Contributed Paper

Biodiversity Conservation in Local Planning

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Abstract: *Local land-use policy is increasingly being recognized as fundamental to biodiversity conservation in the United States. Many planners and conservation scientists have called for broader use of planning and regulatory tools to support the conservation of biodiversity at local scales. Yet little is known about the pervasiveness of these practices. We conducted an on-line survey of county, municipal, and tribal planning directors* (n = 116) *in 3 geographic regions of the United States: metropolitan Seattle, Washington; metropolitan Des Moines, Iowa; and the Research Triangle, North Carolina. Our objectives were to gauge the extent to which local planning departments address biodiversity conservation and to identify factors that facilitate or hinder conservation actions in local planning. We found that biodiversity conservation was seldom a major consideration in these departments. Staff time was mainly devoted to development mandates and little time was spent on biodiversity conservation. Regulations requiring conservation actions that might benefit biodiversity were uncommon, with the exception of rules governing water quality in all 3 regions and the protection of threatened and endangered species in the Seattle region. Planning tools that could enhance habitat conservation were used infrequently. Collaboration across jurisdictions was widespread, but rarely focused on conservation. Departments with a conservation specialist on staff tended to be associated with higher levels of conservation actions. Jurisdictions in the Seattle region also reported higher levels of conservation action, largely driven by state and federal mandates. Increased funding was most frequently cited as a factor that would facilitate greater consideration of biodiversity in local planning. There are numerous opportunities for conservation biologists to play a role in improving conservation planning at local scales.*

Keywords: conservation policy, habitat conservation, Iowa, land-use planning, local conservation, North Carolina, urbanization, Washington

Conservación de la Biodiversidad en la Planificación Local

Resumen: *Las políticas locales de uso de suelo cada vez más son reconocidas como fundamentales para la conservación de la biodiversidad en los Estados Unidos. Muchos planificadores y científicos de la conservación han hecho un llamado para el uso extendido de instrumentos de planificación y regulación para soportar la conservación de la biodiversidad a escalas locales. Pero, se conoce poco sobre la generalidad de estas prácticas. Realizamos un muestreo en línea de directores de planificación tribales, municipales y de condados* (n = 116) *en 3 regiones geográficas de los Estados Unidos: Seattle, Washington y Des Moines, Iowa; y Research Triangle, Carolina del Norte. Nuestros objetivos fueron estimar la extensión a la que los departamentos locales de planificación atienden la conservación de la biodiversidad e identificar factores que facilitan o limitan las acciones de conservación en la planificación local. Encontramos que la conservación de la biodiversidad raramente fue una consideración importante en estos departamentos. El tiempo del personal*

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se dedicó principalmente a mandatos de desarrollo y se invirtió poco tiempo en la conservación de la biodiversidad. Las reglamentaciones que requerían acciones de conservación que pudieran beneficiar a la biodiversidad fueron poco comunes, excepto reglas referentes a la calidad del agua en las 3 regiones y la protección de especies amenazadas y en peligro en la región de Seattle. Los instrumentos de planificación que podrían incrementar la conservación de hábitat no fueron usados frecuentemente. La colaboración entre jurisdicciones fue extensa, pero raramente enfocada a la conservación. Los departamentos con un especialista en conservación tendían a estar asociados con mayores niveles de acciones de conservación. Las jurisdicciones en la región de Seattle también reportaron mayores niveles de acciones de conservación, conducidas principalmente por mandatos estatales y federales. El incremento del financiamiento fue citado con más frecuencia como un factor que podría facilitar mayor consideración de la biodiversidad en la planificación local. Hay numerosas oportunidades para que los biólogos de la conservación jueguen un papel en la mejoría de la planificación a escalas locales.

Palabras Clave: Carolina del Norte, conservación local, conservación de hábitat, Iowa, planificación del uso de suelo, políticas de conservación, urbanización, Washington

Introduction

In North America the largest populations and highest diversity of native species tend to occur in the most productive portions of the landscape, where humans also reach their highest densities (Scott et al. 2001; Miller & Hobbs 2002; Huston 2005). As a result urbanization has emerged as a leading cause of species imperilment in the United States (Wilcove et al. 1998; Czech et al. 2000; Brown & LaBand 2006). Commercial and residential development also threaten biodiversity on more marginal lands, including the landscapes in which many of our large national parks and wilderness areas are embedded (Hansen et al. 2005; Huston 2005).

Decisions regarding urban, suburban, and exurban development are typically made at relatively low levels of government, such as the county or municipality (Duerksen et al. 1997; Lawrence 2005). Consequently, efforts to stem habitat loss and declines in native species have increasingly turned to land-use planning at local scales (Steelman 2002). In recent years numerous authors have called for greater integration of ecological principles in land-use planning to improve biodiversity conservation (e.g., Babbitt 1999; Beatley 2000; Groves 2003; Radeloff et al. 2005). Ecologists and other environmental professionals have proposed a variety of guidelines for land-use planners aimed at protecting habitat and minimizing negative effects of development on biodiversity (e.g., Duerksen et al. 1997; Dale et al. 2000; Steiner 2000; Nolan 2004). To implement these guidelines, there exists a wide array of planning and land-protection tools, including zoning ordinances, subdivision- and land-development regulations, growth-management programs, and conservation-development frameworks (Bengston et al. 2004; McElfish 2004; Milder 2007). A growing number of publications detail the application of these tools in the context of biodiversity conservation and describe case studies that are considered models of effective practice (McElfish 2004; Duerksen & Snyder 2005; Michalak & Lerner 2007).

