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Applied Geography 24 (2004) 161–180

APPLIED GEOGRAPHY

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A comparison of perceptions of biological value with scientific assessment of biological importance

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Abstract

A distinguishing feature of conservation planning and analysis methods is that they generally rely on biological assessments carried out using scientific sampling protocols and methodologies. Few conservation planning methods explicitly include what is variably described as values, understanding and perceptions. In this study, we examine the potential use of local values of biological resources in conservation planning by comparing this with scientific biological assessment of the same region, using the example of Prince William Sound, Alaska (USA). Specifically, we compare the spatial coincidence of local perceptions of biological importance (or value) identified in a survey of Alaska residents with biologically significant areas identified by scientists familiar with the area from a marine conservation workshop. The results indicate a moderate degree of spatial coincidence between local values and scientific assessment with obvious geographic areas of agreement and disagreement. We suggest that incorporation of local perceptions of biological importance can complement and strengthen scientific biological assessments and propose an iterative conservation planning process that includes both methodologies.

Keywords: Conservation planning; Local values; Spatial analysis; Participatory GIS

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0143-6228/$ - see front matter
doi:10.1016/j.apgeog.2004.03.006

Introduction

Conservation planning includes the process of identifying biologically significant components, patterns, and processes of ecosystems that warrant protection, developing and implementing the means to achieve protection of the system, and monitoring the system for deviation from expected or desired outcomes. Much attention in conservation planning has focused on identifying geographical areas for protection including areas that are already in reserves.

A distinguishing feature of conservation planning theory and analysis techniques is that these are driven and developed by those with biological or ecological training, and the techniques rely on biological assessments or inventories carried out using scientific sampling protocols and methods. Few techniques explicitly provide for the inclusion of what is variably identified as "traditional", "local", "tacit", "indigenous", or "folk" knowledge. The exclusion of such local knowledge from conservation planning continues despite the fact that the availability of reliable species richness data for any taxon usually lags far behind conservation threats. It also appears unlikely that additional resources to acquire scientifically derived biological data will fundamentally alter the persistent lack of ecological knowledge for conservation planning. Conservation planning also ignores a growing body of knowledge that indicates that humans interact most strongly with the environments and policies that govern them via their own perceptions, rather than the conveyed knowledge they hold (Alessa, Bennett, & Kliskey, 2003).

If one were to acknowledge that "no single procedure for identifying areas of conservation interest is likely to be universal" (Prendergast, Quinn, & Lawton, 1999: p. 486) and "the science of setting spatial priorities must be values-based" (Jepson & Canney, 2001: p. 225), then the application of local values, understanding and perceptions to conservation efforts can only yield benefits to all stakeholders.

One alternative for expanding the availability of biological data for conservation planning, while explicitly recognizing multiple values for conservation, would be to tap local values inherent in the human population of a locale. Conservation planning can lead to technically effective policy that is scientifically based yet may not be socially acceptable at the local level (Meo et al., 2002). The inclusion of some element of local stakeholder review or knowledge in conservation planning is increasingly considered necessary to obtain fully legitimated policy and has led to calls for a widening of the knowledge base on which the goals and practices of conservation are based (Harrison & Burgess, 2000). However, local knowledge and values are often not incorporated into scientific assessment in conservation planning despite the potential richness of such knowledge (Cowling & Pressey, 2003; Mackinson, 2001). Arguments for exclusion of this knowledge include that it is "subjective, biased, and value-laden" (Bojorquez-Tapia et al., 2003: p. 367).

For nature conservation to embrace cultural and scientific values within a variety of worldviews pluralist approaches to conservation strategies are necessary (Jepson & Canney, 2001). Our approach adds to the plurality by inductively comparing local peoples' values of biological importance with a scientific assessment of biological importance for the same region. We demonstrate the potential for integrating apparently disparate types of knowledge for an ongoing conservation planning effort in Prince William Sound, Alaska (USA).

Local values and scientific assessment

Local values evolve through continued encounters with a landscape and its resources. This knowledge is acquired in a familiar place and may be passed down through generations. Local values are place-specific and embedded in social and cultural practices related to the natural world (Brown, Reed, & Harris, 2002; Harrison, Burgess, & Clark, 1998; Nygren, 1999). When applied to native populations, local values and knowledge are often called indigenous knowledge or traditional ecological knowledge.

In this study, the phrase scientific assessment encompasses knowledge often developed through controlled scientific experimentation or systematic observation and reproduced within formal institutions (Winklerprins, 1999). Because local values are based on experience and informal replication, some scientists may view it as "non-knowledge" since it is not derived rationally (see examples in Nygren, 1999).

Local values have three advantages over scientific assessment: (1) local people are experts on their local environment and the processes that affect it; (2) local people may have direct experience with the interconnectedness of the local ecology; and (3) local people know how to use the natural and mechanical resources at their disposal efficiently (DeWalt, 1994). But not all people in a local culture are equally knowledgeable, and local values may have little application to other locations.

