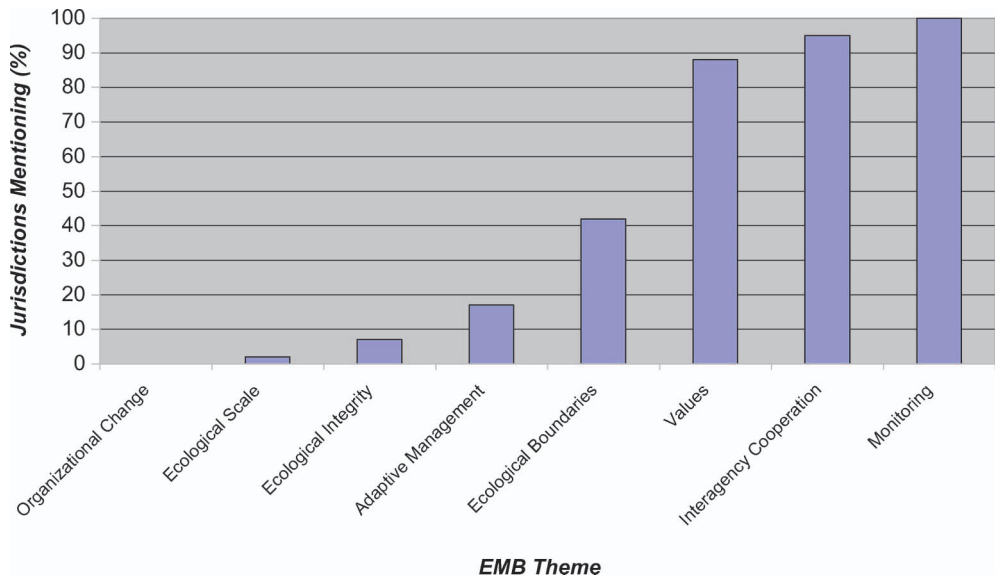


Figure 1. Percentage of respondents who mentioned themes associated with EBM (mentions were only counted once per respondent).

monitoring component had either conducted monitoring several years ago and had not resumed, or suggested that they did not have the knowledge, technical expertise or other resources to commence a monitoring programme. Explanations about monitoring consisted of discussions of the state of inventories, field sampling and GIS/Mapping. When respondents discussed inventories, they were primarily referring to an assessment of all the flora, fauna and landscape features in their jurisdiction. All agreed that inventories would be very helpful in developing environmental policy, but some (71%) indicated that inventories existed, and others (29%) claimed that they were either in the process of, or soon to begin collecting such data. Details of what was being monitored varied by jurisdiction, but generally consisted of some locally-initiated monitoring projects, and several state or federal projects. Respondents also suggested that field sampling and mapping were important for conducting any analysis or assessment of existing data.

5.1.2. Inter-agency co-operation

Across the respondents 95% mentioned inter-agency co-operation as an important issue in the review of developing local environmental ordinances. They carefully distinguished between inter-agency co-operation that occurred across jurisdictional boundaries (city and city, or county and county), and that which occurred between city and higher levels of government (e.g. state or federal). This difference is identified as horizontal versus hierarchical inter-agency co-operation. In addition, 92% of the planners noted that when inter-agency co-operation occurred through formal mechanisms, the interaction was technical in nature, often consisting of questions relevant to specific scientific literature, legal advice or code interpretation. All respondents suggested that informal, horizontal inter-agency co-operation was the dominant form of interaction across jurisdictional boundaries, and that this occurred primarily between similar jurisdictions in close geographical proximity.

Describing the value of informal, horizontal inter-agency co-operation in the design and implementation of workable CAOs, one environmental planner in a small city (population 7,500) stated that:

Working with the State is often difficult because they don't always understand the constraints for a small city like ours. We tend to rely on other cities near us to understand how they are doing it and we tend to share information and develop these polices together.