Aside from a handful of examples, it is unknown how pervasive recommended conservation practices are among local jurisdictions. To what extent do local planning departments address biodiversity conservation in their plans and policies? Do planners follow the guidelines offered by academics, natural resource agencies, and nongovernmental organizations? How widespread is the implementation of land-use planning tools to achieve conservation goals? To address these and other questions concerning the role of biodiversity conservation in local land-use planning, we surveyed planning personnel in 3 regions of the United States that have experienced high levels of population growth in recent years: the Research Triangle, North Carolina; greater metropolitan Des Moines, Iowa; and greater metropolitan Seattle, Washington. Our objectives were to gauge the extent to which local planning departments address biodiversity conservation and to identify factors that facilitate or hinder conservation actions in local land-use planning.

Methods

Study Regions and Sample Frame

We used Metropolitan Statistical Areas (MSA), as defined by the U.S. Office of Management and Budget, to delineate our 3 study regions. An MSA consists of an urban core (population ≥50,000) and adjacent communities that have a high degree of social and economic integration with that core (U.S. Census Bureau 2007).

All of these MSAs experienced substantial population growth from 1990 to 2005 (U.S. Census Bureau 2007): Seattle-Tacoma-Bellvue (hereafter, Seattle) 25.2%, Raleigh-Cary and Durham (hereafter, Research Triangle) 58.2%, and Des Moines—West Des Moines (hereafter,

Des Moines) 25.5%. Yet they differ markedly in terms of spending for land conservation at the state level. Washington and North Carolina were among the top 10 states in terms of expenditures for land conservation from 1992 through 2000 ($382 million and $258 million, respectively; Lerner et al. 2007). Iowa ranked 28th among the states in land conservation during this period, with expenditures of $25 million (Lerner et al 2007), and was one of 3 states that approved the lowest level of funding through open-space ballot measures from 1996 to 2004 (Szabo 2007).

We surveyed planning directors (or senior planners in jurisdictions without a director) in all municipal, county, and tribal planning departments in each region. Directors were targeted because their supervisory role implies a broad knowledge of their department's planning activities and local land-use policies. Moreover, all planning departments have a director or an equivalent position, which provided us with a consistent respondent across all 3 regions. Jurisdictions that did not have staff dedicated to planning activities were excluded from the survey.

Survey Instrument

The survey instrument consisted of open- and closed-ended questions that addressed biodiversity conservation in local land-use planning (see Supporting Information). At the beginning of the survey, we defined *biodiversity* as "native plant and animal species (terrestrial and aquatic) and the habitats that support them." To enhance face validity for the target population, we pilot tested our survey among a group of planning directors working outside the 3 sample frames (Washington: $n = 9$, North Carolina: $n = 7$, Iowa: $n = 5$) and revised it based on their comments. The survey and study plan were approved by the Institutional Review Boards at the 3 home institutions of the researchers.

The survey was administered in an on-line format with Survey Monkey (http://www.surveymonkey.com/) and Dillman's (2000) tailored design methodology. First, an invitation to complete the survey, which included an informed consent agreement and a link to the on-line version, was sent by email in early April 2007 to 64 planning directors in the Seattle MSA, 34 directors in the Research Triangle, and 18 directors in the Des Moines MSA (total $n = 116$). Those who had not completed the survey were contacted by phone 1 week later, and again 2 weeks after the initial invitation. Emails with a link to the survey were sent immediately after these phone calls. The survey was closed on 4 May 2007.

Of the 116 planners we contacted, 84 completed the survey for an overall response rate of 72.4%. The response rates by region were Seattle 68.8% ($n = 44$); Research Triangle 73.5% ($n = 25$); and Des Moines 88.8% ($n = 15$). Response rates for individual questions varied slightly because some respondents did not answer every question; the maximum variation in any single region was 15%, but more commonly variation was <5%.

Emphasis on Biodiversity Conservation in Local Planning

We asked respondents to select from a list the 3 activities that consumed the largest percentage of staff time and to quantify the percentage of staff time spent on efforts to conserve biodiversity. We also presented several lists enumerating actions that could potentially benefit native species and asked whether the jurisdiction had plans or ordinances that required or encouraged any of these actions. Similarly, we presented lists of planning tools and economic incentives, and asked whether any of these had been used to promote biodiversity conservation.

In addition to questions focused at the scale of individual jurisdictions, we also wanted to know whether local planning departments engaged in collaborative efforts with neighboring jurisdictions to conserve biodiversity. Numerous authors note that such coordination is essential to achieving regional conservation goals (Duerksen et al. 1997; Dale et al. 2000; McElfish 2004). Specifically, we asked respondents to rate the importance of cross-jurisdictional collaboration and the frequency with which it occurs. We also asked which activities were the targets of such collaborative efforts.

