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A Background Report on the
Potential for Use of Economic Instruments for the
Conservation and Preservation of Wildlife Habitat
in the Lower Fraser River Estuary and Associated Floodplains

prepared

by

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for

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EXECUTIVE SUMMARY

This project is a background report on the economic and institutional factors affecting the interaction between agricultural practices and wildlife habitat in the Lower Fraser River estuary. The research contained in this report evolves from an extensive literature review of academic and government publications, interviews with public and private agency officials and working files and documents at the University of British Columbia. The report presents information on economic and institutional issues relating to wildlife and agriculture, and addresses four key areas: 1) A general overview of the nature of wildlife and agricultural interactions in the Lower Fraser Basin and Estuary (including the Boundary Bay Area and Serpentine-Nicomekl watersheds), describing in particular habitat and food supplies from wetlands and floodplain forests; 2) Describes the markets and infrastructure, social institutions and government policies affecting and constraining the relationships between agriculture and wildlife in the area; 3) Highlights potential areas where economic instruments could be applied to the agricultural sector (and other land use sectors) to improve wildlife habitat and, lessen the impact of agricultural practices on wetland ecosystems; and, 4) Outlines a program of future studies and work required to implement a system of economic incentives and develop cost effective solutions to agricultural and wildlife issues.

The Fraser River Estuary is one of the most productive and diverse natural settings in Canada. Since settlement, much of the region's wetlands and forests have been lost to dyking and development. Much of the remaining wildlife habitat coincides with the agricultural belt that extends from Brunswick Point east into the Serpentine-Nicomekl Floodplain. Agricultural land cannot be easily separated from the urban environment which surrounds it, even though it accounts for almost 50% of land use in the study area. Urban, agricultural and wildlife processes interact with and substantially affect one another. Mismanagement of the agricultural (and urban-industrial) landbase will impact wildlife habitat quantity and quality, affecting local and migratory wildlife populations with international consequences.

At the heart of the economics of agricultural land use and wildlife habitat are economic externalities: the pecuniary influence of urban shadow, the nuisance impacts and uncoded benefits of ownership and production externalities, and the public goods externalities related to scenic amenities and agricultural chemical disposal. Unique approaches to such problems are

important and require flexible adaptive institutions that empower individuals to act on new information and values.

Agriculture and Wildlife in the Lower Fraser Estuary

The Lower Estuary is a critical wildlife habitat area, with a number of distinct ecological areas in three broadly defined ecosystems: the Coastal-Intertidal, the Fraser River Foreshore, and the Fraser Lowlands. These distinct areas and ecosystems are linked ecologically, hence economic uses can affect land concurrently, adjacently, and over distances through fluid mediums such as creeks and viewsapes. Agricultural and urban landscapes dominate the area, with valuable forested areas increasing in abundance east of the study area.

How agriculture is practised on the land is driven by the institutions that affect landowners. While markets play a big role in agricultural production, they are distorted by the presence of numerous government support programs, unique marketing institutions, international trade agreements, and proximity to urban growth areas.

Linkages between agricultural markets bring the different levels of the agri-food industry together, and permit economic incentives at one level to affect activities in another. Urban encroachment and wildlife issues act directly on those levels of the agri-food industry closest to primary production and extensive land use. There are numerous forms of organization within the agri-food industry; regional and commodity oriented cooperatives with varying degrees of production or marketing control are common. Sometimes these organizations are voluntary, but among the supply managed commodities, binding legal production and marketing controls are in place. The current system of agricultural support and organization is likely to change over the implementation periods of the General Agreement on Tariffs and Trade, and the North American Free Trade Agreement.

One of the greatest influences on land use is the urban shadow: the geographical range of significant pecuniary effect on land prices and land use due to the presence of a growing urban core. Greater Vancouver's urban shadow affects agricultural land use as far east as Rosedale, and affects land development as far south as Bellingham, WA. The Agricultural Land Reserve, while it protects land from outright urban development, does not prevent the withdrawal of land from high value extensive agriculture, and promotes the fragmentation of land by exacerbating the opportunity costs of holding large land units. There also exist some important distributional consequences associated with the ALR due to artificial scarcity of developable land and lost option value in ALR designated lands. Wildlife habitat is threatened

from a combination of urbanizing influences on rural land, and institutional distortions of economic incentives on agricultural production.

Institutions and Instruments in Land Use and Wildlife Habitat

Institutions are the social environments in which economic instruments operate. Economic instruments are mechanisms that alter economic incentives to change behaviour. Instruments are often employed in combination. The report identifies eleven broad categories of instruments (all of which revolve about some aspect of property): 1) land acquisition; 2) land transfers; 3) density transfers; 4) land use zoning; 5) land management and stewardship programs; 6) restrictive covenants; 7) conservation covenants; 8) advocacy, education and extension; 9) charges and taxes; 10) standards; and, 11) performance bonds. Each of these instruments is effective to one extent or another in achieving habitat objectives; either directly influencing (potential) agricultural production and development, or reducing or eliminating the speculative influence and economic externalities associated with the urban shadow.

The number of agents (institutions) “actively employing economic instruments is large. Many are actively pursuing habitat objectives in cooperation with other groups within coordinating bodies such as the Fraser River Estuary Management Program (FREMP) or the Pacific Coast Joint Venture (PCJV). The coordinated effort of these groups is characteristic of the broadly distributed benefits of habitat preservation relative to the market benefits of development that accrue to single agents and land owners.

Implementation and Further Research

To overcome problems of habitat loss, economic instruments can be employed as an alternative to command and control. Planning has traditionally been employed to effect a distribution of land-uses; economic instruments achieve a desirable distribution of land-uses without the inflexibility and malconsequences of centralized municipal/regional planning. Habitat has traditionally been secured through land acquisition. But, a greater use of property rights will permit the securement of habitat objectives without acquiring complete land ownership. An expanded reliance on property instruments also deals with the distributional consequences of restricting land-use through zoning and production regulations. Ownership and technical externalities can be overcome by better defining property rights; either by attenuating holders of conflicting rights, or extending rights that are incompletely specified.

Four areas of future research are highlighted. Habitat objectives have yet to be economically quantified and related to various regional landscape alternatives. The economic implications of a system of tradeable development permits must be explored as an alternative to massive regional planning. The use of conservation covenants has been well documented by the West Coast Environmental Law Foundation; however, creative alternative property instruments exist outside of BC which should be fully explored, particularly in areas experiencing similar problems in Canada, the U.S. and Europe.

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LIST OF ABBREVIATIONS

AACA:	Accelerated Capital Cost Allowance Pollution Control Program
AFDB	Agri-food Development Branch, Department of Agriculture, Canada
ALC:	Agricultural Land Commission
ALR:	Agricultural Land Reserve
AMS:	aggregate measure of support
BBAS :	Boundary Bay Area Study
BCMAF:	British Columbia Ministry of Agriculture and Food
BCMAFF:	British Columbia Ministry of Agriculture, Fisheries and Food
BCMOE:	British Columbia Ministry of Environment
BCMOELP:	British Columbia Ministry of Environment, Lands, and Parks
BCMOTH:	British Columbia Ministry of Transportation
BOD:	Biological Oxygen Demand
C-BCSCP:	Canada - B.C. Soil Conservation Program
CFVRD:	Central Fraser Valley Regional District
CUSTA:	Canada - United States Free Trade Agreement
CWS:	Canadian Wildlife Service, Department of Environment, Canada
DARD:	Dewdney-Alameeda Regional District
DFO:	Department of Fisheries and Ocean, Canada
DP:	Development Permit
DRP:	Development Rights Purchase Program
DU:	Ducks' Unlimited
EMR:	Department of Energy, Mines and Resources, Canada
EPF:	Environmental Partners Fund
ESA:	Environmentally Sensitive Area
FBI:	Fraser Basin Initiative
FRAP:	Fraser River Action Plan
FREMP:	Fraser River Estuary Management Plan
GATT':	General Agreement on Tariffs and Trade
GVRD:	Greater Vancouver Regional District
LMAP:	Land Management Assistance Program
NAFTA:	North American Free Trade Agreement
NAWMP:	North America Waterfowl Management Plan
NISA:	Net Income Stabilization Account
PCJV:	Pacific Coast Joint Venture
PCP:	Permanent Cover Program
PECP:	Pacific Estuary Conservancy Program
SSFP:	Small-scale Forestry Program
TDR:	Tradeable Development Permit
WMA:	Wildlife Management Area

CHAPTER 1:

FARMLAND AND WILDLIFE HABITAT

Outline of this Report

This report describes the economic and institutional factors affecting the interaction between agricultural land use and wildlife habitat in the Lower Fraser River Estuary. An objective of this report is to consider the effectiveness of the current mixture of market and management institutions in meeting the changing demands of the community for wildlife habitat. In particular, it considers the potential uses of economic instruments to preserve, enhance and restore wildlife habitat in a working landscape. Chapter 1 describes the context of the problem, and introduces the economic concept of “externality” as the problem vector. It concludes with a brief discussion of the nature, form and importance of compensated land use as central to an effective solution to the current conflict. Chapter 2 details the role of landscape in wildlife abundance and highlights the implications of the contemporary production environment of agriculture. Chapter 3 describes economic instruments and strategies taken in the preservation of habitat, as well as the role of land use regulation in determining the landscape. The chapter concludes with a discussion of current agencies and programs operating in the area of habitat conservancy. In chapter 4, the potential of implementing an economic instrumental approach to land use management is discussed. The chapter conveys some institutional changes necessary to take this approach, and makes recommendations for further research in the area of operational design and the role of liability for negative externalities.

Introduction

The Fraser River Estuary is one of the most productive and diverse natural settings in Canada. Over four million adult salmon begin their upstream migration in the Fraser River, 800 million juveniles use its marshes and subaquatic vegetation, Dolly Varden Char, White Sturgeon and Pacific Lamprey can be found in the lower reaches of the river. Several million birds use the estuary’s many important wetlands and farmed areas each year as they migrate to and from summer breeding areas and wintering grounds — for many ‘birds, the estuary is a winter home. The estuary provides ,habitat for numerous plant and animal species; the Boundary Bay eelgrass beds are an important breeding area for herring, and a major food source for waterfowl. It is

also home to one of Canada's fastest growing urban/ industrial centres, one of the world's busiest ports, and some of Canada's most productive agricultural lands. Over the last 125 years 84% of the valley's wetlands have been lost to development (99% of wet meadows and salt marsh of the lower estuary). Of what remains, only 10% remains set aside for conservation (CWS 1993).

Agriculture plays an important role in the regional economy, both monetarily and socially. The agricultural community of the area is one of the largest users of land in the estuary. Agricultural Land Reserve (ALR) areas in Richmond (5180 hectares), Delta (10,200 ha), Surrey (8900 ha) and Langley (23,740 ha) total 48,000 ha, or about 50% of the 97,000 ha in these four municipalities. How land in the estuary is used is important to its residents; and because of the international importance of the estuary to world populations of migrating birds and marine mammals, land use in the estuary is also of concern to non-residents of the Valley.

