STATE/FEDERAL RELATIONSHIPS

CHAIR: VERNON C. BLEICH, CALIFORNIA DEPARTMENT OF FISH AND GAME

DENNIS AND RAY DEMARCHI - WILDLIFE AND WILDLIFE HABITAT INVENTORY TO MEET LAND-BASED PROGRAM PLANNING NEEDS FOR MOUNTAIN SHEEP

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Abstract: A review of state and federal mapping of North American mountain sheep (*Ovis* spp.) distribution during the past nearly 100 years revealed that despite advancements in mapping technology and the availability of aerial photography, satellite imagery, and computerized geographic information systems, there has been little progress in relating biological and physical properties to actual or potential sheep distribution and abundance. We describe a system designed and applied in British Columbia to predict current habitat suitability (i.e., actual) and habitat capability (i.e., potential) for mountain sheep and other wildlife species. Wildlife and wildlife habitat inventory, as conducted by the British Columbia government, is designed for multi-scales for both planning and management. Planning processes can vary from international cooperation on grizzly bear management: provincial planning, for identifying and protecting areas to be set aside as Provincial Parks; sub-regional, planning, for identifying resource extraction, conservation or management priorities; landscape unit planning and forest development planning for setting forest harvest rates, location and timing; to local planning for operational resource extraction. In order to accommodate that level of complexity a number of resource inventories have been standardized through the multi-agency provincial Resources Inventory Committee. Most of the ecosystem-based inventories and classifications currently being recommended in British Columbia are not stand alone and, in fact, they accommodate portions of classifications or information from many other such inventories. We recommend that an appropriate government agency assume the responsibility of initiating and coordinating a cooperative international mountain sheep habitat mapping project and habitat registry.

The North American wild sheep literature contains numerous reports and publications that include maps of historic and present mountain sheep including bighorn sheep (*Ovis canadensis*) distribution (Sheldon 1911, Hornaday 1914, Seton 1927, Cowan 1940, Buechner 1960, Trefethen 1975 and USDA and BLM 1995). Comparing the thinhorn sheep (*Ovis dalli dalli, O. d. stonei and O. d. fannini*) map prepared by Sheldon (1911) prior to the advent of vehicular access and aerial photography with the maps of sheep distribution in recent published literature reveals little progress has been made in this field. State and federal maps of mountain sheep habitat do not rate habitat quality with habitat availability or suitability. The absence of the application of a relative scale of habitat quality results in maps that over-estimate the area occupied and, therefore, apparent abundance of mountain sheep. Also, the most productive areas may be overlooked or masked by the inclusion of poor quality habitats. This makes it difficult for wildlife agencies to direct their protection and management efforts toward the most important areas or to convince competing land users of their importance to population survival.

Wildlife species recovery programs are based on projections of historic or "potential" population

abundance and distribution from these generalized maps. This has established an erroneous belief that bighorn sheep, for example were far more numerous in pre-Columbian times than is ecologically possible (Demarchi, 1977). These and other maps, including both the historic and current maps of bighorn distribution in the Western U.S. compiled by Buechner (1960), plus that author's acceptance of Seton's (1927) unsubstantiated claim of 1.5 to 2.0 million bighorns have done much to exaggerate both the magnitude of the losses and the expectations for recovery.

The logical progression in the development of habitat capability maps is: Phase One Maps that depict species distributions; Phase Two Maps that include subjective application of density ratings; and, Phase Three Maps that are ecological maps and incorporate a quantitative assessment of species habitat attributes (e.g., Sweanor et al. 1996). Nearly all agencies in the U.S. and Canada have long-since perfected Phase One Maps and some have made progress towards Phase Two Maps by overlaying distribution maps on land status and vegetation zonation maps (Cassidy 1997, ESWG 1995, ONHC 1998). To our knowledge, Phase Three Maps have not yet been developed for any wildlife species in the U.S.