Thus, horizontal inter-agency co-operation proved more beneficial to creating a workable CAO than hierarchical inter-agency co-operation. Similarly, another environmental planner in a different small city stated that hierarchical co-operation was limited by its mode of interaction with the jurisdiction:

We are often faced with a situation where the State mandates a new [environmental] policy, and if we have never seen anything like this, then we have to rely on our partners. I talk to about 3 to 4 counterparts in other cities near us, and they are very helpful in learning more about how we meet the requirements of the mandate.

5.1.3. *Values*

Because of the political nature of the environmental planning process, planners involved in developing critical area ordinances often work with community members to better understand how their values are being represented (or not) in policy recommendations. Values, specifically those held by local people, were mentioned in terms of community feedback about the policy. Many respondents (78%) identified that community values help shape the process (and final product) of developing environmental policy:

We try to work with as diverse a constituency as possible. We don't want our policy to backfire, so we try to gather as much information as possible from our community and then we synthesise and integrate into environmental policy. So far it has worked well for us.

Information gathered from the community includes, for example, ecological information such as recent erosion of stream banks, flooding frequency, social information about neighbourhood stream stewardship projects or settlement patterns in a specific watershed area. However, other respondents (9%) noted that community values were important, but political priorities were often the primary and only consideration. For example, a planner in a large jurisdiction (population 310,000) stated:

Trying to please everybody is not possible. We have literally hundreds of interest groups in our city, and if we were to try to talk with everyone of them and learn about their opinions, we would never get anything done. So, we end up looking to satisfy city council members first, and then if they ask us to vet our ideas with the community, we do.

In this case, although some community values may be reflected by input from city council members, the sheer scale of governance and the planner's ability to involve the community in environmental planning is often trumped by political realities.

5.1.4. *Ecological boundaries*

Fewer respondents (42%) explicitly identified ecological boundaries in the environmental management process. Instead, they identified the challenges of using biophysical landscape features in developing environmental policies. Many planners recognise that their

jurisdictions are part of a larger ecosystem, such as a watershed or wetland, and they identified how natural landscape features served to either unite or sever relationships with other jurisdictions. For example, a quote from one planner captured a common sentiment:

We are the downstream recipients of everything that happens with the jurisdiction north of us. When they don't enforce environmental laws, we experience changes in our water quality. Unfortunately, our town is the most heavily impacted from cumulative effects of our upstream neighbours.

5.1.5. *Adaptive management*

Issues related to adaptive management were described by planners, but mentioned by only 17% of the study participants. Although no respondent explicitly mentioned the phrase 'adaptive management', aspects of adaptive management captured as secondary themes included updating, policy assessment and laws requiring policy review. For example, while respondents consistently described the need to "be responsive to policy mandates", and "reconsider the effectiveness of specific ordinances", they did not, even when probed, describe the rationale or the approach they would use to reconsider the effectiveness of a policy.

5.1.6. *Ecological scale*

While planners referred to scale through concepts such as ecological boundaries, no planners identified how the interaction of ecological functions across spatial and temporal dimensions would be part of a local environmental ordinance. Respondents were generally aware that activities in their jurisdictions may have ecological impacts on the surrounding landscape, but their statements focused primarily on the mandate to satisfy policy specific to their jurisdiction. For example, respondents were concerned with 'getting city council approval' or whether the State Department of Ecology 'would approve their ordinance'. Such sentiments suggest interest in geographic and temporal scales that are legally defined, either by jurisdictional boundaries or those with higher statutory authority.