Scientific assessment has four advantages over local values: (1) science can provide a specialized body of knowledge in specific fields; (2) scientific approaches can identify the principles or mechanisms by which things work; (3) science is based on an effective process of scientific method to approach problems; and (4) science can lead to knowledge which is transferable across time, space, and societal setting (DeWalt, 1994). Scientific assessment, however, may be theoretical and not easily generalized (Stankey & Shindler, 1997). The weakness of scientific knowledge stems from the reduction of a problem to such a narrow focus that scientists may lose sight of the larger context, the long term effects, or other factors that may affect a complex system. Scientific assessment of biological significance can utilize a range of survey techniques including biodiversity gap analysis (McKendry & Machlis, 1993) and remote sensing based assessments (Turner et al., 2003). In some situations expert biological knowledge is used as a means of synthesizing scientific data and to build a scientific consensus for conservation planning (Maddock & Samways, 2000). Comparisons of expert-based assessments and algorithm-based approaches reveal similar results with exceptions where expert-based assessments highlight areas of high local biological importance (Cowling et al., 2003). However, the use of such expert opinion in conservation planning has been criticized for being subjective and contradictory (Bojorquez-Tapia et al., 2003).

Recent efforts to include broader value sets from residents of an area alongside scientific expert-driven assessments use consensus building processes such as the common good approach (Harrison & Burgess, 2000). Such attempts highlight the strength of combining analytical approaches with more discursive approaches (Burgess, Harrison, & Clark, 2000). In this paper, we extend these efforts by setting out an approach for documenting the spatial context of local values that can be used alongside expert-driven mapping of biological importance for conservation planning. We explain the results and discuss the implications of our findings for future conservation planning efforts.

The research hypothesis—comparing local values and scientific assessment of biological significance

In this study, we compare the spatial coincidence of local peoples' perceptions of biological importance with biologically significant areas identified by scientific assessment. Data on local people perceived values of biological importance come from a survey about the future of Prince William Sound, Alaska (Brown, 2001). We used a variant of participatory GIS (Abbot et al., 1998) or "bottom-up GIS" (Talen, 2000) where local values of biological resources were acquired using simple paper mapping techniques for integration with GIS. In the survey, respondents located places on a map that represented biodiversity values and also special places that they identified with biological resources. In our study the scientific assessment of "biological hotspots" was based on a workshop where scientists identified, mapped, and prioritized areas of Prince William Sound for biological conservation (National Wildlife Federation, 2002).

The specific hypothesis examined in this study is that local people identify places with biological significance in Prince William Sound that do not spatially coincide with locations identified by scientists as "biological hotspots." To test this hypothesis, we compare the actual distribution of local persons' identified points of biological value against a random distribution of points that would occur in the scientific hotspots by chance. With rejection of the null expectation we quantify the spatial overlap between local values and scientifically identified areas by using survey point densities to measure the actual percentage of area overlap. An expectation of spatial coincidence between the two is based on local residents' biological values being driven by observable biotic phenomena and conditions, such as species abundance, that also form the basis for scientific assessment (Mackinson, 2001). In the case of local residents their rationale for "observing" biological phenomena may arise from harvesting activities such as fishing for which some knowledge of biological conditions would be beneficial.

Methods

Study location—Prince William Sound

Prince William Sound is located in South-central Alaska on the north side of the Gulf of Alaska (see Fig. 1). For the purposes of this study, the Sound includes the lands that surround it, the islands contained within it, and the water. Two large islands, Montague and Hinchinbrook, shelter the Sound from the Gulf. The Kenai

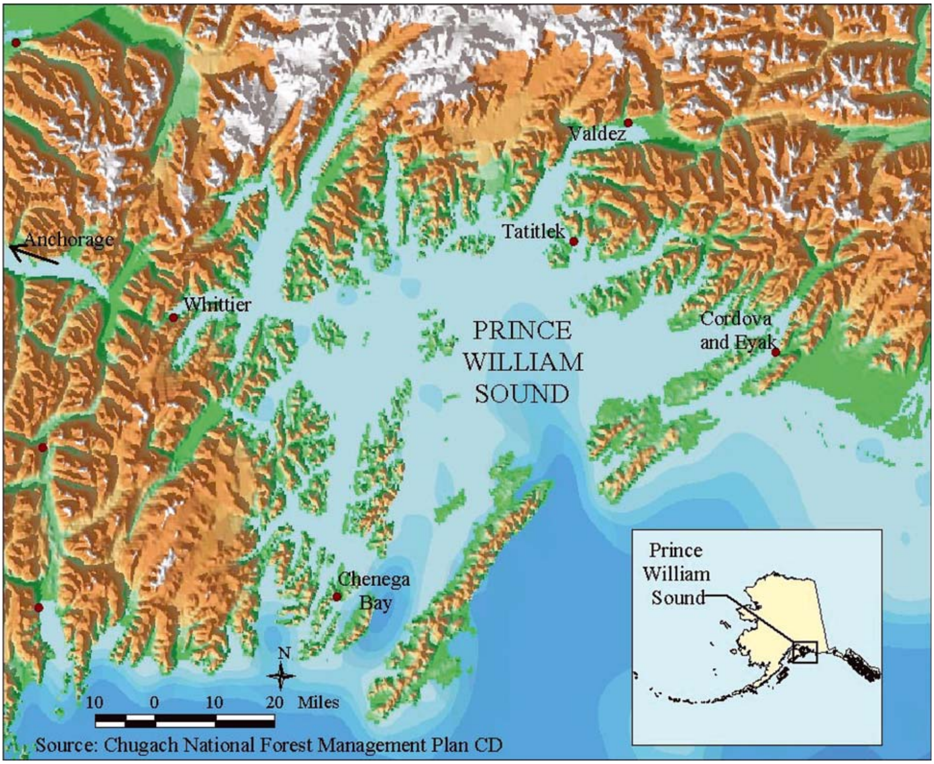

Fig. 1. Prince William Sound, Alaska (USA).