An additional impediment to bighorn recovery is that because of jurisdictional separation there is a resistance to produce cohesive habitat maps that are jurisdictionally neutral. In an attempt to overcome this barrier in one region, the British Columbia Wildlife Branch contracted Demarchi *et al.* (1999) to produce a single Phase Two Map of bighorn distribution and abundance for the Rocky Mountain population of Rocky Mountain bighorn sheep (*O. c. canadensis)* shared between Alberta, British Columbia and Montana. Rocky Mountain bighorn sheep distribution and abundance maps were developed by Blower (1988) for BC and by J. Jorgensen (pers. commun., 1999) for Alberta, while L. Bailey (pers. commun., 1999) produced the maps for Montana. The result of combining these individual jurisdictional maps is shown in Figure 1.

Armentrout and Boyd (1996) attempted unsuccessfully to develop a Phase Three Map for bighorn sheep in the Western U.S. They applied the USFS ecological maps of Bailey et al. (1994) to California (*O. c. californiana*) and Rocky Mountain bighorn sheep distributions and concluded that, "Ecosystem management which includes California and Rocky Mountain bighorn sheep will require boundaries other than those provided on current ecoregion and MLRA (Major Land Resource Area) maps".

Demarchi et al. (1999) attempted a similar exercise utilizing bighorn sheep distribution taken from the map which accompanied the first edition of Trefethen (1974) and overlaying it on the ecological map of Western North America produced by Demarchi (1994). The result is shown in Figure 2. Nearly all bighorn sheep populations appear to fit within Demarchi's (1994) ecozones. Perhaps more significantly, separation into the three North American bighorn subspecies (*O. c. canadensis, O. c. californiana and O. c. nelsoni)* while only assessed subjectively appears to have a high degree of "fit" at the both the Ecodivision and Ecoprovince levels. This fit appears sufficient to support further habitat map development at the more detailed Ecoregion and Ecosection levels. In the interest of moving mapping of bighorn sheep habitat into the third phase of map development at both strategic and operational mapping scales, we describe the system that has been developed and applied in British Columbia.

METHODOLOGY: Habitat Mapping in British Columbia: The overall goal of the wildlife species and wildlife habitat inventory program done for the government of British Columbia is to provide site-specific inventories of those resources across the province in order to meet operational and higher level planning requirements. Those inventories generate the information needed for the designation and management of specific wildlife populations, and habitats for the development of various plans, guidelines and practices in order to meet the requirements set out in a number of provincial and regional planning processes.

Wildlife habitat identification in British Columbia is the result of interpreting the ecological or site series (Pfister et al. 1977) information from detailed ecosystem mapping products, for the purpose of assigning values for select wildlife species such as, bighorn sheep, Rocky Mountain elk (*Cervus elaphus*), or grizzly bear (*Ursus arctos*) etc. (Resources Inventory Committee 1998a, b, c, d). Such habitat values may be a measure of either the current suitability of the habitat to support those species' living requirements, or the potential capability of the habitat in the correct successional stage under specific management to meet those wildlife species' living requirements (Resources Inventory Committee 1998d). All such values are based on benchmark densities for the best habitats for each species within the province of British Columbia. Thus, the bunchgrass terraces above the Fraser River in the Junction Provincial Park become the benchmark habitats for rating all other habitat for California bighorn sheep in the province; while the early seral stage bunchgrass terraces above the Wigwam River become the benchmark habitats for rating habitat for all other Rocky Mountain bighorn sheep in the province; and the early seral stage northern ryegrass/trembling aspen rocky slopes in the Muskwa Foothills in northeastern British Columbia become the benchmark for rating all habitat for Stone sheep in the province.

The Input of Scale: Wildlife and wildlife habitat inventory projects must be balanced between scale and level of survey intensity and the planning level that the inventories are to be used in. Inventory projects must also meet the planning horizon of the intended plan if they are to be useful, and they must meet a prioritized planning schedule for input into various plans (assuming that all planning is being generated from broad to site-specific levels). For example, Land and Resource Management Plans (LRMP) are higher level plans that form a bridge between international or national and provincial strategic resource use plans and the Landscape Unit, Forest Development, and Resource Use plans (Figure 3). The wildlife species and wildlife habitat inventories that are conducted for these higher level plans are done at a broad level, but they provide guidance for prioritizing areas requiring more detailed inventories.