On the basis of responses to a number of the questions described above, we quantified conservation activity in several ways for the purpose of hypothesis testing (see next section). First, we developed an index derived from the sum of positive responses to questions asking whether a jurisdiction included particular conservation actions in comprehensive plans or ordinances (range = 0–10). Second, we ranked jurisdictions by their use of conservation planning tools by rescaling responses to the planning tool list as follows: 0, no tools; 1, 1–3 tools; 2, ≥4 tools. These data were rescaled because some tools could be implemented for reasons unrelated to conservation and the use of multiple tools was a good indication that at least some conservation goals were being addressed. Third, we summed the number of conservation actions required in permitting processes (range = 0–10). We used 2 additional measures of conservation activity: the amount of staff time devoted to biodiversity conservation (scaled from 0 to 4 to represent 0–30% staff time) and whether the jurisdiction offered economic incentives for conservation (yes or no).

Factors that Facilitate or Hinder Conservation Planning

Using the 5 indices described above, we tested a number of hypotheses regarding factors that might facilitate efforts aimed at biodiversity conservation in local planning departments. Snyder and Duerksen (2005) note that larger planning departments and those with staff trained in natural resource management tend to be more involved

in conservation planning. We tested these 2 hypotheses with each of the 5 indices and data on the number of planners and support staff in each department, whether or not individuals in a given department specialized in biodiversity conservation planning, and whether individuals in the department had training in conservation biology or ecology.

Several researchers have documented a relationship between socioeconomic status and patterns of biodiversity (Schwartz et al. 2002; Hope et al. 2003; Martin et al. 2004). We hypothesized that wealthier jurisdictions are associated with higher levels of conservation activity in local planning, and we examined the relationship between median household income (U.S. Census 2000) and the 5 indices. Furthermore, we expected jurisdictions experiencing higher rates of urbanization to be associated with higher levels of conservation activity. To test this hypothesis, we examined the relationship between percentage housing growth, calculated as the difference between the 2000 and 1990 censuses (U.S. Census 1990, 2000), and each of the 5 measures of conservation activity.

We expected that the region in which a jurisdiction was located would exert a strong influence on the level of conservation planning there. Specifically, we hypothesized that respondents from the Seattle MSA are more involved in conservation planning compared with the other 2 areas, given Washington's Growth Management Act (Azerrad & Nilon 2006), the recognition garnered by Seattle in habitat protection (Duerksen & Snyder 2005), and the presence there of several populations of federally listed salmonids.

To characterize the relationship between local planning and state or federal mandates, we included a series of questions focused on specific conservation actions. We asked whether a given action was being addressed in the jurisdiction and, if so, whether it was initiated by the planning department without federal or state mandates, whether it was in response to such mandates, or whether it went beyond what was mandated.

Land placed under conservation easements may be taxed at reduced rates, and this could cause jurisdictions to resist using easements to protect land. Consequently, we asked how this potential loss of revenue affected the jurisdiction's interest in land conservation. We also asked whether funding for biodiversity conservation was being provided to the jurisdiction from governmental or nongovernmental sources and, if so, whether this resulted in higher rates of conservation activity.

Adequacy of scientific information and staff expertise is thought to hinder or facilitate biodiversity protection (Dale et al. 2000; Lindenmeyer et al. 2007). We asked respondents to identify sources of information typically used in making planning decisions regarding conservation. Several follow-up questions addressed the availability of relevant scientific information and whether greater

access to information would translate into greater conservation efforts. Respondents were then asked to select from a list of factors likely to increase activities aimed at biodiversity conservation in their jurisdiction.

Data Analyses

We downloaded survey data from Survey Monkey and removed all identifiers to maintain confidentiality. Codes were added to designate the respondent's region and type of jurisdiction. We tabulated summary statistics in SPSS (version 15.0; SPSS 2007) and tested relationships between predictor variables and indices of conservation activity with logistic regression in JMP (version 7.0; SAS Institute 2007).

Results

Emphasis on Biodiversity Conservation in Local Planning

Few respondents listed biodiversity conservation among the top 3 activities consuming staff time. Biodiversity conservation ranked far behind activities such as permitting, zoning, and development review (Fig. 1). The majority of respondents reported that ≤5% of staff time was devoted to biodiversity conservation (Seattle 63%, Research Triangle 68%, Des Moines 80%). Although a few planning directors reported that up to 30% of staff time was spent on biodiversity-related planning, 14–20% of the respondents indicated their department spent no time on this issue.

Protecting water quality was the conservation topic most commonly addressed in plans and ordinances among jurisdictions in the 3 regions (Table 1). A much greater percentage of jurisdictions placed emphasis on federal- or state-listed species in the Seattle region than in the other 2 regions. Both the Seattle and Des Moines MSAs had a greater percentage of jurisdictions that used plans and ordinances to protect habitat by conserving open space than the Research Triangle. Nevertheless, a greater percentage of jurisdictions in the Research Triangle used ordinances to create parks and open space for reasons that included biodiversity conservation. In all 3 regions, <50% of the jurisdictions had plans or ordinances that called for inventories of unique habitats of native species, and this was especially rare in the Research Triangle and Des Moines (Table 1). Also rare in all 3 regions was the establishment of specific goals for biodiversity conservation.