Mountains on the Kenai Peninsula to the west and the Chugach Mountains on the mainland to the north and east separate it from the interior of Alaska. These mountains contain large icefields which feed tidewater glaciers and deep fjords on the west and north sides of the Sound. Fjords and large bays on the east side contribute to more than 5600 km (3500 miles) of shoreline. The maritime climate results in moderate temperatures year-round and high rainfall in the summer. The diverse topography of the Sound provides habitat for a diverse range of species.

The Chugach National Forest encompasses the Sound and includes most of the islands within it. The State of Alaska manages some land, mostly through its State Marine Park system, and most of the submerged and tidal lands up to the mean high tide mark. Native corporations also own land, and a few private parcels exist.

Three major communities lie on the Sound's shores. Whittier, in the northwest at the end of Passage Canal, started as a military base in World War II and today has a population of 182 (US Census, 2000) people year-round with a large influx of summer seasonal labor. Whittier provides the most convenient access to the Sound for Anchorage residents. The economy of Whittier depends on transportation, recreation, and tourism (ADCED, 2001). Valdez, in the northeast, began as a point of departure for gold miners heading inland. With a population of 4036 (US Census, 2000), Valdez's economy relies on the oil industry, government employment, commercial fishing, and freight transportation (ADCED, 2001). In the southeast, commercial fishing and seafood processing support the local economies of Cordova and the Native community of Eyak, while tourism is playing an increasing role (ADCED, 2001). Cordova has a population of 2454, and Eyak, which was annexed by Cordova, has 168 (US Census, 2000). Two small Native villages in the Sound, Tatitlek in the northeast and Chenega Bay in the southwest, are not considered separately in this study, but their residents are included with Sound residents.

A fourth community is considered in this study. Anchorage, Alaska's largest city, lies 120 km (75 miles) to the north of the Sound. Seventy-three percent of Alaska's population reside in Anchorage and the communities to the north of it, within easy driving distance of the Sound (Murphy, Suring, & Iliff, 2001).

Data sets

The data sets used in this study came from two sources—a survey of Alaskans about Prince William Sound (Brown, 2001) and a scientific workshop about biodiversity hotspots in the Sound (National Wildlife Federation, 2002). The survey produced two types of data—tabular responses to survey questions and spatial data containing the locations of environmental values and special places. The scientific workshop produced a map of biologically important areas (hotspots) in the Sound.

Survey responses

In the fall of 2001, researchers at Alaska Pacific University developed a survey in cooperation with the National Wildlife Federation. The purpose of the survey was to measure what Alaska residents value about Prince William Sound and to measure attitudes and opinions about specific policy issues such as shoreline development, tourism growth, jet-ski use, and cruise ship regulation (Brown, 2001).

Questions were divided into five parts. Part 1 asked respondents about use and knowledge of the Sound, including number of days spent there and perception of the Sound's condition. Part 2 contained a list of current and potential activities in the Sound and asked respondents to indicate whether they favored or opposed the activity. Part 3 sought opinions on use and development issues that might arise in the Sound during the next 10–15 years, including shoreline development, personal watercraft use, increased numbers of cruise ships and tour boats, and increased visitation.

Part 4 addressed values held for the Sound. The first question asked respondents to rank 13 values for the Sound by imagining they had \$100 to allocate to the values (see Table 1 for the list of values). The second question asked respondents to place dots on a map of the Sound to indicate the location of the values for which they had allocated any of the hypothetical \$100. The map was a grayscale copy of a Chugach National Forest map, reproduced at a scale of approximately 1 in. equal to 11 km (6.8 miles). The dots were mnemonically coded for the

Table 1
Environmental value definitions used in Prince William Sound survey

A	A	A	Aesthetic value—I value Prince William Sound for its scenery—its mountains, glaciers, forests, tidelands, bays, and islands
E	E	E	Economic value—I value Prince William Sound because it provides commercial economic opportunities in industries such as fisheries, tourism, timber, minerals, or oil transport
R	R	R	Recreation value—I value Prince William Sound because it provides a place for outdoor recreation activities
Lf	Lf	Lf	Life sustaining value—I value Prince William Sound because it is a place that helps produce, preserve, clean, and renew air, soil, and water
Lr	Lr	Lr	Learning value—I value Prince William Sound because we can learn about the environment from it through scientific observation or experimentation
B	B	B	Biological diversity value—I value Prince William Sound because it provides a variety of marine life, plants, waterfowl and places for them to live
Sp	Sp	Sp	Spiritual value—I value Prince William Sound because it is a sacred, religious, or spiritually special place to me or because I feel reverence and respect for nature there
I	I	I	Intrinsic value—I value Prince William Sound in and of itself for its existence, no matter what I or others think about it
H	H	H	Historic value—I value Prince William Sound because it has places and things of natural and human history that matter to me, others, or the nation
F	F	F	Future value—I value Prince William Sound because it allows future generations to know and experience the Sound as it is now
Sb	Sb	Sb	Subsistence value—I value Prince William Sound because it provides necessary food and supplies to sustain people's lives
T	T	T	Therapeutic value—I value Prince William Sound because it makes people feel better, physically and/or mentally
C	C	C	Cultural value—I value Prince William Sound because it is a place for people to continue to pass down the wisdom and knowledge, traditions, and way of life of ancestors
			Extra dots—Use these dots if you need more for a value. Place the value code on the dot
P1	P2	P3	Special places—Use these dots to mark your three most special places in Prince William Sound
			Extra dots—Use these dots if you need more for a value. Place the value code on the dot

13 values, and three dots were provided for each value. Six blank dots could be used for any value.