Social welfare can be thought of as the wealth of communities; it includes extracted resources, manufactured goods and services, as well as the many "environmental goods" not exchanged in a market, such as wildlife and scenery. It is important to separate the value derived from private markets (financial values) from values derived from the set of goods which lack markets (social values); economic and ecological goods and services, such as: bogs (as bogs), mountain vistas, greenspace, etc. Mismanagement of the land base will adversely impact wildlife habitat quality and quantity, affecting the variety and abundance of wildlife populations. When man's private activities in the estuary cause wildlife populations to decline and habitat to be degraded, social welfare may decline, bringing groups and individuals (who bear costs and receive benefits separately) into conflict. Social welfare and individual welfare are not alike. Social welfare refers to an aggregate of the individual welfare of all persons in a relevant region of reference. The aggregation makes no attempt to describe the distribution of welfare across individuals within the reference group. A particular action or institution may be socially desirable because it increases social welfare, however, the change in the distribution of welfare that results may be socially unacceptable or politically contestable.

This report focuses on the economic and ecological distributional consequences of particular institutions and instruments. It considers the conflicts that have motivated the regulation of land use and land development in the Lower Fraser Estuary — it is often the distribution of welfare (not necessarily of income) from a particular set of institutions which motivates groups and individuals to support or contest changes to the status quo — and describes the economic and institutional factors affecting the interaction between agricultural land use and wildlife habitat.

Local, provincial, and federal governments have acted for many years to provide land for the purposes of preserving wildlife habitat. Parks and wildlife refuges (which account for approximately two per cent of the agricultural land base) are an important resource already in existence. The provincial government has acted to preserve the best agricultural lands from further development through the establishment of the ALR. The B.C. government is currently engaged in a systematic review of lands to be included in a series of protected areas (parks and ecological reserves) that are representative of B.C.'s ecological heritage. A better understanding today of a need for additional lands to maintain and enhance wildlife populations has seen the formation of many private organizations and government partnerships securing land for wildlife by various means, and promoting wildlife issues.

The reservation of land through legislation or purchase is the predominant outcome of wildlife habitat conservation strategies. A plethora of agricultural programs and institutions tends to support the expansion of agricultural land, while policies surrounding land use in urban areas discourage the continued stewardship of land under agriculture. Farmland preservation without adequate legislation or compensation will preserve farmland, but not necessarily farming. Habitat securement and enhancement for wildlife will make land available for wildlife use, but will not necessarily protect that wildlife from activities on adjacent or ecologically linked land. It is argued in this report that so long as farmland and wildlife habitat remain economically estranged from ecological interdependence, so long as land policies fail to consider the ecological role of landscape, so long as land owners remain inadequately compensated for providing wildlife habitat *and* remain unaccountable for habitat alteration, the existing quantity and quality of wildlife habitat will remain indefinitely and increasingly threatened.

Economics, Agriculture and the Environment

The Lower Fraser Estuary is a large area encompassing much of the southwestern half of the GVRD. Its ecological and economic importance have brought a number of groups and individuals into conflict. While wildlife habitat is occasionally prominent in the conflict (the habitat reclamation conditions of the third runway project of the Vancouver International Airport, for example), it is often the unconsidered victim of policies designed to promote or protect agricultural operators near urban areas. For the purposes of this report, only areas where agriculture and important ecological systems co-exist are considered (see Figure 1). The agricultural lands of Richmond, Sea Island, South Delta, and the Serpentine and Nicomekl floodplains (Surrey Flats) are the focus of this report.

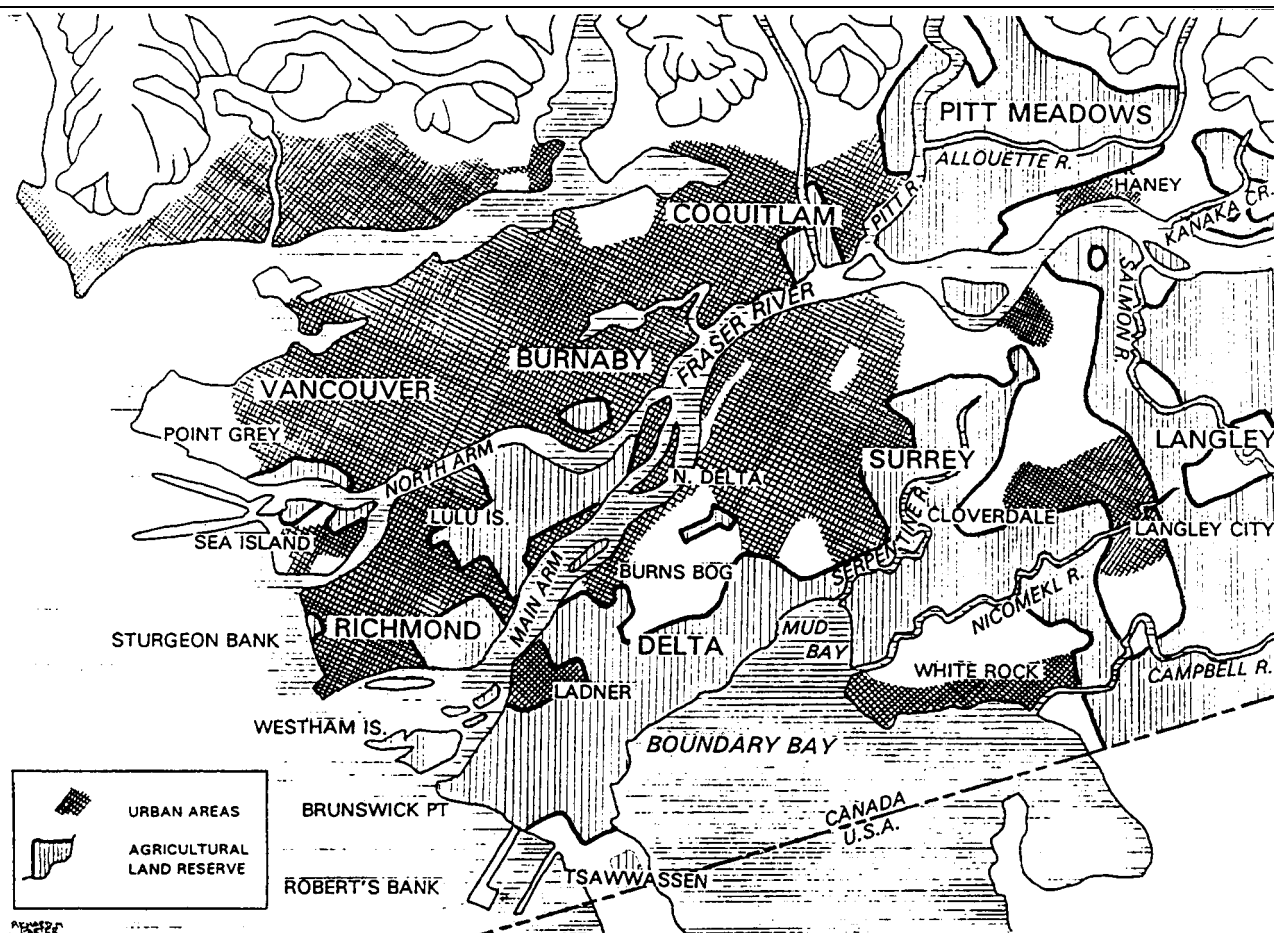


Figure 1A
Lower Fraser Valley West

Although other important agro-ecological communities exist in Surrey, Langley, and the municipalities of regional districts east of the GVRD, they do not have the same ecological and economic importance, nor do they face the same environmental threats as the lands of the lower estuary.¹ Additionally, government agencies and private organizations have focused their conservation and education efforts to secure habitats in these agricultural lands.

1. The author does not want to undervalue the ecological sensitivity of the areas outside the GVRD, or the estuary itself. All land uses and wildlife contribute to society's well being. It is the degree of conflict and social significance that focuses attention to the lower estuary of the Fraser River. Recent projections of population growth in the Fraser Valley predict rapid growth in areas east of the GVRD (see GVRD 1993a, 1993b). It is likely that many of the issues discussed in this report for the Lower Estuary will apply equally to areas as far east as Hope. Indeed, wildlife issues are a growing concern for farmers and residents throughout the Fraser Valley. The Livable Regions Strategy (GVRD 1993a) attempts to concentrate urban growth within the GVRD: in Richmond, Surrey-North Delta, and lands north of the Fraser River. This, too, has long-term consequences for urban pressures on adjacent agricultural lands.