The prevalence of jurisdictions with plans or ordinances addressing water quality was likewise reflected in more specific actions, with a strong emphasis on the establishment of riparian buffers (Table 2). The majority of jurisdictions in the Seattle MSA also focused on the protection of specific aquatic or floodplain habitats (Table 2). There was generally a stronger emphasis on habitat
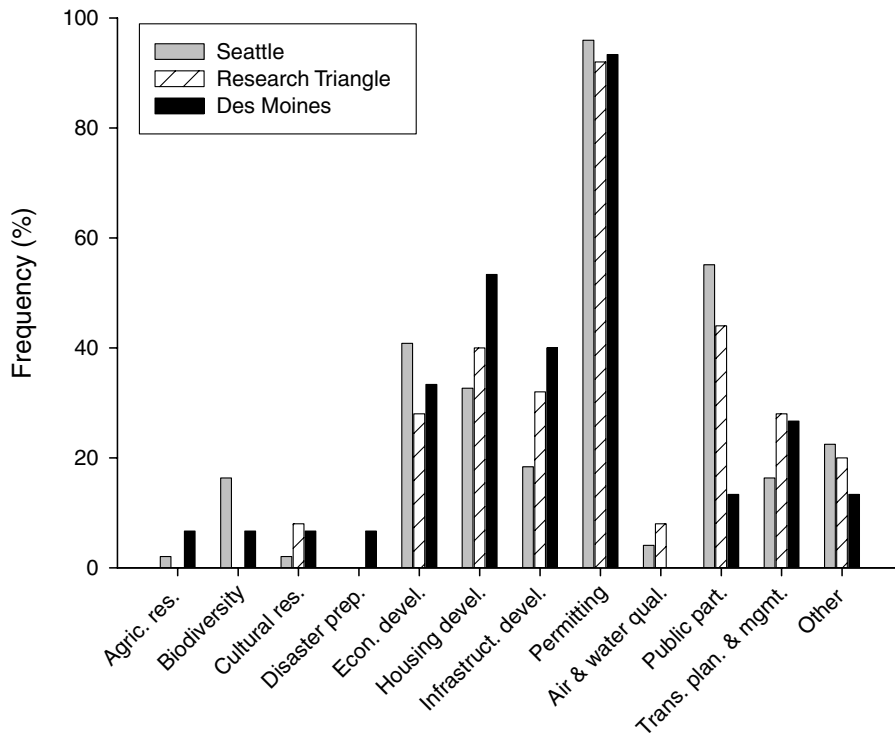
Figure 1. *Items that consumed the largest percentage of staff time according to a survey of local planning department directors in metropolitan Seattle, North Carolina's Research Triangle, and metropolitan Des Moines. Respondents were asked to identify the 3 top items from the following list: agricultural resource protection, biodiversity conservation, cultural resource protection, disaster preparedness, economic development, housing development, infrastructure development, permitting, protection of air and water quality, public participation in planning, and transportation planning and management.*

protection among the Seattle jurisdictions, the majority of which required developers to mitigate adverse impacts on habitat and purchased or acquired property or development rights to protect habitat (Table 2). This emphasis was much less pervasive in the other regions, although a relatively large percentage of jurisdictions in all 3 regions required the inclusion of open space in residential developments. A substantial number of jurisdictions did not require any of the actions we listed (Seattle 5%, Research Triangle 27%, Des Moines 16%).

Respondents reported using a wide range of planning tools in all 3 regions (Table 3). Use of planned unit developments was relatively common in the 3 regions, as was overlay zoning in the Research Triangle and cluster zon-

ing there and in the Seattle region. Most tools, however, were used in a minority of jurisdictions. Performance zoning, a land-use planning tool considered by McElfish (2004) to have much potential for achieving biodiversity conservation goals, was rarely employed.

A variety of economic incentives were used to promote biodiversity conservation, but most were used in <10% of the jurisdictions. The exceptions were the outright purchase of property (Seattle 22%, Research Triangle 13%, Des Moines 27%), property tax incentives, and transfer of development rights (Seattle 15% and 29%, respectively). Many jurisdictions failed to use any of the incentives listed (Seattle 37%, Research Triangle 83%, Des Moines 53%).

Table 1. Percentage of jurisdictions that address various topics regarding conservation in their comprehensive plans or in specific ordinances.*

Conservation topic	Seattle		Research Triangle		Des Moines	
	plan	ordinance	plan	ordinance	plan	ordinance
Conserve federal- or state-listed endangered species	82	82	21	29	7	0
Create parks/open space to achieve objectives including biodiversity conservation	86	35	52	60	73	47
Encourage/require open space focused on habitat protection	81	70	25	38	87	47
Encourage/require greenways to achieve objectives including biodiversity conservation	73	39	48	36	67	27
Inventory habitats unique to the area	40	45	25	8	27	0
Inventory native plants or animals	28	36	21	17	14	7
Specific goals for conserving native plants or animals	33	26	9	18	20	7
Minimize soil loss	41	62	30	74	47	73
Minimize development impacts on native plants or animals	58	65	25	42	27	27
Protect water quality	86	98	48	92	53	73

Respondents were asked to check all that apply.