Through its Resources Inventory Committee the Province of British Columbia has defined a hierarchical ecosystem classification that has four levels: regional, local, vegetation development and field data collection (Figure 4). Each of those levels can be further subdivided into different classifications or can be subdivided into different levels. For example, the Regional Ecosystem Level is composed of the Ecoregion (Demarchi 1996) and the Zonal (Pojar et al. 1987) classifications, and each of those classifications can be further subdivided into a number of classes - 5 for the Ecoregions, and 4 for the Zonal Classification.

There are a number of cases where wildlife species and wildlife habitat inventories are directly or indirectly linked to other resource inventories. In some cases this can mean supplying required data or being an interim step in a more detailed inventory. In other cases, such as the highest level of habitat inventory, Ecoregion mapping that is done by the BC Ministry of Environment, Lands and Parks (1998) is based in part on a product (the Zonal Ecosystem Classification) that has been developed and mapped by the BC Ministry of Forests (1994). Even though the two classifications are mutually exclusive, they are supportive of each other.

There are also linkages between species and habitat inventory. For example, habitat mapping is used as a tool for species surveys, such as stratified random sampling. Also, habitat inventory is used to support species population estimates and the habitat maps provide the spatial level that is required to turn sampling into a population estimate. Conversely, species inventories are essential in providing quantified data for fine tuning capability and habitat suitability ratings; all rating done in the province are measured against the best densities ever counted in the benchmark habitats. In order to calibrate a project area that is not in the benchmark area, animal density determinations are necessary.

Information Levels and Input Criteria: At the national and provincial levels, Ecoregion

(Demarchi 1995 and 1996) and Biogeoclimatic Zonation classifications (Ministry of Forests 1994, Pojar et al. 1987, Meidinger and Pojar 1991) are sufficient tools to provide wildlife and wildlife habitat information for resource planning. These levels are mapped at 1:250,000 but are often presented at much smaller scales. The Ecodomain and Ecodivision levels, and even Ecoprovince levels, are useful for determining the ecological characteristics of species. For example, most of the thinhorn sheep are located in the Boreal Ecodomain, with all of the Stone sheep in the Boreal Cordillera Ecodivision and the Dall sheep located in the Subarctic Highland and the western portion of the Boreal Cordillera ecodivisions (Demarchi et al. 1999).

At the regional and sub-regional (LRMP) levels, overview ecosystem classifications that incorporate Ecosections, Biogeoclimatic sub-zone/variants and Broad Ecosystem classes (Resources Inventory Committee 1998a) provide the most meaningful information. These surveys add field information on wildlife species presence where little is known or documented. They are required, primarily for broad area strategic planning, but also for prioritizing landscape units for more detailed assessments. Overview species surveys provide data for habitat management options over broad areas - more intensive work is used for defining cut-block activities, identifying Wildlife Habitat Areas (WHA - which is a specific land use designation for protecting habitat for Species at Risk in British Columbia), and for determining the scope of general wildlife habitat conservation measures within the Managing Identified Wildlife, Biodiversity, and Riparian Management Area guidebooks under the provincial Forest Practices Code. Each of the units can be defined by geographical area (Ecosections) climatic parameters (Biogeoclimatic subzones), potential climax communities (Broad Ecosystem Units), stand age (succession), and edaphic characteristics (site modifiers), which combine to identify general ecosystem units (Figure 4). Each of those units can be evaluated on their ability to produce species such as bighorn and thinhorn sheep, either in the potential habitat condition that is ideal for those species or in the current successional stage. Such evaluations are important for delimiting the potential habitat for those species and for determining habitat management potential. Due to the coarse nature of this scale, usually only winter range and summer range habitats are identified for ungulates.

At the landscape unit level, general ecosystem classifications (Resources Inventory Committee 1998b) that provide some detail on landforms, terrain and site series, while incorporating Ecosections and Biogeoclimatic sub-zone information provide a meaningful level of information for resource planning. Sample-based (1:50,000) inventory is required for forest management areas having high wildlife values that will not be undergoing forest development within the next 10 years. The 1:50,000 general-level habitat inventories and relative abundance wildlife species surveys provide information about the characteristics and distribution of wildlife species and their habitats and about approximate and potential locations of WHA's. This level of information contributes to decisions in the early stages of landscape-level planning about sensitive habitats and to the establishment of some landscape-level biodiversity objectives. The general-level inventories also provide the framework for limiting and focusing the detailed habitat information requirements in logging plans and silivicultural prescriptions. The rating of habitat units at this scale provides information on existing and potential habitats, for winter and summer ranges, as well as lambing habitat for species such as bighorn and thinhorn sheep.