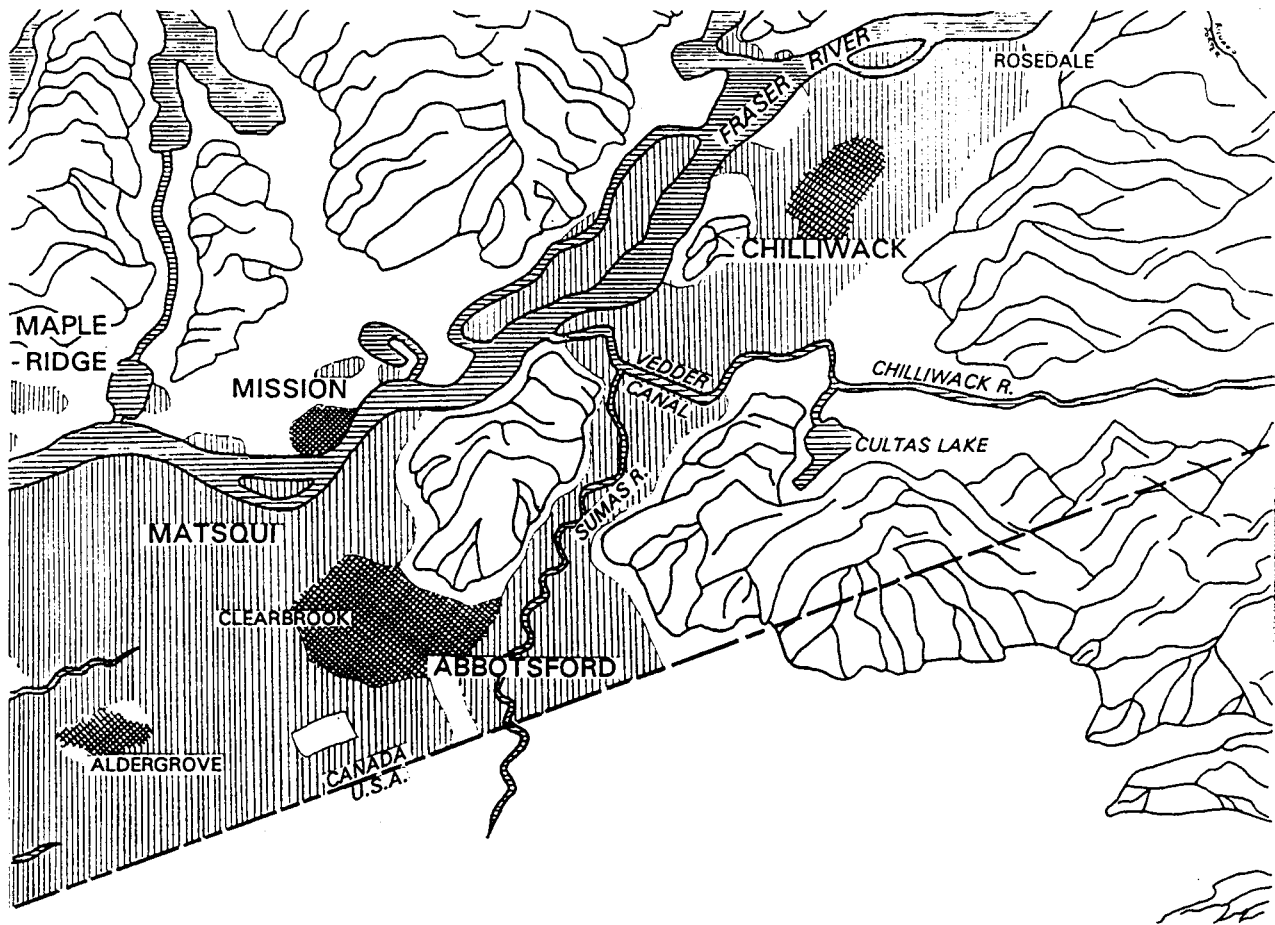


Figure 1B
Lower Fraser Valley East

Urban processes, agricultural processes, and wildlife processes interact with, and impact on, one another. The relationship can be visualized as an interlinked triangle. Economic growth and population growth fuel urban expansion. Urban expansion encroaches on agricultural lands and wildlife habitat because of low development costs and the attraction of nearby greenspace and wildlife. The production knowledge of the farming community combines with agricultural markets and political and legal institutions to influence cultural practices. These practices impact on adjacent urban communities and on the quality and quantity of wildlife habitat. Plentiful wildlife attracts urban residents and influences the viability of some agricultural production. Residents of the region know that a balance of urbanization, agricultural land, parks and wildlife habitat will bring about the highest quality of life (GVRD 1992c). To better understand and work toward this balance society has established a mixture of market, regulatory and land management institutions.

The Consequences of Unconsidered Costs and Benefits

Individuals and firms make consumption and production decisions based on relevant measurable costs. Most costs are measurable because they have prices determined by transactions in a market; but not all inputs and consumer goods possess markets to provide an accurate assessment of their environmental costs. When market prices deviate from social prices — that is when prices do not take account of environmental costs and benefits of a good — too much or too little of a good (such as fertilizer or the waste assimilative capacity of ecosystems) is used. For example, a corn farmer applies fertilizer to her land to improve her yield. The amount of fertilizer she applies will depend on the farm-gate price of corn, the incremental increases in yield from applying the fertilizer, and the cost of the fertilizer itself. What she does not consider in her decision to use fertilizer is the detrimental impact run-off will have on wildlife to anyone other than herself because there is no market or mechanism to provide such information (neither in the price of fertilizer, price of waterways, or liability for wildlife health).

The presence of agricultural chemicals in the environment places wildlife at risk, affects water quality and subsequently reduces social welfare. The run-off of agricultural chemicals also poses an environmental health risk (see Hagan 1990; Dorcey and Griggs 1991; Diebel *et al.* 1992; and Leibscher, Hii and McNaughton 1992); but such issues fall outside the scope of this report. Many of the environmental costs of using agricultural chemicals do not enter the production function of the farmer — they remain unconsidered and are passed onto others. These unconsidered costs create a reciprocal benefit that is captured by the producer as an “environmental” subsidy.² As a result the farmer does not apply the amount of fertilizer that promotes community welfare, but instead applies the amount of fertilizer that optimizes her private costs and benefits. Largely as a result of poorly specified ownership and/or incomplete markets, the farmer is able to obtain a direct benefit herself by imposing unconsidered costs on others.

This is an example of an externality: when the actions of one individual or firm unintentionally influences the welfare or profitability of another. More specifically, “externalities arise whenever the value of an objective function, for example the profits of a firm or the happiness of an individual, depends upon the unintended or incidental by-products of some activity of others” (Lin 1974). Baumol and Oates (1988) prefer to describe the existence of

2. For all intents and purposes, producers and consumers in the Valley are unable to affect the price of agricultural products — prices are determined largely by world markets. Unless indicated otherwise, this is assumed throughout the report.

externalities as occurring when the value of real (nonmonetary) variables — inputs and consumption goods — are chosen by others (individually or collectively) without particular attention to their affect on other individuals. The subtle differences in definition between Lin and Baumol and Oates implies that a distinction exists between types of externalities: private externalities and public externalities.

Ownership, or private externalities involve the interaction of agents and the by-products of production or consumption. They are amicable to property or economic instrument oriented solutions. Public externalities persist because there exists no incentive for individuals to provide a good or curb its consumption. Public externalities, or public goods externalities, involve the joint production of, or collective provision and protection of undepletable goods — a special class of goods, of which consumption by one individual does not interfere with consumption by another, i.e., consumption is non-rivalrous. Scenic amenities are a classic example of public goods. Public goods externalities are amicable to non-economic allocative solutions, such as standards. Externalities involving land use often have elements of both privateness and publicness, hence solutions to specific externalities involve a mixture of non-economic and economic instruments and institutions. Indeed, many organizations concerned with land conservation or the preservation of wildlife habitat employ a mixture of instruments to achieve their objectives (see chapter 3).

Matters of law or institutional relationships will only affect the amount of the externality and not effect its existence because externalities are identified expressly with technical relationships (Dorfman 1974); hence institutions can be employed to resolve externality related conflicts. A distinction between the types of externalities is important, then, for they influence policy solutions (institutional and instrumental response to the externality) and the ability of groups, firms and individuals to shift external costs and benefits (rent- and transfer-seeking behavior). Externalities may be positive or negative. A positive externality occurs when the externality “product” of one agent increases the welfare of another. This is referred to as an external economy (the pastoral landscape of hayfields and pasture, or greenspace, is a common external economy in agriculture). When the externality “product” reduces the welfare of another (as in the fertilizer example above) a negative externality, or external diseconomy, occurs. Who bears the burden of a policy solution will depend on not only on the measure of publicness of the externality, but also whether it generates positive or negative economies.

Externalities exist because not all goods are ownable or owned, because property rights are overlapping, contain gaps (see Dorfman 1974), or that they lack a measurable expressed

value — they lack a market, or at best an informed market, to give them a price.³ But these goods (i.e., wildlife, greenspace and common water courses) do have subjective value that informs individuals; collectively these goods have a value to society. Conflict over land use occurs when one individual uses land or affects land in such a way that its value to another is reduced. Resolving these disputes requires careful consideration of the externality driving the dispute (if indeed, an externality exists at all).

Individuals value wildlife, habitat, farmland, and urban space differently (see Goldberg 1977, Gardner 1977 and McCauley 1992). How land is used by its owner will depend on how society values the land for its different uses, institutions concerned with land use, and the owner's individual preferences (see Haney, Phillips and Adamowicz 1991; Barichello, Porter and van Kooten 1995). Not everyone owns land, but the fugitive nature of wildlife and the publicness of its habitat ensures a public interest in the continued presence of wildlife and a varied landscape. Thus, the manner in which private land is used influences the quality of the environment and the quantity of wildlife habitat. When private land use degrades the components that comprise an individual's "environment" welfare is reduced.⁴

When a loss of welfare is perceptible, individuals will seek to remedy the loss.⁵ How

3. A good discussion of asymmetric information and pecuniary (money) effects can be found in Tirole (1988). A pecuniary effect occurs as a result of ordinary market operations, no public or private externalities need be present. Pecuniary effects affect resource re-allocation (they are centripetal to the price mechanism of market efficiency), they do not result in resource mis-allocation — hence, they are irrelevant externalities with respect to allocative efficiency, but relevant when considering the distributional consequences of the institutions and instruments of policy. For example, when a residential development is built in an agricultural area it induces an increase in the land values of adjacent properties (given their potential for future development). These raised land values increase the operating costs of agriculture (its land costs), but are unrelated to actual production; these increased costs can reduce the economic return of land to nil (see Hazeldine *et al.* 1989). The increased land costs are due to the market — they are said to be pecuniary. Pecuniary effects are an important part of the urban shadow effect on land use and conversion discussed in chapter 2.

4. The components of an individual's "environment" can be thought to be comprised of manufactured goods such as cars, roads, groceries, etcetera, as well as landscapes, the abundance and richness of wildlife, air and water quality, and quality attributes of his or her community (i.e., safety, empowerment, stability, etcetera). Many of the components of the human environment are qualitative descriptions of institutional objectives, others refer to ecological objectives (e.g., air and water quality, and biodiversity). This report will largely concern itself with the role of institutions and community objectives and how these interact with wildlife and other ecological components of this environment.

5. In surveying the literature involving positive and negative externalities, considerable discussion is devoted to remedying only negative externalities. With respect to wetlands and waterfowl, the provision of waterfowl from private land is a positive externality — waterfowl are not a traded commodity, they are not priced, and apart from crop damage, they do not figure highly in the production function of the farmer, but contribute positively to the happiness of the general public. However, wetlands development results in less available habitat, and hence, less

that loss is remedied will depend on the degree to which the statutory rights and property rights of land owners, residents and wildlife have been defined, and the degree of access individuals and groups have to government agencies. The establishment of wildlife refuges, the regulation of production, and private conservancy trusts are examples that demonstrate a perceptible loss of welfare exists — perceptible because that loss is great enough that individuals voluntarily incur the costs necessary to seek and obtain a remedy. This voluntary behaviour takes many forms. Negotiations — called a Coasian solution — between parties to an externality can result in the transfer of real property, the establishment of covenants or lease restrictions.

In other cases victims and generators of externalities seek a political solution. Which avenue is pursued depends on the type of externality. Where scope exists for agents to pursue a political solution that transfers costs and benefits (a form of externality shifting) when a Coasian solution is appropriate, the welfare and efficiency impacts of the externality will either be exacerbated or replaced with other economic inefficiencies. The variety of mechanisms currently used by institutions attests to the existence of a mixture of externality types, differing access to government, a variety of defined, implicit, and undefined property rights, as well as the different values individuals place on land for its different uses.

The relationships between urbanization, agriculture and wildlife are just beginning to be understood. Growing awareness of the impact land use has on wildlife led to the establishment of private and public institutions whose mandate is to secure and enhance land for use by wildlife. The manner in which these institutions operate, and their goals, reflect an understanding (complete or incomplete) of who benefits from wildlife habitat preservation, and who bears the burden of preservation. The value of wildlife is great (Filion, *et al.* 1989). The value of land to preserve wildlife may exceed the value of the same land in other exploitive uses (such as housing, industry or agriculture).^b The preservation of existing wildlife populations is of considerable interest to many and is by no means limited to local residents — the

waterfowl--wetlands development involves a negative externality. It is curious to note that farmers and land owners rarely object to, and, have never demanded, *a priori*, as a group, to be compensated for the positive externality (merely the crop damage) (w Gray and Sulewski 1994). Calls for compensation are related to restrictions placed on land development or wetland preservation that restricts development (the lost option value of their land). Such restrictions are employed as uncompensated institutional means of forcing the costs of providing waterfowl to the non-land owning public on to farmers and land owners.