Table 2. Percentage of jurisdictions that take actions regarding water quality and biodiversity conservation.*

Action	Seattle	Research Triangle	Des Moines
Water quality			
protect specific aquatic or floodplain habitats	80	24	13
regulate fertilizer and other nonsource pollutants	23	20	0
require riparian buffer areas where no development is allowed	98	100	40
other	11	4	27
Biodiversity conservation			
control the spread of invasive plants and animals	41	16	20
encourage/require subdivisions to include open space	68	80	40
maintain habitat connectivity	50	20	13
maintain conservation areas using ecological processes (e.g., fire, mowing)	14	12	40
maintain up-to-date inventory of native species in your jurisdiction	25	20	7
purchase/acquire property or development rights for habitat conservation	52	16	27
require developers to mitigate impacts of development on native habitats	80	16	27
other	4	0	7

**Respondents were asked to check all that apply.*

Cross-jurisdictional collaboration was considered important by the majority of respondents (Seattle 62%, Research Triangle 67%, Des Moines 80%), occurring monthly in many jurisdictions (Seattle 40%, Research Triangle 50%, Des Moines 53%) and weekly in some

Table 3. Percentage of jurisdictions that use planning tools to address issues of biodiversity conservation.*

	Seattle	Research Triangle	Des Moines
Cluster zoning requiring open space	52	64	27
Conservation subdivisions	2	36	40
Farmland preservation	7	28	33
Impact fees/exaction	34	24	13
Incentive-based zoning	48	20	20
Overlay zones	34	52	13
Performance zoning	5	8	7
Planned unit development	55	64	60
Purchase of development rights	21	8	0
Zoning for agricultural protection	6	8	40
Other	34	4	0

**Respondents were asked to check all that apply.*

(Seattle 33%, Research Triangle 29%, Des Moines 13%). Collaboration was most often directed toward activities such as transportation (Seattle 86%, Research Triangle 83%, Des Moines 93%) and infrastructure development (Seattle 71%, Research Triangle 71%, Des Moines 93%), and much less often involved biodiversity conservation (Seattle 31%, Research Triangle 13%, Des Moines 7%) or natural resource management (Seattle 48%, Research Triangle 17%, Des Moines 20%). Consistent with the emphasis on water quality, relatively high numbers of jurisdictions in the 3 regions collaborated to protect streams and rivers (Seattle 62%, Research Triangle 46%, Des Moines 33%).

Factors that Facilitate or Hinder Conservation Planning

Jurisdictions with larger planning departments tended to provide economic incentives for conservation, but the notion that these jurisdictions were otherwise more involved in conservation planning received little support in our analyses (Table 4). Nor were departments whose personnel had training in ecology or conservation biology associated with higher levels of conservation action. There was, however, strong support for the hypothesis that departments with a conservation specialist on staff have greater involvement in conservation planning (Table 4), although few respondents reported having such an individual (Seattle 26%, Research Triangle 8%, Des Moines 13%) or that such an individual existed in another department in their jurisdiction (Seattle 7%, Research Triangle 13%, Des Moines 20%).

Our analyses did not support the contention that jurisdictions with higher household incomes or elevated levels of housing growth were more likely to have higher levels of conservation actions (Table 4). Planning directors in the Seattle region reported higher levels of conservation actions in comprehensive plans or ordinances and were more likely to require a greater variety of conservation actions in the permitting process than their counterparts in the other 2 regions (Table 4).

Our respondents indicated that state or federal mandates were strong drivers for select conservation efforts. Habitat conservation in the Seattle MSA and stream and river protection there and in the Research Triangle appears to be largely driven by such mandates (Table 5). State or federal regulations also exerted a strong influence on water-quality protection and the prevention of soil erosion in all 3 regions (Table 5).

The notion that potential losses in tax revenue might adversely affect a jurisdiction's interest in conservation did not receive much empirical support. Over 75% of the respondents either disagreed that this was a factor or had no opinion. A greater impediment to conservation appeared to be a lack of funding; nearly half of the Seattle jurisdictions (48%) and more than half in the Research Triangle (54%) and Des Moines (53%) received no funding

Table 4. Results of logistic regressions designed to test the influence of various factors on levels of conservation action in local planning departments.[a]

Source	df	*Index of conservation action*				
		1	2	3	4	5
Number of planning staff	1	0.27	2.38	3.26[b]	1.74	6.05[b]
Staff with training in conservation/ecology	1	0.78	0.41	0.14	0.23	1.48
Conservation specialist on staff	2	6.50[c]	11.49[d]	10.20	8.84[c]	2.83
Received funding (yes or no)	1	4.79[c]	0.83	8.44[d]	2.54	1.34
Median household income	1	1.52	0.01	0.12	0.44	0.17
Housing growth	1	0.17	0.70	1.61	0.76	0.02
Region	2	8.06[c]	7.42[c]	22.32[e]	4.67[b]	11.52[d]