At the logging or cut-block level, detailed ecosystem information is required in order to make sound resource management decisions. The sample-based (1:20,000) inventory is required for all forest management areas that within the next ten years will be undergoing active forest development planning. Detailed 1:20,000 wildlife habitat inventories and absolute abundance wildlife surveys provide information about the characteristics and distribution of wildlife species and their habitats and about potential locations of WHA's. This level of information contributes to decisions in the early

stages of forest development planning about where to log, and to the establishment of landscape-level biodiversity objectives. They also provide the framework for limiting and focusing the detailed habitat requirements in logging plans and silivicultural prescriptions. The rating of habitat use by each species at this scale can be precise, with habitat use by season and life history requisite (cover, foraging, migration, lambing, rutting, etc.).

Wildlife species and population inventories further address government's responsibility under the FPC to provide landscape-level biodiversity objectives, to identify and characterize species at risk, and to determine the measures required to protect critical habitats of those species that have been designated as *Identified Wildlife* in the Managing Identified Wildlife Guidebook (MIWG).

DISCUSSION AND CONCLUSION: The lack of progress towards the development of habitat-based capability maps in nearly 100 years of sheep mapping history has hampered bighorn sheep recovery efforts in the United States and Canada. If bighorn sheep populations are to be restored to any semblance of their past we should have a good handle on how many there were, where they were, how many there are, where they are, and where they could be. We believe that, because of the wide range in ecological diversity in British Columbia the habitat capability mapping method developed there is applicable to all ecosystems and many vertebrate species. The opportunity to take this system, develop it and apply it to both bighorn and thinhorn sheep is available to any agency or corporation willing to undertake this project.