5.1.7. *Ecological integrity*

This principle was only addressed in specific references to the importance of salmon in rivers located in particular jurisdictions. Because endangered salmon species are present in many of the jurisdictions included in the study, planners there are actively engaged in improving local riparian habitats. Ecological integrity is a larger concept than salmon; one that includes the ability to support and maintain a balanced, integrated, adaptive ecological system having the full range of elements and processes expected in the natural habitat of a region (Karr 1996). None of the respondents explicitly mentioned the role of a balanced, integrated and adaptive biological system, nor how any of their approach to ordinance development could address the ecological elements of the region. While respondents did describe specific aspects of flora, they generally neglected to mention how that feature could impact ecological integrity:

Our goal is to establish vegetation along the river corridor. The problem is that in an urban area, we cannot place large amounts of vegetation for a variety of reasons, such as private property, and existing concrete. So we need to figure out how to work in our highly urbanised areas to increase buffer widths.

5.1.8. Organisational change

This was never mentioned directly, and rarely even alluded to by the interview participants. Indeed, when management approaches were mentioned, respondents focused more on what the state or other jurisdictions could do to improve their management approach instead of examining the limitations in their own organisations. Planners rarely perceived that their own organisations were inflexible or unresponsive to new information (or mandates) during the development of environmental policy. Indeed, because they often have regulatory authority, planning agencies are required to enforce any ordinances they pass. Many respondents stated that mandates requiring specific end results but without prescriptions about how to achieve those ends were preferable. It was this understanding that prompted one planner to state:

We are a small jurisdiction and do not have the resources to do things exactly as the State would like. Sometimes we have to make ordinances that are not the ideal, but serve the function of our jurisdiction, specifically when we have to enforce those ordinances.

In this case, the planner recognised the limits of their jurisdiction to enforce regulations, but did not consider that developing an 'ideal' ordinance may require changes to the structures or processes of their own organisation.

6. Discussion

This study examined the process of developing environmental policy from the point of view of the urban environmental planner. By examining how these planners are dealing with a mandate to update their CAO using BAS, the study has attempted to evaluate the extent to which EBM themes were considered. The findings suggest that the extent to which aspects of EBM are considered by planners could be increased. It was found that only four of the eight central themes of EBM were generally mentioned by environmental planners in 41% of the jurisdictions. While the consideration of four EBM themes by 41% of planners may seem to represent a victory for ecosystem-based environmental policy making, other results derived from the interview data suggest that most planners have considerable difficulty translating scientific information for use in locally relevant urban environmental policies. The mention of EBM themes by planners, while indicating awareness, does not always translate to ecosystem protection. In addition, EBM principles are interpreted differently among planners, and some planners are more familiar or comfortable with some EBM principles than others.

Despite sustained enthusiasm for bio-regional planning (Dodge 1990, Goldhaft 1995, Moss and Milne 1998) or management systems based on ecological features (Dale *et al.* 2006), planners in the study were sceptical about the effectiveness of either of these approaches, often mentioning that their legal authority extends only to the boundaries of their jurisdiction. Even in cases when a jurisdiction was impacted by 'upstream events' or 'agencies outside their jurisdiction', environmental planners were doubtful about developing management systems based on regional or ecological boundaries. These sentiments may reflect existing governance structures, such as city councils, tax regimes and legal constraints that preclude planners from considering anything outside their jurisdiction. As one planner stated, "... if the issue is on the other side of Skagit River, we are not concerned with it". Moreover, while urban policy may one day embrace ecological

boundaries as an organisational entity, it still remains a theoretical concept, with limited implementation in the context of western Washington's urban areas.

Other prominent EBM themes mentioned by environmental planners were inter-agency co-operation and values. Unlike statements made about ecological boundaries, both inter-agency co-operation and values were perceived as important and regularly brought into the process for developing CAOs. State agencies, such as the Washington State Department of Ecology and CTED, offer technical assistance and are responsible for final approval of local environmental ordinances. As a result, respondents generally co-operated with state agencies only when interactions with existing networks of similar, local jurisdictions were exhausted or unavailable. Fear of non-compliance was often cited as the reason for the limited inter-agency co-operation with the state agencies.