[a]*Each column consists of chi-square values for 1 of 5 indices of conservation action: 1, the number of conservation actions included in a jurisdiction's comprehensive plans of ordinances; 2, a jurisdiction's use of conservation planning tools; 3, number of conservation actions required in a jurisdiction's permitting process; 4, the amount of staff time devoted to biodiversity conservation; and 5, whether or not a jurisdiction offered economic incentives for conservation. See "Emphasis in Local Planning on Biodiversity Conservation" for details.*
[b]$p < 0.10$.
[c]$p < 0.05$.
[d]$p < 0.01$.
[e]$p < 0.001$.

for biodiversity conservation. Increased funding was the factor cited by the greatest percentage of respondents in all regions as most likely to lead to increased biodiversity conservation activity (Fig. 2). Greater public support and support from elected officials were the next most frequently cited factors (Fig. 2). The most frequently cited funding sources for biodiversity conservation were local governments (Seattle 19%, Research Triangle 17%) and the state (Seattle 17%, Research Triangle 21%, Des Moines 7%). Jurisdictions that received funding were more likely to include conservation actions in their plans and ordinances and to require such actions in their permitting process (Table 4).

More science-based information was the least cited factor for increasing efforts to protect biodiversity in the Seattle MSA, whereas >50% of the respondents in the Research Triangle said that more information would result in greater conservation efforts (Fig. 2). Comparable results for these regions were obtained in another, similar question on this topic. Nevertheless, responses to these 2 questions were contradictory for the Des Moines

MSA. A majority of respondents there indicated more information would have a positive impact on biodiversity conservation (Fig. 2), but only 20% indicated this was so in responding to the earlier question. Approximately twice the percentage of respondents in Des Moines (27%) and the Research Triangle (25%) compared with Seattle (13%) noted they had difficulty attaining objectives related to biodiversity conservation because they did not have sufficient access to science-based information.

The most frequently cited source of information for biodiversity conservation planning was state agencies (Fig. 3). In the Des Moines region, a similar percentage of respondents cited in-house experts, nongovernmental organizations, and private consultants. The latter was also cited by nearly 70% of the Seattle jurisdictions. The second-most frequently cited information source in the Research Triangle was academic institutions, which was cited by a much smaller percentage of the jurisdictions in the other 2 regions. Approximately 20% of all jurisdictions used scientific journals to inform conservation efforts (Fig. 3).

Table 5. Percentage of jurisdictions with various planning goals for environmental protection relative to what is required by state or federal mandates.

| Planning goal	Seattle			Research Triangle			Des Moines		
	state & federal	beyond state & federal	without state & federal	state & federal	beyond state & federal	without state & federal	state & federal	beyond state & federal	without state & federal
Habitat conservation	61	21	2	25	13	4	0	13	20
Water-quality protection	73	25	2	63	29	8	47	33	7
Storm-water regulation	66	27	5	67	25	8	27	53	0
Stream & river protection	48	48	5	58	38	4	27	53	13
Soil erosion prevention	55	27	11	54	38	8	60	27	0
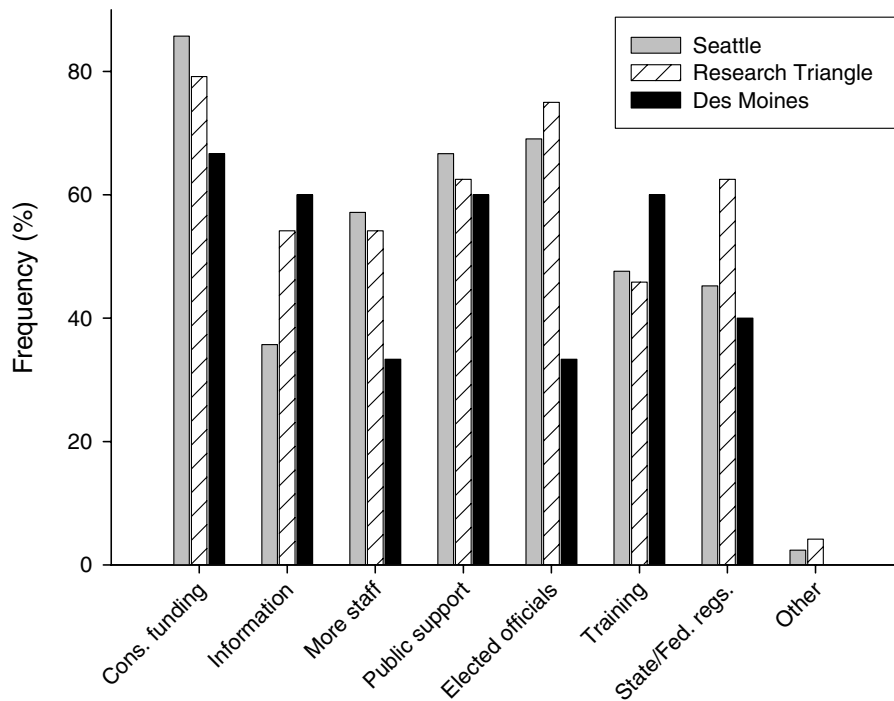
Figure 2. Factors that would likely lead to increased biodiversity conservation activity. Respondents were asked to check all that apply from the following list: increased funding for conservation, more information, more planning staff, greater public support, more support from elected officials, more training, and state or federal regulations.