6. A central argument of this report is the compatibility of agricultural land-use and wildlife habitat under the right conditions. Agricultural output *and* wildlife may have a combined social value that exceeds agricultural or wildlife use alone. This remains to be determined, however.

international importance of the estuary to migratory birds includes 30 countries. The mechanism by which wild populations are maintained or enhanced will affect the welfare of individuals and the distribution of the economic surplus associated with wildlife.⁷

Compensated Land Use

The development of land is biologically an irreversible process. Land may be restored, but never to the pristine state that existed prior to development. Development can also be economically irreversible. When developed land can technically be restored but the costs of restoration are excessively costly in both resources and time, then society may be better off not restoring the land (van Kooten 1993). The decision to preserve or reserve land for a productive use or limit activities on land can be thought of as a social or political choice to avoid biological and economic irreversibility.

The economic surplus associated with wilderness is the motivation for wilderness preservation — the prevention of biological or economic irreversibility in the present for future benefits. Because the surplus is embedded in land, we witness efforts to restrict land use activities or acquire land for wildlife (the emphasis tends to be on land securement and not the processes that drive land use). This economic surplus is the sum of values individuals place on the quantity and quality of wilderness at some point in time. This value is embedded in the ability of wilderness to provide goods into the future through delayed development (option value). Option value is an important component in the total economic surplus associated with wildlife and wilderness as a public asset. Figure 2 shows that the option value of delaying development today can be socially beneficial because of the increased or maintained future benefits tomorrow (it need not always be this case). These benefits include medicines and other

7. Within economics, consumer's surplus is often defined as the sum of an individual's willingness to pay for each unit of a good. Because an individual, generally speaking, is willing to pay less for each succeeding unit of a good, the surplus is a sum of individually determined falling values (Katz and Rosen 1991); it measures the benefits of consuming *n* units of a discrete good (Varian 1990). When the consumer's surplus of all individuals is aggregated the total consumer's surplus of a good is determined for a market or for society. Wildlife is a good to which individual's assign incremental unit values; a good for which consumer's surplus exists. For a marketed good, prices will limit consumption affecting net consumer's surplus, the 'wealth' of individuals. Net consumer's surplus, then, is the difference between what an individual is willing to pay for *n* units of a good and what they actually paid for each unit. Wildlife has no market to determine a price, but the preservation of wilderness does have a cost. Which individuals pay the price of preservation will determine the distribution of net consumer's surplus for wildlife. Many land-use conflicts involving wildlife and wilderness preservation are motivated by the distributional consequences of policies which permit habitat transformation (i.e., land clearing for sub-divisions) or preservation (i.e., parks and ecological reserves). Such policies often transfer benefits to *one* group in society while imposing the costs on another segment of society.

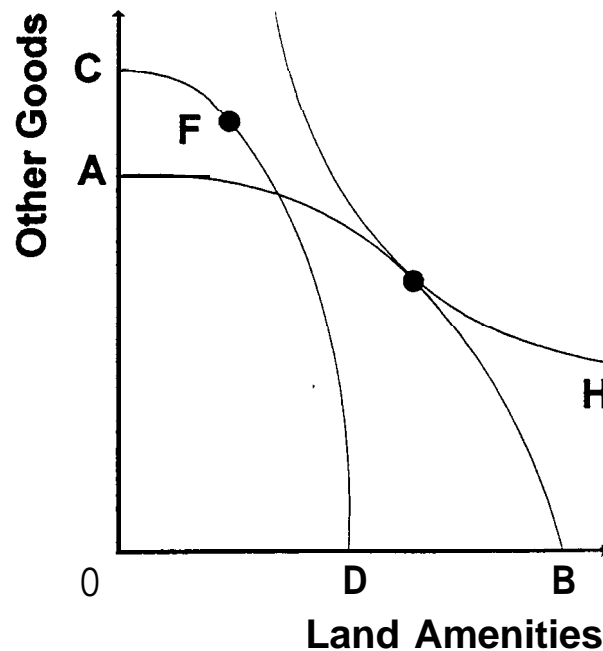


Figure 2
The option value of land preservation.

goods derived from advanced technologies, as well as a continued and preserved supply of wildlife and other environmental amenities.

Goods can be obtained through land development, or by leaving land undeveloped society maintains a quantity of environmental goods (wildlife). These goods are plotted on the axis of Figure 2, land amenities along the ordinate and other goods along the abscissa. Because the amount of land is fixed, society must trade-off between goods derived from land development and the environmental amenities derived through non-development. This trade-off is depicted by the production possibility frontier, AB. Inefficiencies due to institutions and technologies may only permit a combination of goods on or between the origin and the frontier. AB represents the possible combinations of these goods which available land and technology can provide. Advances in technology will push the frontier up (the productivity of developed land is increased), but the amount of environmental amenities provided by land does not change, so there is no outward expansion of the frontier over time.

Society will seek out the best combination (balance) of these goods given its means and resources and its preferences (taste and happiness derived from use). The community will be indifferent to certain combinations of these goods which allow society to derive the same, level of social welfare. This community indifference curve is represented by the curve GH. At point E, society's welfare is maximized given its ability to provide these goods from the fixed land base. Combinations that lie above and to the right of E allow society to realize greater welfare from increased amounts of the two goods. Such points are on indifference curves yielding higher welfare, but which cannot be achieved today given limits to technology and the land base.

As land is developed, the quantity of environmental goods will decline, but the quantity of other goods will rise; for example, to the frontier CD. Such a frontier may result because of externalities or institutions that promote development over conservation. The community's ordering of preferences will not have changed necessarily, but its welfare will have. Although greater numbers of goods from development are available, there are less environmental goods, and social welfare (although maximized) has declined — F provides less welfare than E. In order for development to provide greater social welfare, technology must advance sufficiently so that society is at least compensated for the loss of environmental amenities — attaining a new community indifference curve to the right of GH — assuming society can agree on compensation at all. Hence, there can exist clear benefits to delaying land development through conservation and preservation. How the costs and benefits from delayed development and preservation are distributed depend on the mechanisms pursued.

CHAPTER 2:

AGRICULTURE AND WILDLIFE IN THE FRASER ESTUARY

This chapter surveys the nature of wildlife and agricultural interactions in the Lower Fraser Estuary, Fraser Lowlands, the Boundary Bay Area and the Serpentine-Nicomekl floodplains. Markets and infrastructure, social institutions and government policies affecting and constraining the relationship between agriculture and wildlife in the area are also described. Particular attention is given to the role of the urban shadow in influencing agricultural land use. The implications of ecological and economic relationships for wildlife populations and habitat conclude this chapter.

Wildlife Abundance and Land Use in the Estuary

Wildlife at Risk

The landscape of the lower estuary is a disturbed landscape. There exist no habitats or landforms which do not bear the effects of development and land-use in the region. Floodplain forest, bogs and wetlands were historically common, but have been broken and altered as land was, and continues to be logged (or mined), cleared and reclaimed for agricultural and urban/industrial purposes. Such activities render some species vulnerable, and threaten the persistence of others. Tables 1 and 2 highlight fauna that are at risk and plants that are rare, and subsequently at risk, due (in some degree or other) to large scale alterations in the regional landscape. Apart from Garry Oak (*Quercus garryana*)⁸ there are no threatened or endangered plants present in the study area — there are individuals and populations, rare to the region (which are noted in Table 1) whose future status is uncertain. Giant Helliborine (*Epipactus gigantea*) is considered threatened, but is only known to occur near Cultus Lake (Straley *et al.* 1985). Gartner Lee Ltd. (1992) note that no comprehensive study across the region exists

8. Garry Oak occurs on Sumas Mountain and near Yale in the Fraser Canyon (Hosie 1979). There is an unconfirmed herbarium record of its presence in the vicinity of Abbotsford. Inside the study area there are several Garry Oak trees on a half-acre section of the BC Forestry Association arboretum in Surrey; several sites within the Green Timbers Forest Reserve (a 300 acre wood in central Surrey) contain bunches of the shrub variety. Garry Oak is currently the focus of attention as a unique landscape form, rare, imperiled, and important to the biodiversity of British Columbia (BC Conservation Data Centre 1993).

Table 1
Rare vascular plants present in the Lower Fraser Estuary.

Scientific Name	Common Name	Location	Rarity
<i>Centarium muhlenbergi</i>	Muhlenberg's Centaury	Stanley Park	R1
<i>Claytonia spathulata</i>	Pale Spring Beauty	Boundary Bay	R2
<i>Dechampsia flexuosa</i>	Wavy Hair Grass	Vancouver	R1
<i>Eleocharis parvula</i>	Dwarf Spike-rush	Delta	R1
<i>Eupatorium maculatum</i> var. <i>bruneri</i>	Joe-pye-weed	Sea Island, Delta	R2
<i>Grammica pentagona</i>	Five-angled Dodder	Elgin	R1
<i>Gratiola neglecta</i>	American Hedge-hysop	Fraser Lowland	R2
<i>Hydrophyllum tenuipes</i>	Pacific Waterleaf	Clayburn	R1
<i>Juncus bolanderi</i>	Bolander's Rush	Burnaby, Richmond	R2
<i>Juncus oxymeris</i>	Pointed Rush	New Westminster	R1
<i>Myriophyllum hipporoides</i>	Western Water-milfoil	Queensborough	R2
<i>Phragmites australis</i>	Common Reed	Fraser Lowland, Ladner	R2
<i>Poa howellii</i>	Howell's Blue Grass	Tsawwassen	R1
<i>Quercus garryana</i>	Garry Oak	Surrey	R1
<i>Rubus chamaemorus</i>	Cloudberry	Camosun & Burns Bog	R2
<i>Rubus nivalis</i>	Snowy Dewberry	Fraser Lowland	R2
<i>Salix geyeriana</i>	Geyer's Willow	Vancouver	R2
<i>Scirpis fluvatilis</i>	River Bulrush	Vancouver	R1
<i>Sidalcea hendersonii</i>	Henderson's Checker-mallow	Fraser Lowland	R2
<i>Utricularia gibba</i>	Humped Bladderwort	Vancouver	R2
<i>Viola howele</i>	Howell's Violet	Fraser Lowland	R2

NOTE: R1 = single or few populations, few individuals in each population. R2 = few or several populations; relatively large number of individuals in each population. SOURCE: Straley *et al.* 1985, Gartner Lee Ltd. 1992.

detailing the relative distribution of rare and threatened species; such a study may add new species to the list and change the status of others. Certain habitat types, however, occur over large, almost continuous stretches. Sufficient forest cover exists for wildlife (not large mammals) to inhabit and move throughout the region. 'Old field', fallow and cropped lands cover extensive contiguous acreages.

Table 2 lists a number of red- and blue-listed species (endangered and threatened, respectively) which occur in the Georgia Depression (the lower estuary constitutes the southwestern portion of this eco-province). Of particular concern to this study is the status of

Table 2
Fauna at risk in the Georgia Depression Eco-province.