Three dots were marked P1, P2, and P3 to indicate special places in the Sound. Special places refer to specific locales where place attachment to the landscape is identifiable (e.g., Eisenhauer, Krannich, & Blahna, 2000; Williams & Stewart, 1998). In the survey questionnaire, respondents were also asked why they considered each of their identified places to be special.

The last section, Part 5, asked about the demographics of the respondent, including age, place and length of residence, occupation, education, and ethnicity.

Table 2
Distribution and response rate for Prince William Sound survey

Community	Surveys mailed	Did not participate[a]	Surveys returned	Response rate[b] (%)
Anchorage	410	24	90	23.3
Cordova	425	7	169	40.4
Valdez	425	5	153	36.4
Whittier	114	12	46	45.1
Tatitlek/Chenega Bay	42	–	5	11.9
Statewide	410	29	79	20.7
All communities	1826	77	542	31.0

[a] Undeliverable or unable to participate due to death or moved out of state.
[b] Proportion returned of surveys sent to that community.

The occupation variable was regrouped into three categories for analysis: those who work in commercial fishing occupations ($n = 61$), scientists ($n = 14$), and all others ($n = 380$). The commercial fishing group included seafood processors ($n = 11$). The scientist group included individuals identifying themselves as scientists, though not necessarily biologists. The scientist group provides a limited basis for comparing the perceptions of scientists who live in or are familiar with the Sound and the scientists who participated in the hotspots workshop.

The survey was sent to 1826 Alaskan households in November 2000. Each survey had a unique identifying number to track responses. The sample was drawn from the Permanent Fund Dividend[1] list available from the state. A reminder card was sent a few weeks after the initial mailing, and a second survey package was sent to non-respondents in January 2001. The overall response rate was 31% while the response rates for the Prince William Sound communities of Valdez, Cordova, and Whittier were higher (Table 2). Cordova and Valdez residents comprised 60% of the survey respondents. The response rate in this survey was comparable to other mail out surveys undertaken in Alaska (Brown, in review).

Spatial data—survey point locations

The spatial data set consisted of the 8123 dots that respondents placed on the maps provided with the survey. The dots represented spatial locations for 13 environmental values and special places. The dot locations were "heads-up" digitized using ArcView® software. With "heads-up" digitizing, points are placed digitally on a map that is displayed on a computer screen. Survey responses were linked to the point locations using a 1:1 cardinality.

The special place locations were classified into 13 categories based on reasons provided by the respondent. Of particular interest to this study were special places

[1] The Permanent Fund Dividend is an Alaska program that provides an annual dividend payment from oil revenues to Alaska residents. The PFD list provides the names and addresses of most Alaskan adults.

indicating biological significance by the respondent. For this study, a special place was coded or classified as "biological" if the supporting reason included wildlife, vegetation, or utilization of natural resources. Utilization included fishing, hunting, bird watching, berry gathering, and wildflower picking. Over 25% of the special place locations were coded as having biological significance ($n = 311$).

The special place biological points and the biodiversity value points ($n = 629$) comprise the two spatial data sets that identify locations of biological importance in the Sound. As a shorthand for discussion, the special place biological points will be referred to as SP(B) and the biodiversity value points will be referred to as simply B.

Spatial data—hotspots

On 18 January 2001, 31 scientists and other environmental professionals attended a workshop sponsored by National Wildlife Federation, National Audubon Society, US Fish and Wildlife Service, and the University of Alaska Marine Studies Program. The participants held science and non-science positions with government, educational, and non-profit organizations and brought a wide range of expertise to the workshop. A list of participating organizations appears in Table 3.

The participants identified biologically important areas, so-called hotspots, in Prince William Sound. The Copper River Delta was excluded from consideration. The organizers provided three criteria for selecting areas: (1) critical area for keystone species; (2) areas with fundamental physical and/or biological processes; and (3) areas with a convergence of critical factors or processes. Hotspots only needed to meet one criterion. The participants divided into three groups to identify hotspots. Selections were discussed by the entire group and a final list of 14 hotspots was agreed upon (see Fig. 2). These hotspots covered an area of 5.35×10^9 m^2, or approximately 2000 square miles. Hotspots were ranked in two ways. First, each

Table 3
List of organizations with participants in Prince William Sound biological assessment workshop

List of organizations
United States Geological Survey, Biological Resource Division
Chugach National Forest
National Marine Fisheries Service
National Oceanic and Atmospheric Administration
Alaska Department of Fish and Game
Alaska Department of Natural Resources
University of Alaska Natural Heritage Program
Institute for Marine Studies at the University of Alaska Fairbanks
North Gulf Oceanic Society
The Nature Conservancy
National Outdoor Leadership School
Prince William Sound Regional Citizens Advisory Council
Prince William Sound Science Center
Exxon Valdez Oil Spill Trustees Council