Managing urban areas from an ecosystem perspective requires commitments from local, regional and state agencies as well as from individual property owners and private institutions. This shared responsibility is acknowledged by environmental planners through their consistent recognition that community values play a vital part in the environmental policy development process. Although public engagement in decision making is mandated by Washington's GMA, respondents indicated that the extent and type of engagement varied by jurisdiction.

6.1. Consideration of EMB themes

Several reasons may account for the presence or absence of EBM themes during the development of the CAO. The ubiquitous presence of 'monitoring' may be associated to the guidance provided by CTED. While CTED has provided extensive materials to aid jurisdictions in developing CAO under the BAS amendment, several documents specifically highlight the importance of surveying, mapping and monitoring when developing ordinances. On the other hand, issues of adaptive management and ecological integrity are rarely mentioned in CTED documents (CTED 2007). In addition, the presence of inter-agency co-operation may also be due to the type of guidance provided by CTED. Numerous jurisdictions stated that they received technical information from the state, and that they were encouraged to consult with CTED if they had questions or concerns about the policy development. This association between state guidance and mentions by planners suggests that the state plays a formidable role in the type and extent to which EBM themes are considered when developing local environmental policy.

Many of the respondents implied that local political concerns regarding economic development were the primary focus of policy efforts. This finding confirms results from other studies in other parts of the United States. For example, Norton (2005) found that local elected officials (to whom planners are accountable) believed that the principle pollution sources were upstream rather than local and that they tended to rely on the state to provide adequate environmental protection. As a result, the political constraints imposed by an elected official on the types of local policies promulgated can profoundly hinder (or encourage) a planner's ability to consider EBM principles.

The level of formal or type of informal education and training may also affect the extent to which EBM principles were considered. While the data do not contain information about the types of training each planner received (e.g. level of education or supplementary courses), the role of education has been well documented in the consideration of other resource management decisions (Jacobson and Marynowski 1997, Ewel 2001, Shandas 2007). A review of planning curricula in the United States suggests that within all the accredited planning schools in the US, over 80% offer courses

on environmental planning (Planetizen 2007). Although current planning programmes include environmental planning courses, the extent to which ecological concepts are applied in urban and regional plans remains unclear. In addition, within the national planning research conferences (Associated Collegiate Schools of Planning, American Planning Association), the environmental planning section has been growing stronger for two decades and continues to attract extensive participation.

Other reasons for the presence or absence of specific EBM themes may have to do with the type and/or number of staff in each jurisdiction. In an earlier study, using the same data, Francis *et al.* (2004) found that the population size of a jurisdiction was a strong determinant of the type of science used and the extent of scientific review. While this may describe some of the variation in the presence or absence of EBM themes, knowledge of environmental planning methods by individual planners may also affect the consideration of scientific information. For example, in the analysis, it was noted that several smaller jurisdictions (population < 10,000) with limited planning staff considered a greater proportion of EBM themes than jurisdictions with very large populations. This result suggests that continued training and education of staff, especially in the smaller jurisdictions, may serve a critical role in ensuring the consideration of relevant scientific information when developing environmental policy. Additional reasons for the presence or absence of EBM themes could include: (1) differences in the definition of EBM among ecologists and planners (Arkema *et al.* 2006); (2) lack of relevant science (Mills *et al.* forthcoming); and/or (3) the general lack of 'real-world' applications of specific EBM themes in jurisdictions, especially urban ones.

7. Developing systematic environmental management approaches

The EBM themes of scale, ecological integrity and organisational change were rarely mentioned by planners in the interviews. Examining this gap provides the basis for recommendations to foster or encourage more comprehensive consideration of EBM dimensions when developing environmental policy. Given the extensive legal, political and administrative challenges planners are faced with when developing local environmental policy, they cannot be faulted for limited use of EBM principles. Because EBM provides one example of a systematic framework, these suggestions are offered not to imply that EBM is the *only* approach, but as means for systematically reviewing scientific information when developing local environmental policy.