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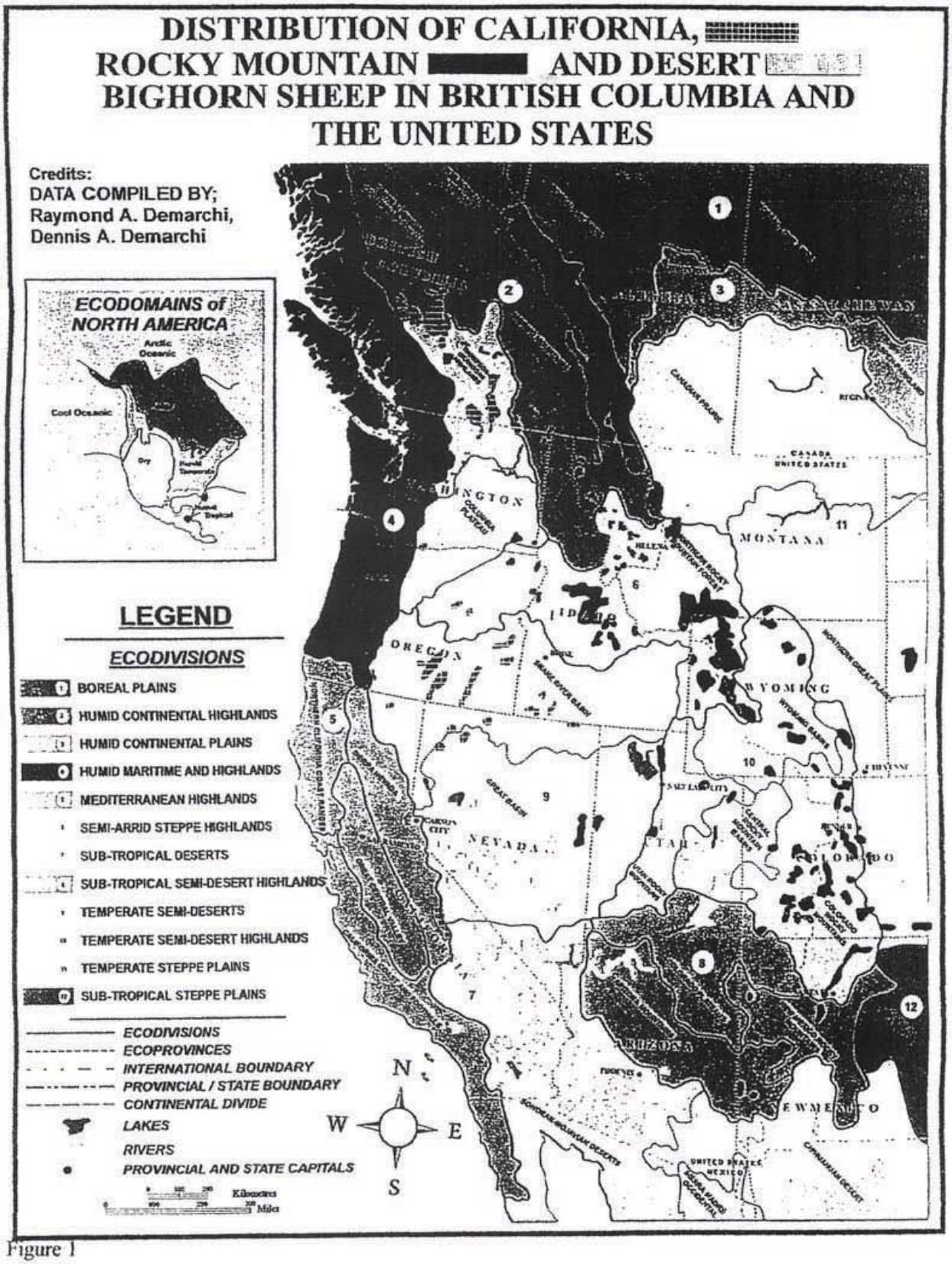
DISTRIBUTION OF CALIFORNIA,
ROCKY MOUNTAIN
AND DESERT
BIGHORN SHEEP IN BRITISH COLUMBIA AND THE UNITED STATES
Credits:
DATA COMPILED BY;
Raymond A. Demarchi,
Dennis A. Demarchi
ECODOMAINS of NORTH AMERICA
Arctic Oceanic
Cool Oceanic
Dry
Humid Tropical
LEGEND
ECODIVISIONS
1 BOREAL PLAINS
2 HUMID CONTINENTAL HIGHLANDS
3 HUMID CONTINENTAL PLAINS
4 HUMID MARITIME AND HIGHLANDS
5 MEDITERRANEAN HIGHLANDS
6 SEMI-ARRID STEPPE HIGHLANDS
7 SUB-TROPICAL DESERTS
8 SUB-TROPICAL SEMI-DESERT HIGHLANDS
9 TEMPERATE SEMI-DESERTS
10 TEMPERATE SEMI-DESERT HIGHLANDS
11 TEMPERATE STEPPE PLAINS
12 SUB-TROPICAL STEPPE PLAINS
ECODIVISIONS
ECOPROVINCES
INTERNATIONAL BOUNDARY
PROVINCIAL / STATE BOUNDARY
CONTINENTAL DIVIDE
LAKES
RIVERS
PROVINCIAL AND STATE CAPITALS
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NEVADA
WYOMING
COLORADO
NEW MEXICO
CANADA
UNITED STATES
UNITED STATES MEXICO