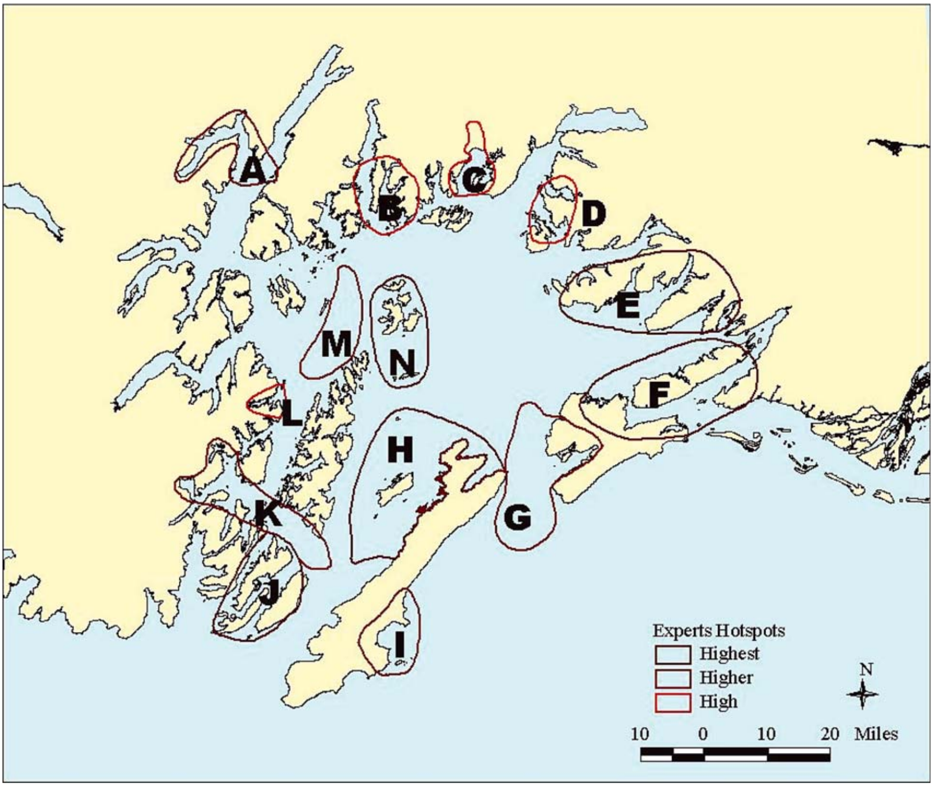

Fig. 2. Experts hotspots in Prince William Sound.

participant chose three areas he or she felt were most important biologically. Then the entire group classified the areas into three categories: high priority, very high priority, and extreme priority—with a limit of five areas with extreme priority (see Table 4).

Methods for comparing spatial coincidence of local values and scientific assessments

We compared the observed distribution of survey points inside the expert hotspot polygons with the expected distribution of points by generating random points in the study area equal to the number of B points ($n = 629$) and SP(B) points ($n = 311$). This method provides a test of the hypothesis that survey points fare no better than randomly chosen points in overlapping with the expert hotspots. The integrity of the random point generating algorithm was first tested by running trials. The proportion of random points generated inside expert polygons closely approximated the proportion of the study area occupied by the expert hotspots indicating soundness of the randomization algorithm. Chi-square statistics were then calculated to determine whether the observed number of survey points

Table 4
Scientific hotspots in Prince William Sound

Map code[a]	Name	Number of votes[b]	Priority[c]	Location in Prince William Sound
A	Harriman	<6	Very high	Harriman Fjord
B	Unakwik	<6	High	Unakwik Inlet, Wells Bay
C	Columbia	<6	High	Columbia Bay
D	Tatitlek	<6	High	Tatitlek Bay, Galena Bay
E	Gravina	10	Extreme	Port Gravina
F	Orca	6–9	Extreme	Orca Inlet, Hawkins Island, North Hinchinbrook Island
G	Hinchinbrook	<6	Very high	Hinchinbrook Entrance
H	North Montague Strait	20	Extreme	Green Island ,N. Montague Strait
I	Wooded	<6	Very high	Patton Bay, SE Montague Island
J	Elrington	6–9	Extreme	Evans, Elrington, and LaTouche Islands
K	Knight	<6	Very high	Knight Island passage to Icy Bay
L	Eschamy	<6	High	Eschamy Lagoon and Bay
M	Black Hole	<6	Very high	West of Naked Island
N	Naked	6–9	Extreme	Naked and Smith Islands

[a] See Fig. 2.
[b] Number of votes for most important biologically (of the 14 hotspots).
[c] Priority based on workshop discussion.

falling inside the expert polygons exceeded the number that would be expected by chance.

With rejection of the hypothesis, we sought to quantify the spatial overlap between local values and scientifically identified areas by calculating survey point densities using ArcView Spatial Analyst®. To calculate spatial coincidence, we generated a series of 3000 m density grids using a 4-mile (6437 m) search radius from the survey points to overlay with the 14 expert hotspot polygons. Density grids were created for both the B and SP(B) point datasets for each of the three response groups (fishers, scientists, and all respondents) for a total of six grids.

Because density is influenced by the number of survey points, we generated standardized polygons from each of the density grids. The standardized polygons approximate the proportion of the study area occupied by the expert polygons. The density grids were converted to polygons by selecting areas of maximum point density to match the area contained within the expert polygons (considered standard for this analysis). Grid values (point density) were converted to integers, based on a scale of 1 (no density) to 9 (maximum density). The areas for local values polygons were then summed according to their value (2–9). The final local values polygons were generated by aggregating grid cells starting with maximum density to accumulate an area as close as possible to 26.3% of the study area, the aggregate area occupied by the expert polygons. Spatial coincidence or overlap was defined as the area of intersection between local values polygons and scientifically identified polygons—the proportion of standardized polygons contained within the expert hotspot polygons.

Results

Expected vs. observed distribution

The observed proportion of survey points falling inside the expert hotspot polygons differed from the expected distribution of points for all SP(B) points and for all the points identified by the two subgroups of fishermen and scientists (see Table 5). With the exception of the aggregate B points, we reject the hypothesis that observations of the local residents' are independent of scientific assessment of biological hotspots in Prince William Sound. The independence hypothesis is also rejected for B points if "whole Sound" survey points located in the center polygon are excluded from the analysis.