First, the limited mention of scale may be due to the localised nature of each environmental policy decision. Environmental planners, by definition, are required to manage environmental conditions in their jurisdiction – concerns about other jurisdictions occur only when they know of or speculate about a direct impact to their management system (e.g. changes in budget, resources, or procedures). However, issues of ecological boundaries were frequently mentioned by respondents. As a first step to improve the consideration of scales in the review of environmental policy, planners could be encouraged to consider how their place within the physical landscape (e.g. watershed, wetland, geologic hazard zone) can be used as an organisational unit for linking other jurisdictions experiencing similar conditions. State agencies might provide incentives and guidance for local jurisdictions to develop networks based on ecological characteristics, such as the lower Skagit River or Georgia Basin/Puget Sound eco-region. In addition, if existing 'checklists' provided by the state are linked to EBM elements through compliance, they could help address issues of inter-agency co-operation and scale, two important elements of EBM that are currently not explicitly considered in environmental policy development.

Second, ecological integrity was rarely mentioned by the respondents. The EBM literature clearly states that ecological integrity consists of the presence of native diversity and the resilience of organisms in the local environment. While monitoring for organisms seems to be occurring in most of the study's jurisdictions, the absence of specific mention of the concept of ecological integrity suggests a potential shortcoming in the development of environmental policy. A second step that is frequently overlooked in any monitoring effort is assessment. Assessment is the critical link that consists of aligning the measurement endpoints (what is monitored) to the assessment endpoints (the ecological goods and services society seeks to protect) (Karr and Chu 1999). Accordingly, jurisdictions should work to develop assessment protocols as a means for fostering discussions about what types of monitoring should occur and how these data can be used to improve local environmental policies aimed at protecting natural resources.

Third, organisational change was rarely mentioned by any of the environmental planners who were interviewed. The constraints posed by local, state and federal laws appear to prevent jurisdictions from developing responsive management systems that can adapt to changing fiscal and political conditions. While institutions have been defined as entities that function according to established rules and codes of operation, to date few institutions have embodied flexibility and adaptability within an environmental management system (Gunderson *et al.* 1995; Gregory *et al.* 2006). Fostering organisational change is by no means an easy process, but Kotter (1996) and others (Yaffee 1996, Danter *et al.* 2000) provide several examples of organisations that have created flexibility and adaptability in their approach to managing natural resources.

Finally, the development of tools that allow environmental planners to incorporate EBM principles into environmental management could foster more systematic assessment and application of scientific information into policy. For example, The Nature Conservancy's decision support toolkit for marine managers aims to provide information and case studies that help in the assessment of marine ecosystems and the identification of opportunities to enhance their conservation and management (TNC 2007). Through presenting multi-objective case studies, marine managers can identify the central principles to account for the multiple management objectives of marine conservation. Developing tools and case studies that aid and demonstrate systematic approaches for conservation in environmentally sensitive areas may improve the extent to which EBM principles are incorporated in environmental policy.

8. Conclusions

The consideration of scientific information when developing environmental policy is often stated as a shared goal for ecologists and planners. Examining the presence or absence of EBM principles in the process of developing environmental policy provides a means for understanding factors that may facilitate as well as hinder effective ecosystem protection. The study here begins to shed light on how urban environmental policy is formed by examining the development of CAOs. Although this represents only one type of environmental policy, exploring the CAO as an initial case study clearly illustrates the types of considerations planners employ when developing environmental policy.

Regardless of the reason for the lack of consideration of some themes, if the objective is to foster the use of EBM themes (or another systematic approach) when developing environmental policy, then guidance provided to jurisdictions by states or other regional planning organisations should reflect such approaches. In addition, if organisational change is not seen as an approach for responding to new information and mandates, then

the ability of jurisdictions to adapt to the foreboding pressures of climate change and urbanisation may be limited. Jurisdictions will benefit from development of internal guidance and policies that outline the process by which scientific information will be considered, and draw on the thematic basis of EBM to ensure that a comprehensive approach is used when developing environmental policy.

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