More training for staff would increase efforts to conserve biodiversity according to 60% of the respondents in the Des Moines MSA and approximately half of the respondents in the other 2 regions (Fig. 2). The majority of respondents in the Seattle region and the Research Triangle (79% and 71%, respectively) and 47% of those in

Des Moines noted financial support was available to enable staff to attend clinics or workshops on topics related to biodiversity conservation. Somewhat fewer jurisdictions offered support to enroll in college courses on such topics (Seattle 38%, Research Triangle 42%, Des Moines 27%).
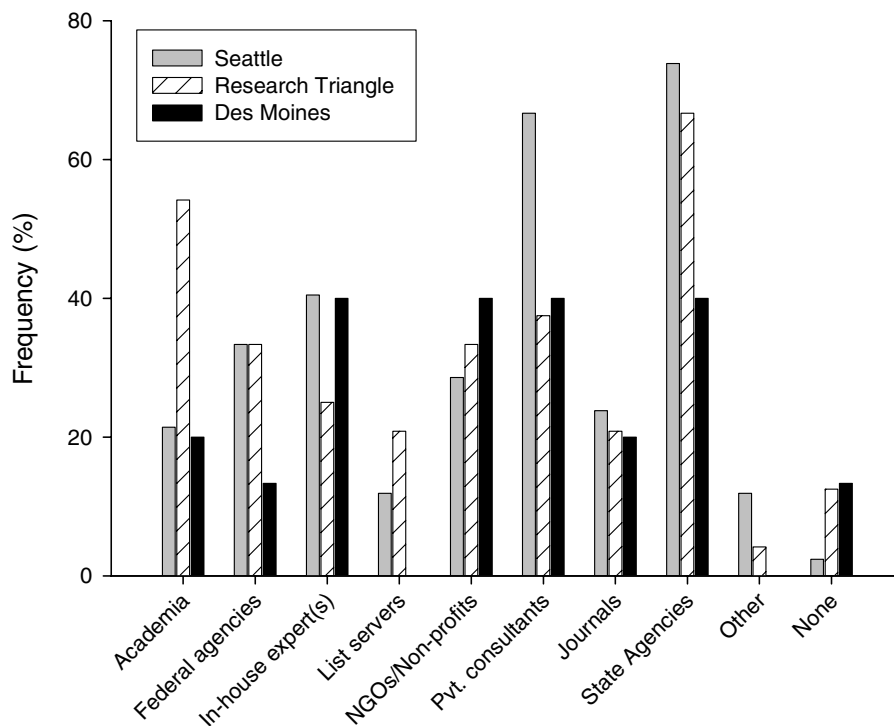

Figure 3. Sources of information used to inform planning decisions regarding biodiversity conservation. Respondents were asked to check all that apply from the following list: academic institutions, federal agencies, in-house expert(s), list-server postings, NGOs/non-profits, private consultants, journals, and state agencies.

Discussion

Biodiversity conservation appeared to be a relatively minor consideration in local land-use planning, when it was considered at all, in the jurisdictions we surveyed. Few of these planning departments allocated much staff time to conserving biodiversity—typically <5% and in a sizeable number of cases, none. Few respondents reported that comprehensive plans or ordinances set specific goals for conserving native plants and animals. In general, few jurisdictions took such basic conservation actions as controlling the spread of invasive species or maintaining habitat connectivity. Although a variety of planning tools and economic incentives were used to address habitat protection, any one of these was typically used only in a small minority of jurisdictions. Cross-jurisdictional collaboration for the purpose of conserving biodiversity over broader spatial scales was infrequent.

Most jurisdictions in these regions emphasized protection of open space and the creation of parks and greenways to meet objectives that included biodiversity conservation; fewer have enacted ordinances requiring developers to help meet this objective. There is some doubt as to the degree to which open space and parks achieve habitat protection (Lerner et al. 2007). Meeting this goal ultimately depends on factors such as parcel size, levels and types of human use, the presence of sufficient resources to meet the requirements of native species, and the nature of the surrounding landscape (Lindenmeyer et al. 2007; Miller 2007).

Protecting water quality was a prevalent objective, as reflected in comprehensive plans, ordinances, and other actions. This was likely in response to provisions of the Clean Water Act, the primary federal statute that addresses point and nonpoint water pollution in the United States. State environmental regulatory agencies are delegated power by the U.S. Environmental Protection Agency to enforce provisions of the act as appropriate given specific conditions in each state. Addressing objectives related to water quality, however, will not necessarily translate to improved conditions for native species (Karr & Chu 1998). Planning departments in the Seattle region had a much greater focus on aquatic and streamside habitats and on habitat conservation generally. Again, this emphasis was likely driven by the listing of salmonid species under the Endangered Species Act and related state mandates. This designation gives the National Marine Fisheries Service the power to regulate activities that may affect these species adversely. Still, actions intended to address the well-being of these species will not necessarily benefit species occurring in other habitats.