Species	Red	Blue
Anna's Hummingbird		*
Bald Eagle		*
Black-crowned Night Heron		*
Common Barn Owl		*
Great Blue Heron		*
Green-backed Heron		*
Long-eared Keen's Myotis	*	
Pacific Giant Salamander		*
Pacific Jumping Mouse		*
Salish Sucker	*	

Species	Red	Blue
Sharp-tailed Snake	*	
Shrew Mole		*
Southern Red Bat		*
Spotted Owl	*	
Tailed Frog		*
Townsend's Big Eared Bat	*	
Townsend's Chipmunk		*
Townsend's Mole		*
Trowbridge's Shrew		*
Vaux's Swift		*

SOURCE: Gartner Lee Ltd. 1992, McPhail 1987, 1994.

the Salish Sucker (*Catostomus* sp.),⁹ Townsend's Mole, Barn Owl, Bald Eagle, and the Herons. The status conferred to a species is a function of ecological assessment, but the cause of their status is related, largely, to economic externalities. The status of a particular wildlife species, or rarity of a vascular plant does not necessarily reflect its economic importance in the social landscape.

Points of Contact in Land-Use

There are numerous points of contact between wildlife and agricultural land use. Broadly speaking we can define three types: 1) concurrent land use; 2) adjacent land use, and; 3) linked land use. A degree of dependency may exist between a particular species and the type of contact under consideration. Many species thrive on disturbed landscapes while others may show little ability to cope with continual disturbance and land conversion.

9. The Nooksack Dace (*Rhinichthys* sp.) is a possible candidate for 'endangered' status (red-listed). That its range falls within that of the Salish Sucker (*Catostomus* sp.) ensures that a degree of protection already exists (McPhail 1994). Apart from the general threats to fisheries posed by urban development, the Salish Sucker and Nooksack dace face an uncertain future due to relative obscurity and parks development that favours charismatic species, such as waterfowl and raptors. McPhail (1994) attributes the disappearance of the Sucker from the Little Campbell River to GVRD parks development.

Concurrent land use defines circumstances where wildlife use the same fields or structures as agriculture as part of their behavioral regime. Barn Owls often use particular structures that are also used to house farm machinery, supplies and produce. Waterfowl use horticultural field crops as an extended food source. Old field landscapes are popular hunting grounds for raptors. Adjacent land use refers to circumstances where landforms in the area remain unworked and provide important habitat for wildlife. A worked landscape, which also provides wildlife habitat, is one that is actively used for horticultural crops, pasture, residence, roads, storage space, etc. An unworked landscape is one where agricultural and urban/industrial activity is absent. Fence lines, hedgerows, idle and fallow lands, dykes, ponds, ditches and copses are examples of landforms in the agricultural landscape that can be affected by adjacent production. Linked land use is an insidious point of contact which describes landforms that are affected by agricultural production (or infrastructure) that may be occurring (or be placed) at some distance, or over a large landbase. The tidal barriers at the mouths of the Serpentine and Nicomekl rivers, and the drainage and dyke systems throughout the region are examples of structures and forms that influence habitat conditions, and which are not, necessarily, adjacent.

When discussing and addressing specific externalities, it is important to consider the type of contact a species enjoys (or is subjected to), or which the agricultural regime presents. Capital upgrading (or neglect) of barns results in declining nest opportunities for Barn Owls. Subsidized drainage and irrigation projects promote the loss of certain wetland forms. Deforestation and urban development in water recharge and discharge areas requires flood mitigation efforts in the lowland floodplains. This aspect of analysis helps identify existing policy instruments which are exacerbating externalities, or ecological characteristics which will limit (in some cases) or enhance (in other cases) the usefulness of certain economic instruments in resolving externalities.

Agricultural Landscapes

Cleared lands not in agricultural production are often referred to as 'old field' habitat. Apart from Sea Island, parts of South and Central Richmond, and protected areas of Surrey and Delta, old field habitat is a function of crop rotation and fallowing by farmers, and speculation by lease holders and land owners. It is abundant in South Delta, the Serpentine-Nicomekl floodplains and the Little Campbell River Valley. Old field habitat provides relatively safe nesting and feeding habitat for waterfowl, passerine and small mammals; but less so as feeding habitat for birds of prey, which are at risk from pesticides build-up in the food chain (Bohn

1994). The agricultural landscape will be considered in greater detail in the later sections of this chapter.

Watersheds, Drainages and Floodplains

Groundwater discharge provides year-round base flow to streams and watercourses — cool groundwater contributes to the moderation of temperature fluctuations in salmon bearing streams. Local spawning areas are associated with stream reaches where groundwater discharges through gravel substrates (Gartner Lee Inc. 1992). The discharge zones of the study area are associated with the Serpentine-Nicomekl floodplain and Salmon River (Halstead 1978, 1986).

Watercourses and discharge areas are critical to fisheries, riparian zones and floodplain forests. On average, over 100,000 salmon spawn within the GVRD. Drainage and stream courses are often altered and re-routed in the advancing path of urbanization and its infrastructure. Infilling, deforestation and re-routing alters stream morphology, reducing the quality of fisheries habitat (or eliminating it altogether) and increasing the risk of flooding downstream due to increased discharge rates (particularly during high precipitation events).

The vast majority of remaining wildlife habitat lies within the historical floodplains and ancient channels of the Fraser River. The flood plains are located where groundwater discharges from nearby uplands, or where high water tables and seasonal ponding occur due to elevational proximity to river and sea water. Much of the floodplain has been dyked and/or filled and reclaimed for agriculture. Under these conditions the natural capacity of the floodplains to absorb high precipitation events is reduced, and channel capacity must be increased to mitigate against potential floods. Recent urbanization in recharge/discharge areas (Sunshine Hills, ~ Panorama Ridge and Cloverdale) has been followed by higher dykes (to increase channel capacity) and high capacity pumps in the drainage infrastructure of the Serpentine-Nicomekl Floodplain.

Forested Landscapes

According to a study by Galli *et al.* (1976), eastern Canadian woodlots of at least twenty hectares were required to support a variety of bird species. Assuming similar requirements for the West Coast, Gartner Lee Ltd. (1992) found that forest blocks (greater than 20 hectares in size) were uncommon in the developed western half of the study area, but increased in frequency moving eastward through Surrey and Langley (see Figure 3).



Figure 3

Distribution of forest lands (> 20 ha) and fisheries habitat (eelgrass meadows and marsh) in the study area.

In addition to providing habitat for wildlife, regional forests serve important ecological functions: regulating groundwater discharge, preventing soil erosion and sedimentation in streams and watercourses, as well as shading fish habitat. The forest remnants along the Tsawwassen Bluffs, Pacific Spirit Regional Park (Point Grey), and along Panorama Ridge, the Delta watershed (Sunshine Hills in North Delta), and in North Surrey along the Fraser River Valley are important for regulating water discharge and controlling erosion, but are threatened by urban development. Urban development of forested water discharge areas has important consequences in the Serpentine-Nicomekl floodplains where pump stations have been installed to cope with increased water discharge rates along Panorama Ridge and in Cloverdale.¹⁰

10. Five new pump stations and a heightening of the upper reaches of the Serpentine were done to mitigate against the ten year flood horizon. Each station required a fish habitat study and incorporates technologies appropriate to the individual sites. The district of Surrey has recognized the potential damage from run-off following deforestation and development. New developments often require detention ponds to slow and smooth out discharge; however this

Forest cover along watercourses in the Salmon River Valley, Little Campbell River Valley and Serpentine-Nicomel Rivers (as well as the Coquitlam and Brunette Rivers) are important in maintaining local salmon and trout spawning/rearing habitat (Department of Fisheries and Oceans 1988, 1989a, 1989b). Stable water temperatures are critical to the survival of these species; stream shading is of particular importance during periods of low streamflow and high ambient temperatures (May through October). The Salish Sucker (a related species of the Longnose Sucker) is a fish species with limited distribution in Canada which favours highly vegetated low velocity low gradient watercourses. It is a known resident of the Salmon River and formerly of the Campbell River (McPhail 1987). The Nooksack Dace is another fish species with limited range in the region, but which lacks the 'endangered' status enjoyed by the Salish Sucker. Both species face an uncertain future due to stream course alteration, siltation and pollution from agricultural and urban run-off (McPhail 1994).

Prime fish habitat is not limited to these riparian areas, but extends to the estuarine marshes and foreshore marshes of the region. The environmental health of these landforms is linked to the amount of forest and riparian vegetation along local watercourses, as well as by the degree of pollutant loading into the drainage system by adjacent agricultural production and urban run-off. The presence of vegetation along watercourses, in addition to shading, offers protection from predation to fish, and contributes important organic materials necessary for the presence of aquatic invertebrates, plants, zooplankton, shellfish, and fish. Aquatic and riparian vegetation play a key role in fisheries in the region; estuarine marshes, sloughs and foreshore marshes are critical habitat for young salmonids, and spawning grounds for herring.

Ecosystem Linkages in the Lower Fraser Estuary

The study area may be divided into three broad ecosystems: Fraser Lowlands, Coastal/Intertidal Zone, and Fraser River System (shown in Figure 4); each is described below. Agriculture is the dominant land use in the Fraser Lowlands, so this terrestrial system is described in some detail.

The Fraser Lowlands

The lowlands are characterized by gradual or flat relief, possessing highly productive soils, and many important vegetative/wildlife functions. Much of the landscape is urbanized or

does not address downstream flooding events due to increased run-off (Emery 1994).