Figure 1

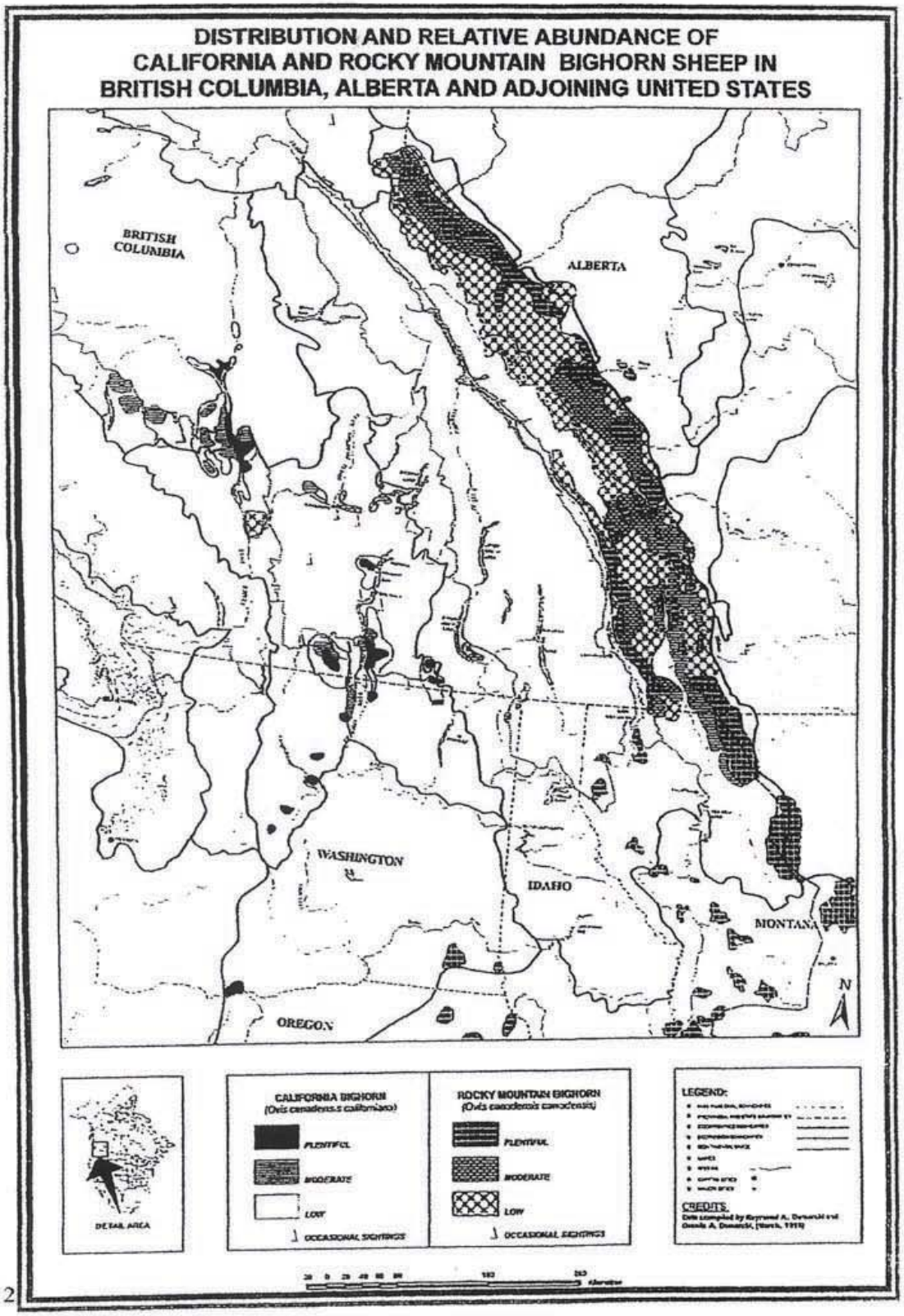
DISTRIBUTION AND RELATIVE ABUNDANCE OF
CALIFORNIA AND ROCKY MOUNTAIN BIGHORN SHEEP IN
BRITISH COLUMBIA, ALBERTA AND ADJOINING UNITED STATES
BRITISH COLUMBIA
ALBERTA
WASHINGTON
IDAHO
MONTANA
OREGON
N
CALIFORNIA BIGHORN
ROCKY MOUNTAIN BIGHORN
PLENTIFUL
MODERATE
LOW
OCCASIONAL SIGHTINGS
LEGEND:
CREDITS