Planning for biodiversity, when it did occur, rarely extended beyond the boundaries of individual jurisdictions. Respondents to our survey reported that their departments regularly engaged in cross-jurisdictional collabora-tion, but typically not for the purpose of protecting native habitats and the species that depend on them. The higher levels of cross-jurisdictional conservation planning in the Seattle MSA were likely in response to Washington State's Growth Management Act. Adopted in 1990 the Growth Management Act requires cooperation among counties and municipalities to counter threats to the environment and quality of life posed by uncoordinated and unplanned growth (Azerrad & Nilon 2006). Elsewhere, the bureaucratic structure for broad-scale planning frequently exists in the form of state planning offices, regional councils, and metropolitan planning organizations (Michalak & Lerner 2007), but these governance bodies often have very weak, if any, regulatory power, rely on voluntary compliance, and have little enforcement power (Bollens 1992). A more stringent, regulatory approach involving incentives and mandates may be necessary to achieve higher levels of jurisdictional collaboration in conservation planning (Wilkinson et al. 2005; Baldwin & Trombulak 2007).

The pervasive lack of emphasis on biodiversity conservation we observed appears to be more the rule than the exception in the United States (Beatley 2000; McElfish 2004; Duerksen & Snyder 2005). The need for a far greater integration of conservation practices in local planning than is evident in our data is brought into sharp focus when one considers that the amount of developed land in the United States is projected to increase in area by 79% during the next 2 decades (Alig et al. 2004).

What can be done to foster a greater emphasis on biodiversity conservation among local planning departments? We found a significant relationship between the presence of a staff specialist in biodiversity conservation and higher levels of conservation activity in a department. The vast majority of respondents also indicated educational opportunities in biodiversity conservation were available to their personnel, and most suggested that more staff training would increase conservation planning efforts. Yet we did not find a significant relationship between departments employing personnel with training in ecology or conservation biology and any of our measures of conservation action. We conclude that jurisdictions that have made biodiversity a priority are also the ones with a specialist on board, and if it is not a priority, educating staff members seems unlikely to elevate conservation efforts in a meaningful way.

Our respondents overwhelmingly replied that prioritizing biodiversity conservation will require increased funding and greater support from local governments and the public. This suggests the need to educate government officials about the role of local planning in preserving biodiversity, and there is clearly an important role for conservation scientists in imparting this message (Broberg 2003).

Ultimately, broader support for conservation planning must be predicated on a well-informed public, but

education in the conventional sense will not be enough to engender such support (Thompson 2004). It has been suggested that one way to foster greater support for conservation among the public is to emphasize the connections between biodiversity and quality of life (e.g., Daly & Klemens 2005; Balmford & Cowling 2006; Miller 2005). The recent engagement of disciplines such as conservation medicine (Aguirre et al. 2002) and conservation psychology (Saunders et al. 2006) in work on this topic is an encouraging trend and has much potential for advancing our understanding of factors that can promote a more widespread conservation ethic.

Compared with increased support, access to science-based information was a lesser concern but was still seen as a barrier in many of the jurisdictions we surveyed. It is noteworthy that academic institutions were infrequently cited as a key information source in 2 of the 3 regions, and departments that relied on the content of scientific journals to guide their efforts were in the minority everywhere. Planning departments more frequently relied on local experts, nongovernmental organization, and state agencies. The recent development of state wildlife action plans by natural resource agencies across the United States may be a particularly useful source of information for planners in terms of species distributions and ways to mitigate threats to biodiversity posed by development (Michalak & Lerner 2007). There is evidence to suggest, however, that the relevance of such guidelines could be greatly improved by engaging local planners in a dialogue regarding their informational needs (Azerrad & Nilon 2006).

Whether or not planners have access to existing information, there are still critical gaps in our knowledge regarding the conservation practices that are being implemented in local planning. Little empirical work has been done to evaluate these practices and there are numerous questions that need to be addressed. For example, how effective are the various planning tools and economic incentives being used to achieve conservation goals? How should the effectiveness of conservation actions be measured? Does open-space protection really benefit native species? Milder (2007) provides guidelines for the optimal location of different types of conservation development in the landscape, depending on goals and patterns of urbanization. This same sort of guidance is needed for a variety of other planning tools. There is also a need to address questions at the scale of individual sites—the scale at which local planners typically work (Forman 2002; Azerrad & Nilon 2006). For example, what is the optimal arrangement of elements in a conservation subdivision, and how does this change depending on the context of the site? Investigation of these and related topics could benefit from collaborative efforts involving conservation ecologists, economists, social scientists, medical researchers, and design professionals.

If conservation biologists are serious about achieving a more pervasive emphasis on biodiversity in local planning, it is essential that they gain a deeper understanding of the various dimensions of land-use planning and become involved in the process. Broberg (2003) suggests that ecologists could contribute to land-use planning in several ways: by educating members of planning staffs and governing bodies engaged in land-use decisions, serving on a planning commission, participating at public hearings, and serving on citizen review panels for land-use regulations and policies. Another way for conservation scientists to interact with planners is to attend their regional or national conferences and to present relevant information there. Such forms of engagement will afford opportunities to bring both our scientific credentials and contributions as concerned citizens to bear on this crucial issue.

Acknowledgments

Supporting Information

All survey questions used in this study (Appendix S1) are available as part of the on-line article. The authors are responsible for the content and functionality of these materials. Queries (other than absence of the material) should be directed to the corresponding author.

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