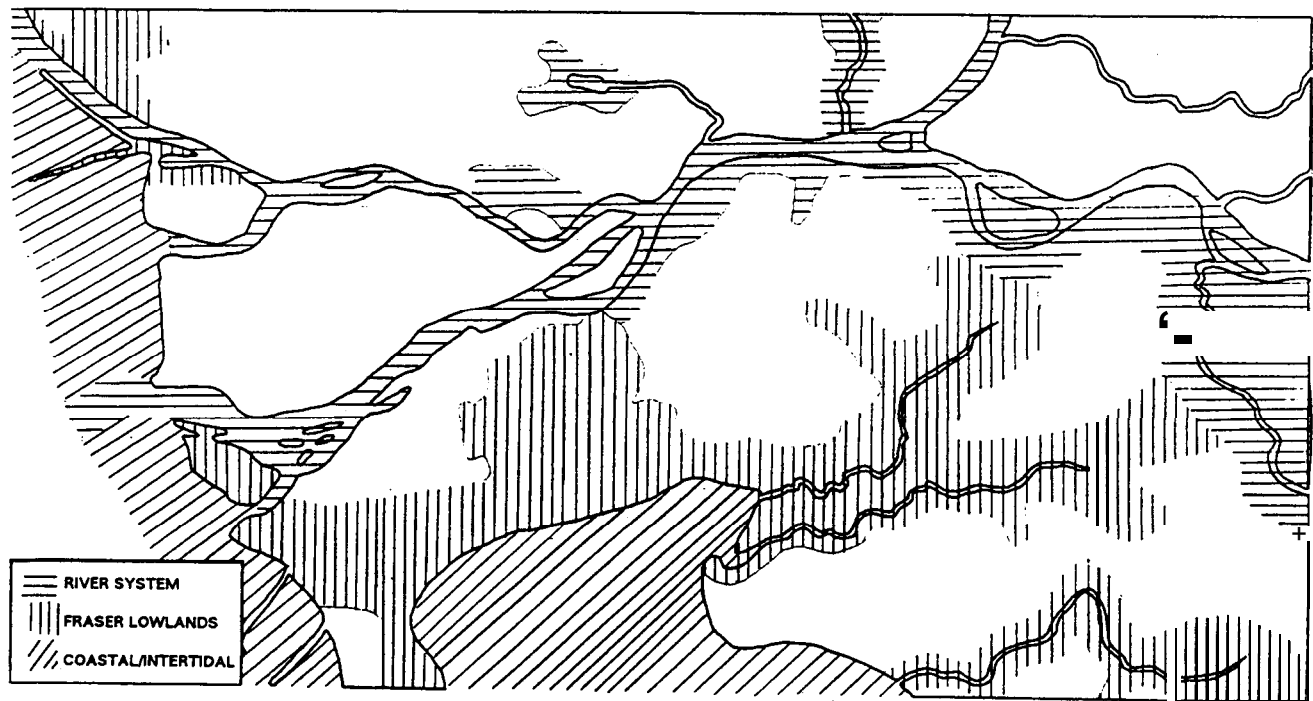


Figure 4
Study area ecosystems.

in agriculture on a floodplain that has been dyked since the turn of the century. While the intensity of urban activity increases, large contiguous areas of this system remain protected from urban/industrial development locked into agriculture by means of the ALR. The only natural area which remains undisturbed by land use is a fragmented zone about the centre of Bums Bog, North Delta. The lowlands provide numerous linkages between the intertidal and river systems which adjoin it. Major water corridors and forested blocks or open fields provide continuous linkages between the system's ecologically sensitive lands. Much of the eastern half of the system remains forested providing extensive wooded areas for a variety of birds and mammals. Species dispersion is facilitated by the large remaining forested blocks, drainage corridors and rural character of the landscape (but increased habitat fragmentation is a growing problem). This region is also visited by the largest concentration of foraging waterfowl, particularly the lower reaches of the Serpentine and Nicomekl Rivers (Butler 1992).

Parts of North Sea Island, Ions Island and Point Grey offer large areas suitable for wildlife. However, these areas are isolated from other areas of the Fraser Lowlands by major urban developments in Vancouver and Richmond. Much of Pacific Spirit Regional Park is advanced second growth forest; some old growth characteristics remain seaward of Marine Drive on the south slopes (GVRD 1991). Camosun Bog (a sphagnum bog) is located within the Park, but outside the nearby ecological reserve. The bog is an important recreational destination within the Park and subject to restoration efforts due to adjacent residential development and roads (Brick 1979; Jull 1983; Pearson 1985; GVRD 1989). The forested regions of the park provide roosting perches for raptors, cavities for nesting birds and mammals (such as Pileated Woodpeckers and flying squirrels), and is home to a large Great Blue Heron colony.

North Sea Island and Ions Island provide a number of habitats: sewage lagoons, hay fields, pasture, abandoned orchards, old fields and hedgerows interspersed with shrubs, isolated trees and small wooded copses. Sixty percent of the terrestrial habitat is in agriculture (Gartner Lee Ltd. 1992). The large amount of worked fields, old field and pasture land has lead to an abundant rodent population (particularly Townsend's vole and Oregon vole). This food source attracts Great Blue Heron, and large numbers of raptors, including the Common Barn Owl and Short-eared Owl (Searing and Cooper 1991; Schieck and Searing 1993; Searing 1993). Considerable attention is paid to wildlife management in the area due to the proximity of Vancouver International Airport, Ions Island Sewage Plant and Ions Regional Park.

Land use in east and south Lulu Island is largely frozen into the ALR. The Richmond Nature Park persists as a pocket of forested bog in the centre of Richmond, surrounded by various developments. The Park is a preserved bog representative of the pre-settlement ecology of Lulu Island (but no longer subject to flooding). Land in east Richmond are actively cultivated for berry crops, or have been converted to golf courses. Lands in south Richmond are mainly in pasture and market vegetables. The agricultural lands in south Richmond are under tremendous pressure from adjacent urban development in Steveston and Central Richmond. Rurban estates with very large houses, livestock (horse) barns and pasturage (similar to developments in Southlands) are displacing the market agriculture that was once a dominant feature of the landscape. ¹¹

11. The image of a "rural estate" conjures up thoughts of the English countryside — of the gentleman of independent means. While the rurban estate attempts to mimic these notions with a large house and ancillary buildings on a (relatively) large acreage, it is not a rural estate. The holder of a rurban estate is still dependant on the urban centre for income and lifestyle — the acreage is insufficient to maintain the facilities found upon it. Hobby farms would fall into this class, but such land uses are agricultural, and not necessarily fashionable

Apart from the Campbell River Valley in the southeast, the Fraser Lowlands south of the main arm of the Fraser River lie as a contiguous whole stretching from Brunswick Point, east to Cloverdale. The predominant land use in this stretch of lowlands is agriculture (except Bums Bog, which remains a mixture of unused lands, land fits, industrial sites, forested parklands, and an exhausted peat mine). Urban and industrial encroachment along the main arm of the Fraser River, Ladner, Tsawwassen, Panorama Ridge and Cloverdale are changing the pattern of land ownership and agricultural enterprises using the land.

The periphery of Bums Bog remains the only undisturbed area of the Fraser Estuary. Much of the original bog ecology has been modified by adjacent industrial activities, agricultural and urban developments; the central portions of the bog were mined for peat into the 1950s. Bums Bog is a unique landform, rare in North America. Five millennia of sphagnum moss growth and deltaic deposits from the Fraser River has resulted in a domed peat bog (Hebda 1977). Forested wetlands, open bog and brushlands in drier areas characterize Bums Bog. What remains of the natural areas of the bog is comprised of its forested edges east of Highway 91, the Delta Nature Park along the northeast and Watershed Park Reserve along the southeast (Biggs 1976, TERA Environmental Consultants Ltd. 1988). The western and southern reaches of the bog are agricultural; industrial and commercial lands flank the north, and extensive residential development covers the North Delta watershed to the east. ¹²Bums Bog supports plants and animals not found elsewhere in the estuary; plant communities include undisturbed heath, sedge, mixed conifer woodlands and mature Western Red Cedar (Hebda and Biggs 1981). Almost 200 species of plants have been identified in the bog (Bums Bog Conservation Society 1991), 24 species of mammals, over 160 species of birds and several insects rare to British Columbia (TERA Environmental Consulting Ltd. 1988).

The Campbell River is a salmon bearing watercourse lying along the southern reaches of the study area. The vegetation of the valley is variable; logging, farming and grazing have altered many of the natural vegetation communities. Well forested riparian zones persist in pockets along the drainage and its tributary creeks; beaver activity in the upper reaches has created some valuable, but isolated, marsh habitats. Much of the watercourse traverses private lands; the 3 km stretch in Campbell River Valley Regional Park and the river's estuary are

or conspicuous.

12. The majority of the Bog was excluded from the ALR, but given technological changes in agriculture and the area's suitability for cranberry farming, portions of the Bog could be taken out of the industrial zone and protected inside the ALR.

protected. The valley supports a variety of vegetation and wildlife, including Blue and Green-backed Heron, a number of small mammals, numerous marsh birds, dabbling and diving ducks, raptors, and a wide variety of owls, including the Common Barn Owl (Haycock and Mort 1988).

The largest area of the Fraser Lowlands ecosystem is comprised of the larger islands of the estuary, South Delta and the Serpentine-Nicomekl floodplains of Surrey. Much of this land is in intensive agriculture (and falls into the ALR). Pasture, field vegetables (potatoes, sweet corn, leafy vegetables and legumes) and horticultural crops (such as strawberries, blueberries and cranberries) are common land uses. Areas not employed in agriculture include lands associated with the Alaksen National Wildlife Area, Reifel Bird Sanctuary, Boundary Bay Airport, Ladner and Tsawwassen villages, several golf courses, Boundary Bay Regional Park and Serpentine Fen. The area is criss-crossed by numerous transportation corridors (many of which are scheduled for improvement and extension into Langley) (GVRD 1993c, 1993d). Urban pressures on agricultural land use are highly pronounced in this area, particularly in the forested floodplain of the Serpentine and Nicomekl Rivers.

The region is used extensively by wintering and migratory waterfowl of the Pacific Flyway (particularly Westham Island, Brunswick Point and the western edges of the Surrey Flats which are prone to pending and winter flooding). The farmlands provide upland habitat for many birds which use the estuarine and maritime habitats of the adjacent intertidal areas (Boundary Bay and Roberts Bank). Many of the old field habitat, and fallow/pasture lands of the agricultural belt provide important forage and nesting habitat for the last remaining populations of the Common Barn Owl in Canada (Butler 1992). Crop and soil depredation from large flocks of foraging birds are a major concern of the agricultural community – an issue that often pits the wildlife interests against the local agricultural community in municipal land use disputes. The eastern reaches of this area are well forested, but as upland slopes out of the ALR give way to urban sprawl, its forested pockets and the ecological functions they perform are being lost. Some of this area is already under protection at the Alaksen and Reifel refuges (600 ha), and Serpentine Fen (80 ha.) (BCMOE n.d.).

Coastal/Intertidal Systems

The Coastal/Intertidal system consists of three distinct land areas: Sturgeon Bank, Roberts Bank and the Boundary Bay complex (Boundary, Mud and Semiahmoo bays). This system is a shallow, low gradient estuarine flat extending several kilometers offshore (the plume can extend to the beaches of the Gulf Islands during peak flows) (Tabata 1972). The mud flats are built-up

from accumulated silt deposition as the Fraser discharges into the Strait of Georgia. Nutrients carried by the rivers and streams of the area give rise to a diversity of micro-organisms, algae and sub-aquatic vegetation that constitute the lowest levels of the food chain in the region (Kistritz 1978).

The coastal/intertidal zone is the fundamental system supporting the diversity of wildlife resident in the Fraser Lowlands and Fraser River fisheries. Many of the juvenile salmon utilize the mudflats, sandflats, eelgrass meadows, and estuarine marshes (Dorcey *et al.* 1978; Levy *et al.* 1979; Levy and Northcote 1981). Pacific herring use the eelgrass beds of Roberts Bank and Boundary Bay for spawning. Crab, shrimp, mussels, oysters, and other crustaceans and molluscs are an abundant and important food sources for fish, birds and marine mammals. The entire estuary (lowlands, watercourses and intertidal areas, but the mudflats of the intertidal areas, in particular, remain the most important resting, feeding and staging area for migrating waterfowl and shorebirds employing the Pacific Flyway. Changes to the quality and quantity of habitat in the intertidal zone has a direct influence on the abundance and viability of many migrating bird species, marine mammals, and other aquatic species.