Spatial coincidence

The spatial overlap between scientifically assessed hotspot polygons and standardized polygons is shown in Table 6. For example, for all survey B points, the standardized set of polygons covered 24.1% of the study area. Of these polygons, 33.4% overlapped with scientifically assessed polygons with highest priority, 13.3% overlapped with higher priority hotspots, and 37.8% overlapped with high priority. The total overlap between standardized B polygons and scientifically assessed hotspots was 27.6%. Commercial fishermen had the greatest total spatial overlap with the scientifically assessed hotspots (43.5%) and also the greatest overlap of B points for the highest (48.0%) and higher priority (37.9%) hotspot polygons. Both commercial fisherman and scientists had the greatest spatial overlap with the highest priority scientifically assessed polygons.

Table 5
Observed and expected percentage of survey points located in scientific hotspots

Survey point set	Expected % of points in hotspots	Observed % of points in hotspots	Chi-square value	*P*-value	Accept or reject null hypothesis
All respondents					
B points ($n = 629$)	25.9	29.3	1.75	0.185	Accept[a]
SP(B) points ($n = 311$)	24.4	41.2	19.72	**0.000**	Reject
Commercial fishermen					
B points ($n = 66$)	25.9	39.4	5.08	**0.019**	Reject
SP(B) points ($n = 56$)	24.4	44.6	9.71	**0.002**	Reject
Scientists					
B points ($n = 25$)	25.9	60.0	14.10	**0.000**	Reject
SP(B) points ($n = 18$)	24.4	50.0	5.80	**0.016**	Reject

[a] Excluding survey points in the Prince William Sound "center polygon" from analysis for B points results in rejection of the null hypothesis. The observed proportion of B points in expert hotspots increases to 32.5% ($\chi^2 = 6.29$, $P < 0.05$).

Table 6
Percentage of area overlap between scientific hotspots and point density polygons

Survey point set	% of study area in standardized polygons[a]	Overlap[b]			Total overlap (%)
		Highest priority (%)	Higher priority (%)	High priority (%)	
All Respondents					
B point density	24.1	33.4	13.3	37.8	27.6
SP(B) point density	18.8	41.3	21.9	49.9	36.1
Commercial fishermen					
B point density	28.2	48.0	37.9	36.3	43.5
SP(B) point density	23.0	42.8	34.1	31.7	38.8
Scientists					
B point density	11.2	31.9	18.7	9.1	25.2
SP(B) point density	9.7	20.8	19.2	0.00	18.0

[a] The "standardized" polygons were derived from the various point density grids to approximate the aggregate area (26.3%) occupied by the hotspot polygons. It was not possible for smaller point sets to achieve the target percentage of 26.3%.

[b] Percentage of the hotspots, based on experts' priority and total hotspot area, overlapped by the standardized polygons.

Specific hotspot results

The local resident and scientifically identified areas of biological significance are displayed graphically in Fig. 3. This figure contains both biodiversity (B) and special place biological SP(B) locations for all survey respondents. Visual examination of the overlay map reveals obvious areas of spatial agreement and disagreement in the perception of biological importance. The tabulation of hotspot specific point densities appears in Table 7.

The survey respondents agreed with the biological importance of hotspot F, rated highest priority by the scientific assessment. Hotspot polygon F falls in the southeast corner of the Sound and includes the community of Cordova. This hotspot had the highest B and SP(B) point densities for all respondents, and for Fishermen B and Scientist SP(B) points. The survey respondents also agreed with the scientists' assessments on C (Columbia Bay), H (North Montague Strait), and N (Naked Island) hotspots with these three areas having the next highest point densities for all survey respondents. The maximum point density for the Scientist B group fell inside the H hotspot polygon while the maximum point density for Fishermen SP(B) points fell inside the A hotspot polygon.

The survey respondents also identified perceived important biological areas not delineated by the scientists. For all survey respondents' B points, the highest maximum densities occurred outside all scientists' hotspots near the center of the Sound (center polygon) or near the mouth of the Eyak River, south of Cordova (outside the F polygon). Fishermen B points had their maximum point density near Eyak (outside the F polygon). In other parts of the Sound, survey respondents almost or completely missed other scientifically assessed hotspots. For