Figure 2

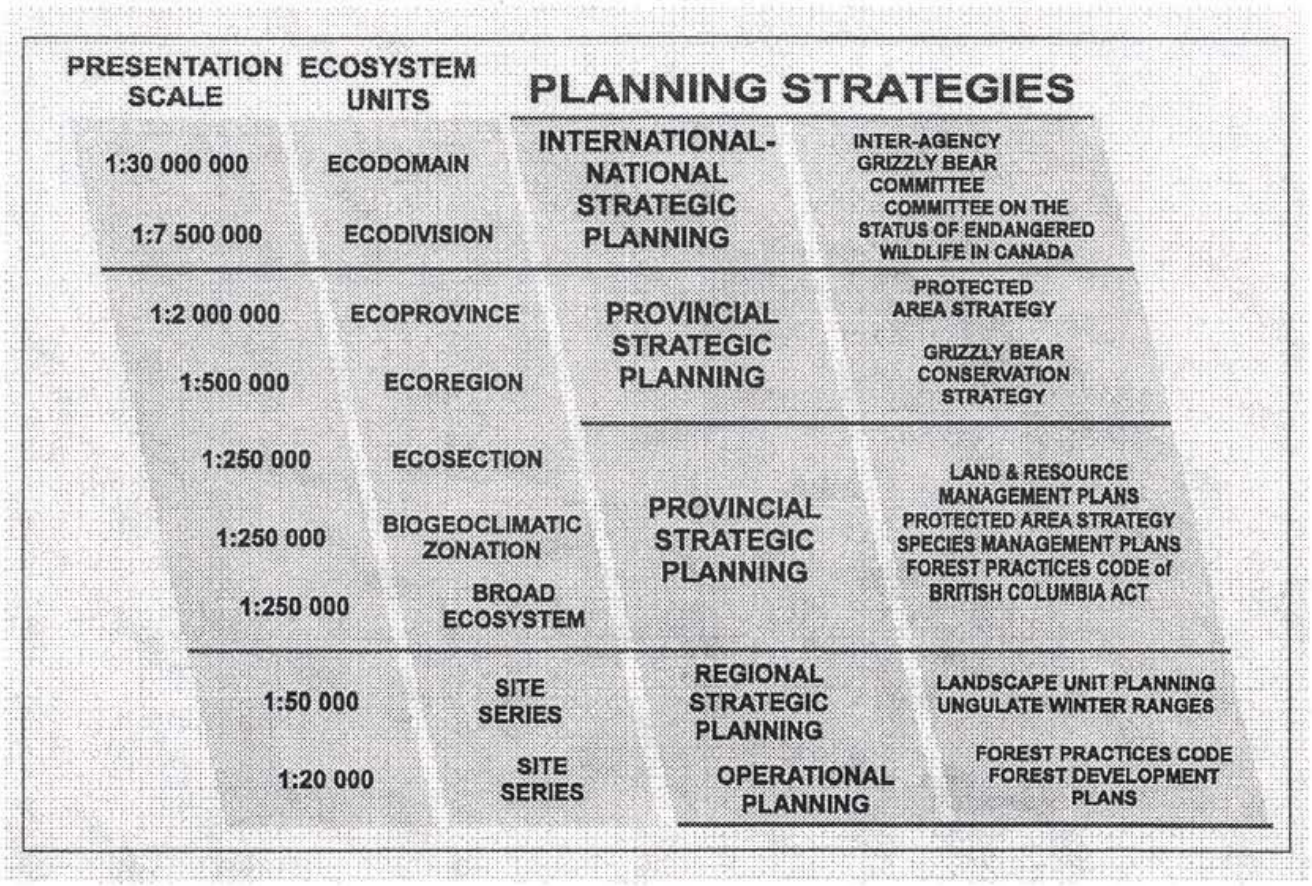

Figure 3. Ecosystem identification level and map scale used in various land based planning strategies that have been initiated by the British Columbia Provincial Government.