The Boundary Bay complex extends north from the Canada-U. S. border to the shorelines of White Rock, Surrey and South Delta, and east to the Tsawwassen headland. Large parts of the bays are exposed at low tide, with the remainder under 10 metres of water. The Serpentine, Nicomekl and Campbell rivers flow into the complex; the influence of the Fraser River is limited by the Tsawwassen headland, leading to relatively higher salinities than what is observed over Sturgeon Bank and the estuarine portion of Roberts Bank. The lowlands of South Delta and Surrey are separated from the salt marsh communities of Boundary Bay by an extensive network of dykes. High salinities in Boundary Bay have permitted remnants of the original *Salicornia-Triglochin* salt marsh to persist outside the dykes. However, the most distinctive vegetation zone of Boundary Bay is the 12 km long eelgrass meadow extending northeast from Tsawwassen into Mud Bay.

The eelgrass beds of Boundary Bay are the most extensive of the estuary; together with the salt marshes and algal mat (shoreward of the eelgrass) they render the Boundary Bay complex an area of international importance to waterfowl, shorebirds, salmonids, marine mammals, and raptors (Boundary Bay Conservation Committee 1992). The eelgrass beds are of primary importance: they reduce wave induced erosion; act as spawning habitat for Pacific Herring; provide protected habitat for invertebrates, small fish; are feeding and foraging areas for larger fish, waterfowl and shorebirds – in particular, Western Sandpiper (*Calidris mauri*),

and Dunlin (*C. alpina*). The Boundary Bay complex is also home to a large nocturnal roost of gulls, and used occasionally by migrating Black Brant *Branta bernicla*) in March and April. Of the three intertidal zones of the estuary, the Boundary Bay complex is used most extensively by migratory waterfowl which rely on the adjacent South Delta lowlands, and Serpentine-Nicomekl floodplain for foraging areas and shelter from high winds.

Roberts and Sturgeon Banks remain separate estuarine areas due to river training activities along the main arm of the Fraser (Hobson 1979). Sturgeon Bank includes the foreshores of Iona, Sea and Lulu Islands; it is bounded by the North Arm Jetty, the dykes of Richmond and the main arm of the Fraser River. Its extensive sandbanks and mudbanks contribute a wide variety of vegetation, shellfish, fish and wildlife. The water of Sturgeon Bank is estuarine; its degree of salinity varies widely due to the fluctuating discharge rates of the Fraser River, winds, tides and currents. Marsh habitat is an important feature of Sturgeon Bank; cattail, sedge and bulrushes form dense stands on the landward side of the bank. Sedge (*Carex lyngbyei*), the predominant species, and bulrushes contribute a major seed food source for dabbling ducks; Snow Geese (*Chen caerulescens*) and Trumpeter Swans (*Olor buccinator*) utilize the rhizomes of many marsh plants. A substantial meadow of eelgrass is present along the seaward edge of the southern reaches of the bank. Pacific salmon fry and smelt (mainly Chinook and Chum) spend extended periods over the Sturgeon Bank foreshore. Staghorn Sculpin and Starry Flounder are abundant on the flats, and are an important food source for foraging Great Blue Heron. A sandbar off the middle arm serves as a haul-out site for Harbour Seal (in addition to the site off Westham Island on Roberts Bank); Steller's Sea Lions and California Sea Lions use the Steveston Jetty at the south end of Sturgeon Bank as a spring haul-out.

The ecological regime of Roberts Bank has been highly modified by numerous man-made structures, dividing the bank into an estuarine zone, similar to Sturgeon Bank, north of the Coalport Causeway to the shipping channel of the main ~m, and a marine zone to the south, similar to Boundary Bay, broken by the causeway and breakwater in Tsawwassen. Relatively higher salinities in the marine zone has led to a distinctive saltmarsh community of American Glasswort (*Salicornia virginica*) and Desert Saltgrass (*Distichlis stricta*); the causeways have changed circulation patterns, influencing the establishment and growth of eelgrass meadows on both sides of the Tsawwassen Causeway. Diving ducks, loons, grebes, cormorants, and other fish eating birds favour the marine zone of Roberts Bank indicating an abundance (or greater availability) of fish prey among the eelgrass meadows.

The estuarine zone of the Bank is strongly influenced by the discharge and sediment loads

of the main arm of the Fraser and Canoe Pass (between Westham Island and Ladner). Discharge and sedimentation not only contributes to the growth of the bank and its marsh communities — where the Short-eared Owl (*Asio flammeus*) is an important resident of the saltmarsh at Brunswick Point — but also provide numerous drift organisms (chironomids, oligochaetes and amphipods) which serve as prey for salmonids, flatfish and sculpins. The wildlife of the bank is dominated by waterfowl with significant numbers of Snow Geese, Trumpeter Swans and Tundra Swans (*Olor columbianus*) off Westham Island and Brunswick Point. Waterfowl numbers are significantly greater than those observed on Sturgeon Bank, but still less than that observed in Boundary Bay; these populations alternate between the banks and the adjacent agricultural fields of the South Delta lowlands and Surrey Flats.

Fraser River System, Foreshore and Associated Drainages

The Fraser River system consists of the channels of the Fraser and Pitt Rivers, and the adjacent marshes and floodplains. In the study area, this system extends from the mouth of the north, middle and main arms of the Fraser River upstream to Pitt Lake, and just east of Kanaka Creek in Maple Ridge — this corresponds closely to the jurisdictional limits of the Fraser River Estuary Management Program (FREMP); it includes the undyked areas of the Fraser floodplain, as well as the associated drainages of Burnaby Lake-Brunette River, the creeks of Burnaby Bend, the Coquitlam River and the Salmon River Valley. Vegetation of the shoreline reduces erosion from widely fluctuating river flows and water levels, as well as the wakes of boat traffic. Erosion of steeper slopes is mitigated by extensive forested areas (i.e., North Surrey), which, in association with riparian habitat corridors and marshes, provides habitat for a variety of birds and mammals, and access inland. Many of these areas are at risk from expanding urban and industrial developments.

The Salmon River Valley comprises an 85 km² watershed that arises from low lying agricultural land and marshy upstream tributaries; the upper and middle reaches of the valley are in a groundwater discharge area providing stable year-round flows. Gravel deposits in the middle reaches of the river are important salmonid spawning areas for Coho, Steelhead and Cutthroat Trout; Coho runs average 3,000 annually. Farmland and riparian woodlands are found in the lower reaches of the drainage, deciduous and mixed forests are adjacent throughout, supporting a population of Columbia Black-tailed Deer, Coyote, Beaver and Muskrat.

The floodplain along the south shore of the Fraser River extends from Amacis Island upstream to Matsqui; undyked areas remain along the Langley rivershore, Tree (at the mouth

of the Coquitlam River), Douglas and McMillan islands, Surrey Bend (by far the largest undyked area in the floodplain at 600 ha) (Kistritz *et al.* 1988). Vegetation communities are as varied as the landscape, and include: deciduous forests, riparian forests of black cottonwood, red alder, Sitka spruce, and western red cedar; bogs and bog forests dominated by hardhack, Labrador tea, willows, shore pine, Douglas-fir, western red cedar, western hemlock; coniferous uplands; and numerous fens, sloughs and wetlands in the undyked axis. Numerous creeks along the Surrey bluffs and in Langley which provide important fish habitat for Cutthroat Trout, Coho and Chum salmon. Wildlife includes nesting Bald Eagles and Great Blue Heron, waterbirds, waders, raptors, cavity nesters and passerine, Beaver, Muskrat, River Otter, Columbian Black-tailed Deer and Coyote.

The Coquitlam River and Floodplain provide important salmon spawning areas, as well as some poorly drained uncultivated open field habitat in the lower reaches. Its plant communities include: bogs, sloughs and wetlands, hedgerows and thickets, coniferous, mixed and deciduous forests, and riparian habitat. Waterfowl, waders, raptor and passerine are common. The floodplain is an important home to nesting Great Blue Heron and Green-backed Heron.

In the heart of Burnaby lies the forested wetlands and uplands of shallow Burnaby and Deer lakes, and the channel of the Burnette River. Vegetation is varied, consisting of mixed, deciduous and coniferous forests, scrub, meadows, and marshes (in the managed picnic and public areas, manicured turf is extensive). Freshwater habitat is extensive, allowing for substantial numbers of Pied-billed Grebe, Mergansers and Ruddy Ducks, other freshwater marsh birds are commonly sighted here. The ravines that drain through Burnaby bend once ended in an extensive wetland, now substantially dyked and turned over to industrial and agricultural land use. The ravines are protected and support a diversity of vegetation and wildlife (included several owls, the Pileated Woodpecker and Green-backed Heron).

The north and middle arms of the Fraser River are heavily developed, dominated by industrial sites, log booms, marinas and docks. Interspersed among the development are marshes and forested wetlands which increase in frequency as the mouth of the Fraser is approached. Waterfowl use is greatest around Musqueam Marsh on the north arm and Swishwash Island at the mouth of the middle arm. The lower Fraser Marshes of the main arm are the focus of concentrated wildlife management and preservation activities. Some of the islands of the marshes are the result of river training activities (i.e., Steveston Island, and parts of Woodward and Duck Island). Since settlement the extent of riverine marshes has grown from

125 ha to 700 ha. The marsh communities are made up of sedge, bulrush and cattail, with willows, and cottonwood pioneering the higher, drier sites. The marshes are important habitat for juvenile salmonids and other fish, as well as numerous waterfowl and wading birds.

Structure of the Agricultural Sector and Environmental Impact

This section describes the institutional environment of agricultural land use in the Fraser Estuary. Land use is driven by markets — in the case of farming in the delta, urban and industrial land markets, as well as the traditional agricultural commodity markets. In recent decades concern over wildlife has introduced a non-market force in land-use decision making. Chapter 3 considers how these wildlife values can enter the land-use decision environment and compete with the orthodox values of organized commodity markets. Over the decades numerous institutions and government programs have been established that insulate and protect the agricultural producer from the markets (and the local climatic uncertainty of soil-bound production) that he/she supplies, or holds land within.

Canadian agriculture, like its American and European counterparts, is often described as a highly subsidized industry. This characterization describes much, but not all, of the agriculture practiced in the estuary. There exist direct and indirect forms of subsidy in many agricultural programs operating or regulating production in the Fraser Valley. These institutions go beyond primary agriculture (farming) but includes support, taxation and public services to secondary agri-food sectors (such as processing and input suppliers). In addition to these subsidies, the agricultural community is indirectly taxed, largely through goods not paid for and legislated restrictions on production management regimes and employable technologies — GATT and NAFTA will have dramatic effects on the way in which primary agriculture is supported over the next 15 years; some of the implications will be dealt with in this section. However, the greatest influence on land-use in the agricultural belt (see Figure 1) is due to the synergy of all market (and non-market) forces acting on the land-owner at the urban fringe — this effect is referred to as the *urban shadow* and it has particular consequences for wildlife and the overall character of the landscape.