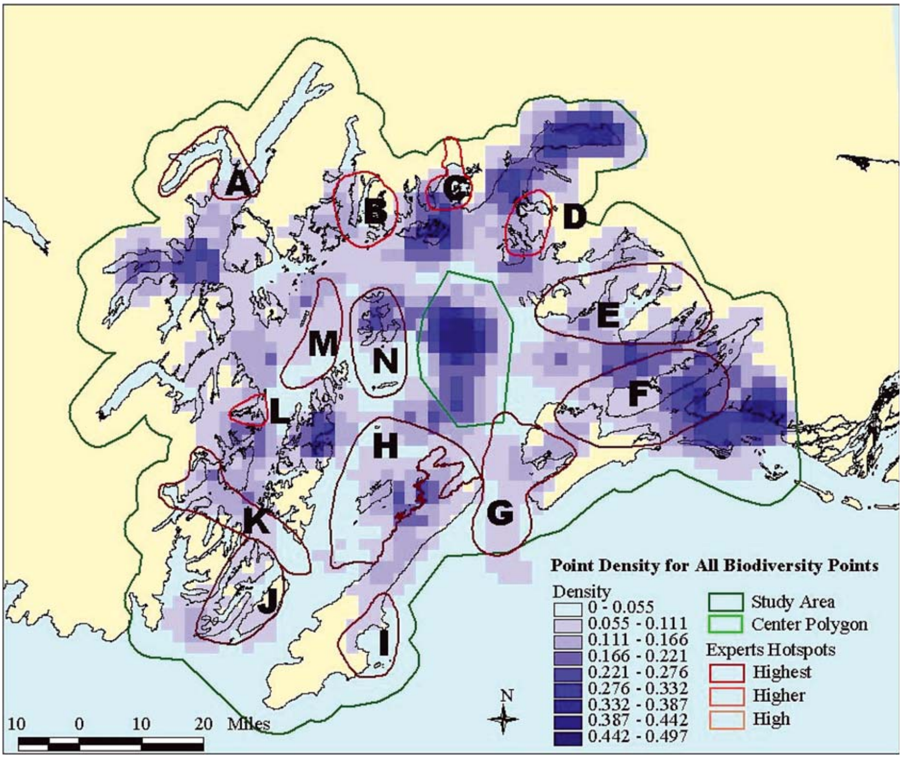

Fig. 3. Overlay of lay (grid cells) and expert (polygon) biological areas.

example, both Fishermen and Scientist respondent groups placed few or no points in scientifically assessed hotspots D, I, L, M, and N. Scientists also placed no points within the A, B, C, or D hotspots. Of the B point sets, the maximum density for only one respondent group, Scientists, fell within a hotspot polygon—hotspot H at North Montague Island.

Both the scientist and fishermen subgroups failed to identify biological value in three scientifically assessed hotspots near the west side of the Sound. One of the hotspots, known as the Black Hole, contains the deepest part of the Sound and was not drawn to include land. The biological significance of the Black Hole stems from the marine processes linked with its depth. Only marine scientists or scientists very familiar with the Sound would appreciate the biological function—deepwater reproduction of zooplankton—this area provides.

Survey scientists did not identify any biological importance in four scientifically assessed hotspots in the north Sound while fishermen placed points in three of these. In fact, the maximum density for the fishermen SP(B) points occurred in hotspot A at Harriman Fjord and Barry Arm. Glaciers define this area, providing icebergs for harbor seal haulouts, while sea otters and sea birds are plentiful. We

Table 7
Spatial coincidence between survey point densities and expert hotspots

Hotspot polygon	Number of cells	Point densities[a–c]					
		All survey respondents		Survey subpopulations			
		All B	All SP(B)	Fish B	Sci B	Fish SP(B)	Sci SP(B)
Study area	2300	0.497	0.338	0.119	0.060	0.100	0.040
A	27	0.100	0.139	0.020	0.000	***0.100***	0.000
B	26	0.139	0.139	0.040	0.000	0.060	0.000
C	15	0.279	0.179	0.040	0.000	0.020	0.000
D	18	0.219	0.139	0.000	0.000	0.000	0.000
E	84	0.179	0.139	0.060	0.040	0.040	*0.040*
F	89	**0.358**	*0.338*	**0.080**	0.020	0.060	*0.040*
G	59	0.159	0.139	0.060	0.000	0.040	0.020
H	83	0.259	0.159	0.040	***0.060***	0.040	0.020
I	25	0.080	0.100	0.000	0.000	0.020	0.020
J	48	0.119	0.139	0.040	0.020	0.060	0.000
K	45	0.179	0.100	0.020	0.040	0.020	***0.040***
L	6	0.139	0.080	0.040	0.020	0.000	0.000
M	26	0.139	0.040	0.040	0.020	0.000	0.000
N	38	0.239	0.139	0.040	0.020	0.000	0.000

[a] Point densities calculated based on number of points located in 3000 m grid cell and surrounding neighborhood using a 4-mile (6437 m) search radius.
[b] Bold values indicate the maximum density for each column (excluding the study area). Italics indicate the maximum value for a given hotspot polygon is also the maximum density for the entire study area.
[c] Underlined values are the maximum density value for the row in that section.

surmise that the biological importance of this region may be embedded and amplified within special place meanings that recognize the overall magnificent aesthetics of the area, not just the specific contributions of marine life to the concept of biodiversity.

Discussion

Spatial coincidence of local values and scientific assessment

An unsystematic visual inspection of the spatial coincidence map (Fig. 3) *appears* to indicate only moderate agreement between the local values and scientific assessment. The more systematic analysis reported here suggests that biological understanding and perception between scientists and local residents is influenced by how the biological assessment question is framed and by the subpopulations participating in the assessment.

Local residents agreed more with the scientists when identifying special places than areas of biological diversity value. Special place relationships between people and natural areas are often forged through direct experience and recurring interaction. With repeated encounters, people learn more about natural areas and their biological features. This empirical knowledge born of experience appears closer to the type of knowledge possessed by the scientists than the more abstract perception of biological diversity value requested of local residents.

Asking the public to assess a landscape for its biological diversity value results in a higher proportion of generalized ‘‘whole region’’ responses reflected by points in the Sound’s center polygon. Isolating and eliminating these non-place specific responses increases spatial coincidence between local resident and scientific assessments, but still fails to achieve the same level of agreement as asking respondents to map special places.