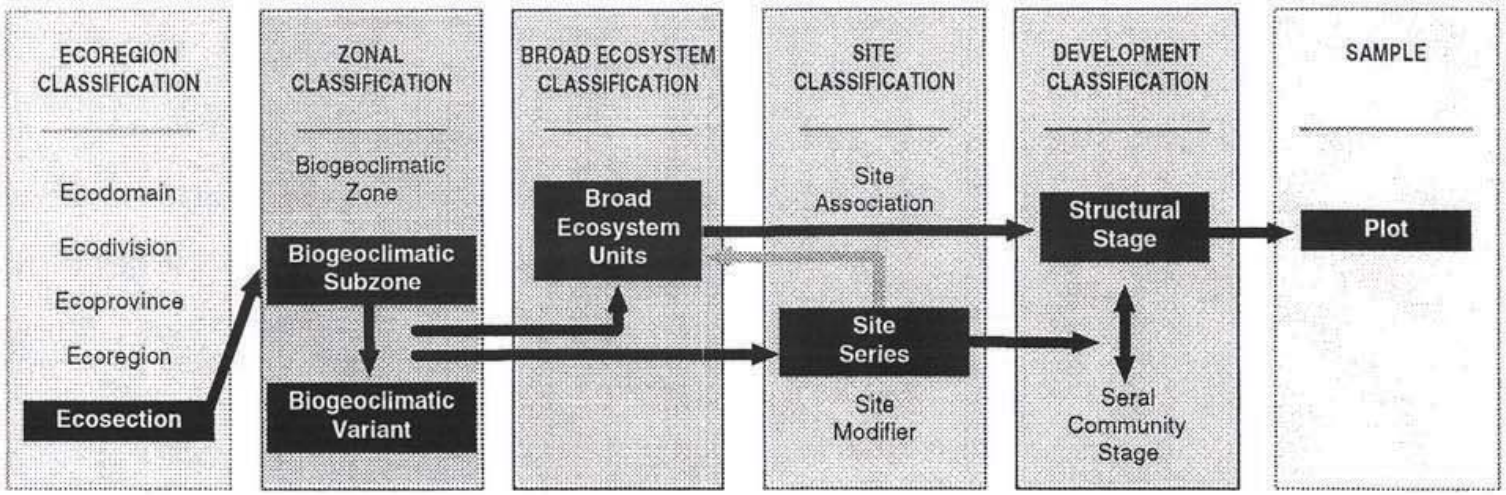

Figure 4. Relationship amongst the various ecosystem classification used for land based resource management by the British Columbia Provincial Government (Modified from Resources Inventory Committee, 1998b).

QUESTIONS, ANSWERS AND COMMENTS - DENNIS AND RAY DEMARCHI PRESENTATION

CRAIG FOSTER, OREGON: This question is for Ray on the international registry for sheep. How often do you see that needing to be updated?

RAY DEMARCHI: I would say that you would have to update it at least every five years, and you probably would want to update it more often than that. The way we're operating electronically now, there's no reason why you can't update it every two years when you're going to conferences.

I wanted to say that this knowledge is in all your heads. We've just presented an objective way of mapping habitat. There was a comment made yesterday: Well, the habitat has changed so much in my state over the last 400 years, I haven't got any idea what the capability is. I don't know if you can figure that out, but I think you can. I mean, has the land changed, has the climate changed?

There are ways to figure out if the climate has changed. You only change the land form when you mine. There are very few other things that change the land form. A lot of the things have stayed basically the same.

What we're doing is a historical review of big game in British Columbia in an attempt to turn back the clock to what we had in the mid-1900s. We already did it for grizzlies. It worked pretty well. We're going to refine it as we go, and you learn as you go. But the thing is, right now, I don't think your ordinary mapping system for habitat is really that organized. I got this information and I've been writing to the states. We've got something that you should take a good, hard look at, because it's very, very useful.

KEVIN HURLEY, WYOMING: Ray, is there a report that might be available, that interested folks could contact you and perhaps get on a mailing list for more information about this?

R. DEMARCHI: Dennis has produced some publications. They're not in the refereed literature. We've got some map products and a lot of this stuff is still evolving. It's old GIS and it's evolving. There are reports but there is no mailing list per se. What we're trying to do is capture some interest so we can stimulate some discussion around this and get a project going. There's no such thing as the Flathead Island habitat or the Southern Selkirk Island habitat. They're all connected. If they're not connected, then maybe the challenge is to get them connected.

People are worried about endangered species. Look what happened to the salmon in the Pacific Northwest. It will change land use, agriculture, and everything forever in that area. So we have a pretty powerful argument. But we haven't applied the tools. You've got the wheels and you've got the axle. You need the bed of the wagon and you put it together and make a wagon. There's no official registry or anything, but it's starting to develop.