The concept of biological diversity or ‘‘biodiversity’’ does not appear to be well understood by the general public. Poll results in the US indicate that only about 30% of Americans are aware of the concept of biodiversity while only a slightly higher percentage were able to accurately define the concept (Biodiversity Project, 2002). Poll results from Australia are similar with only 1 in 10 individuals understanding the biodiversity concept (Nielson, 1999). Although we defined biological diversity when requesting the public to map places of biological diversity, we do not know the specific biological features or attributes the respondents were mapping. Poor cognitive understanding of the biodiversity concept appears to result in a higher level of random point placement. We suggest that our results could be strengthened by complementing the mailout questionnaire survey with focus groups so as to allow residents’ understanding of biological values to be explored in more depth and validated. Given the moderate response rate of the questionnaire survey the results obtained provide a good starting point for examining local values but must be considered with caution.

The ambiguity of assessing and mapping areas of biological diversity value is not limited to the public. Despite workshop instructions, we suspect that some of the scientists were also identifying their own special places. Many of these scientists conduct field research in the Sound, visiting the same location year after year to study specific species or processes. Their large hotspots may not only represent biodiversity but also encompass special places formed through sustained visitation. These repeated encounters with a place transform the research site and its surrounding space into a special place. As objective as scientists would like to be about their work, they remain human and susceptible to cognitive and emotive factors. As scientists study their subjects year after year in a beautiful marine environment, they may form an image of their research area as a special place. We recommend that these results could be enhanced by using remote sensing based techniques (Turner et al., 2003) for mapping biological ‘‘hotspots’’.

Perception will vary from person to person, depending on past experiences and expectations. In general, scientists have great knowledge in a limited area based on systematic observation and the application of the scientific method. The reduction of the environment to a relatively few variables can cause a loss of context for how the observations fit into the overall ecosystem. Local residents, particularly fishermen, who regularly traverse the Sound may actually possess a broader system-wide knowledge of the Sound’s biological resources. The general public, like the scientists, likely know more about a few locations than the entire Sound. But unlike scientists, the general public perceptions are formed through long-term, *unsystematic* observation of a relatively few places.

Implications of using local values and scientific assessment in conservation planning

Conservation planners require biological assessment data to prepare plans and conservation strategies, but constraints on data collection and analysis introduce uncertainty into a plan (Peck, 1998). Data specific to the plan site can reduce the uncertainty inherent in conservation planning. Both scientists and local residents can offer valuable knowledge, but each type of knowledge presents advantages and disadvantages.

Scientific assessment may provide greater objectivity, if the scientist can remain independent of the non-scientific parts of the planning process (Noss, O'Connell, & Murphy, 1997). In some places, no scientist or scientific data will be available, but local experiential knowledge exists virtually everywhere people are found. Local residents and those familiar with a natural area can provide a starting point for scientific study (Calheiros, Seidl, & Ferreira, 2000), supply knowledge that is often inaccessible to traditional scientific methods (Kruger & Shannon, 2000), and present information unavailable to the planner through experience or intuition (The Nature Conservancy, 2001). Not all residents or users of a place have equal knowledge, however, and the planner must distinguish between those who care about a place but have little biological knowledge to pass along and those who know the biology of a place well. The frequency of area use (familiarity) provides an imprecise, but easy to obtain measure of this knowledge. Public responses can be grouped and analyzed accordingly. But most important, the local resident assessment process can be improved by focusing on questions about special places and specific biological features observed in the study area.

The conservation planner would be prudent to incorporate both local values and scientific assessment to determine conservation priorities. Local people whose livelihood depends upon natural resources, such as fishermen, should be tapped as sources of biological information supplemental to available scientific data as has been suggested elsewhere (Harrison et al., 1998; Mackinson, 2001).

We propose an iterative process of combining local values and scientific assessments of biological importance. Because the local resident biological assessment is potentially time and resource intensive, this assessment will likely only be conducted once in a conservation planning process. Thus, the local resident assessment should use comprehensive survey and sampling techniques to elicit responses from a wide cross-section of people. This should be followed up with focus groups to validate aggregated responses to the mapping exercise. Because scientists comprise a relatively small group of individuals, the workshop approach appears a reasonable means to conduct a rapid biological assessment. However, the inclusion of remote sensing based assessments (Turner et al., 2003), for example, would strengthen the scientific assessment.

Both biological assessment approaches, however, present only a part of the conservation equation. Our analysis of the two biological assessment methods leads us to conclude that neither approach represents the ultimate truth or consensus highest priority areas for biological conservation. We suspect the local residents and scientists would appreciate having an opportunity to study and review each other's assessment to adjust boundaries, if not priority areas, for conservation. A second workshop could be conducted for this purpose, but a Delphi technique (Brown, 1968; Dalkey, 1967) at this stage would appear most appropriate. The Delphi technique provides for iterative adjustment of expert opinion based on successive rounds of blind review until consensus, or something approaching it, is achieved. The technique is especially appropriate when the decisive factors for consensus are subjective and where precise information is lacking. Broad representation of diverse backgrounds can be achieved while limiting the influence of over-dominant group members. Starting with an overlay of the local resident and scientific biological assessments, prioritization of conservation areas could be completed using the Delphi technique.

The conservation of biological resources would be well served by a planning process that incorporates multiple sources of knowledge including systematic study, system-wide observations, and discrete experiences and that provide for iterative adjustment of both priorities and areas to receive biological protection. The incorporation of local values, especially that based on system-wide experience, can complement and strengthen scientific assessment, and equally important, satisfy a deep-rooted desire to make biological conservation democratic in form and function. If public support for biological conservation is to be achieved, it is imperative to widen the knowledge base on which the goals and practices of nature conservation are founded.

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