To address these areas, this section has been divided into five parts. The structure of agricultural markets and the relative power of their participants has had a marked influence on the organization of primary agriculture through-out the world — the Fraser Valley is no exception. Grower cooperatives are an important component of the agricultural community. They range from loose voluntary associations of growers to the rigid involuntary organizations

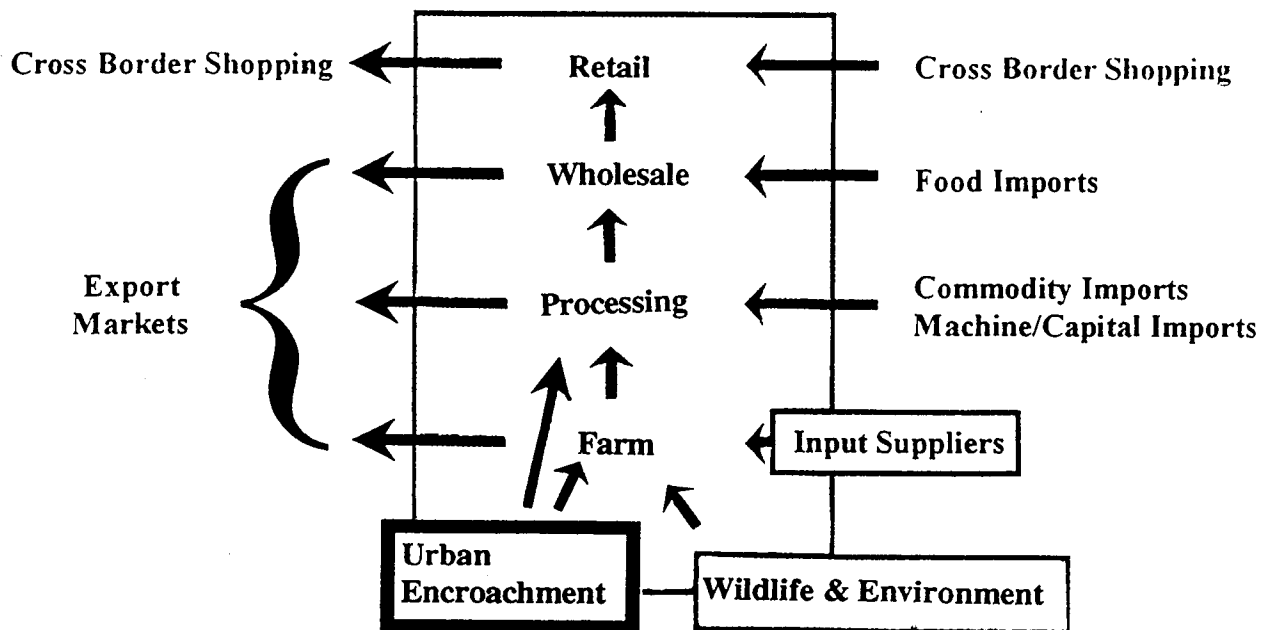


Figure 5

Agricultural market product flows and sources of non-market influence.

in the supply management sectors. Government programs are present providing incomes and infrastructure support, stabilizing commodity price movements and providing marketing and R&D support. This structure of support is going to be affected by new international trade agreements. Market organization and support act to promote agricultural incomes; however, practicing agriculture in an *urban shadow* has particular consequences that act against good stewardship and the security of wildlife habitat.

Agricultural Market Linkages and Structures

Agricultural markets differ in structure within sectors. The domestic agri-food industry can be described as possessing five sectors in four levels (see Figure 5). Some firms operate simultaneously across the spectrum of sectors (i.e., they are integrated firms). The concentration of market power in relatively few firms at the input supply, processing, wholesale and retail levels has led to the formation of grower cooperatives, some of which (Dairyworld and Ocean Spray, for example) are loosely integrated from the farm level to the wholesale level.

Figure 5 depicts the direction of product flows between sectors (dark arrows) and the source and destination of non-market influences (hollow arrows). Input suppliers provide chemicals, seed, fertilizers, and equipment to producers; some suppliers are located locally (in Ladner, Cloverdale, and Aldergrove), others are located outside the study area (in Blaine, Sumas, Abbotsford and Chilliwack). As the number of producers decline in an area, the support services offered by these firms fade as they relocate to areas where producers are more numerous. This has been the case with the agricultural community in Delta, where growers commonly travel south to Whatcom County, WA, or Cloverdale, Abbotsford and Chilliwack to obtain necessary services (Paton, Smith and Gram Ltd. 1983; G. G. Runka Land Sense Ltd. 1990; Klohn Leonhoff Ltd. 1992).

Growers operate at the primary level of the agri-food markets. Product may be sold to processors, wholesalers or directly to retailers and the public for use or consumption locally and abroad. Many growers also sell to (or act as) input suppliers, providing swxi, manure, hay, silage, and other services such as custom machine work, or harvesting. For example, for many poultry producers, the disposal of manure is a problem due to insufficient land base (Chipperfield 1993). Manure is often shipped across the valley as an input to other agricultural activities; however, the number of birds in the region still poses a problem for manure disposal (Leibschner *et al.* 1992), and alternatives are being considered (Poulson and Hurd 1993).

Economies of scale in processing leads to increased concentration of firms involved in turning agricultural produce into food products. Most firms operating at the processing level are integrated forward into wholesale distribution, and in the case of Lucerne Foods Ltd., through to the retail level. Processors often secure supply and prices through contracts negotiated with individual growers, under the auspices of the B.C. Vegetable Marketing Commission. In the case of some commodities (carrots, for example), fields are simply leased and farming operations integrated into the processor's business. In other cases, such as beans and peas, concern for produce quality and narrow harvest-production window force processors to contract for whole crop pest control (such as aerial spraying) or integrate backwards into custom harvesting and delivery. For still other commodities (such as raspberries), the processors offer a price schedule for produce and accept the supply put forward by local producers.

The degree of participation in primary production by a processor depends in large part on the level of cooperation among growers, product quality requirements, and the price of U. S. imports. The presence of economically viable processors producing for a variety of retail food markets (i.e., canned and frozen fruits and vegetables, jams and jellies, snacks and confections,

complete meals, custom meat cuts, dairy products, bulk and label sales, etc.) is important for ensuring a variety of crop production choices among growers. As processing costs rise, relative to other regions (California, in large measure), the fate of large institutional buyers is placed in jeopardy. The recent loss of Royal City Foods Ltd. has affected the range of production choices and demand for crops in Delta and Surrey (Klohn Leonoff Ltd. 1992).¹³

The wholesale and retail markets do not fall into the scope of this paper except that growers, and grower cooperatives often sell directly into these markets, particularly for food products that are highly perishable, require little or no processing, simple or limited on-site grading, and bulk or economical packaging. Large grower cooperatives, such as Dairyworld are involved in complex grading and packaging of a sophisticated set of products; however, grower participation in further processing is limited to a shareholder capacity. That the wholesale and retail markets are directly accessible to growers influences the range of cropping choices available, in addition to the expanded demand for crops provided by the active presence of several large food processors. This fact has implications for the habitat available for various groups of species using the the agricultural lands of the Estuary.

Grower Cooperatives and Supply Management

Cooperation among growers takes two forms: producer groups and cooperatives. Producer organizations can be organized on a regional basis (such as the Delta Farmers Institute) or on a commodity wide basis (such as the B.C. Cattlemen's Association) .¹⁴ Such organizations are, by their nature, loosely held together by common interests — they serve few if any economic functions, but are rather, social or political collections providing a united voice in politics and on a number of agricultural boards and commissions. This does not mean that such groups cannot affect the well-being of their members — that is often their stated objective — only that they lack the authority to actively engage in markets on behalf of their members.

13. In Delta the importance of the processors is acute; almost 2/3 of cropland was dedicated to processed vegetables and forage in 1992 (1/3 and 1/3, respectively) (Klohn Leonoff 1992). Almost 90% of growers surveyed had contracted to processors (including the *major* dairies). Royal City held 54% of processed vegetable contracts, followed by Fraser Valley Foods with 34 % and Nalley's with 26%. The importance of Royal City was not limited to its share of contracts, but included its year round presence in the community and locating its maintenance yard in Ladner (on Westham Island).

14. An important set of producer groups are those existing for the purpose of developing the Code of Agricultural Practices for the Waste Management Act; other like groups are those set up to administer FRDA I and FRDA II grants and sectoral initiatives of the C-BC Soil Conservation Program. In some cases new groups were formed, but more often sub-committees from existing organizations were formed to represent agricultural interests.

Grower cooperatives can be organized in many ways and scales; but they exist for expressly economic reasons (e.g., scale economies in marketing and strategic inputs or bargaining power in asymmetric markets). These groups are organized along commodity lines (i.e., Cloverdale Lettuce and Vegetable Cooperative) or on a regional basis (i.e., B.C. Coast Vegetable Coop). Generally, participation in co-operatives is voluntary. They often act as selling desks or buying desks for their members, and may be able to exert pressure on production levels (such is observed with the two rival mushroom coops). 15

The economic consequence of grower cooperatives (when they are operating smoothly, with few discontented members) is higher, or more stable, output prices or lower input prices for members. However, apart from the supply managed commodities — dairy, poultry and eggs — the sectors are still subject to the vagueries of market demand and the cost of imports. Grower cooperatives may mitigate against much of the market power of large institutional buyers (the processors and wholesalers, and integrated retailers), but these buyers can always import (with the exception of supply managed goods) if growers demand prices that are relatively more expensive.

The supply managed sectors benefit from considerably less volatile markets, and consistently higher values for their output. Dairy, poultry and egg producers benefit from involuntary production restrictions and considerable border protection. This contrasts sharply with the market environment of berry producers (with the exception of cranberry producers) who lack strong coordination and border protection. The enforced production quotas of supply management result in higher producer prices and an effective transfer of surplus from buyers to producers. These stable high relative prices lead to more livestock and land committed to the supply managed sectors than would otherwise be observed in its absence.

By providing incentives to increase livestock numbers within the Lower Mainland, in conjunction with a number of property rights issues, supply management introduces a number of land management problems. High livestock numbers on a small landbase pose a problem for manure disposal. Dairy producers are, generally, large land owners (or hold sufficient property through lease arrangements) and problems associated with manure disposal are limited to smell (and run-off due to excessive rain-fall). However, poultry and egg producers must often find off-farm sources for manure disposal (Chipperfield 1993). The concentration of egg, poultry

15. In the absence of involuntary controls on production, the ability of co-ops to enforce production restrictions is limited, and inevitably leads to conflict (the continuing saga of Monies and Pacific to control marketing of fresh mushrooms is a case in point).

and hog producers east of Surrey has led to problems with Nitrogen and Phosphorous loading, exposing local residents to environmental health risks, particularly in drinking water (Leibscher, Hii and McNaughton 1992). Manure is often transported west into Surrey and Delta to restore organic matter and supplement applications of inorganic fertilizers.

Income Support and Stabilization Structures

All producers benefit from national and provincial programs designed to increase the economic viability of agriculture relative to other sectors of the economy. Direct price supports and price stabilization programs are not an important component of the agriculture practiced in the lower mainland. However, much of the support provided to the grain and feed sectors has an impact on the price of feed for livestock (this is exacerbated by grain export subsidies in the E.U. and U.S.A.). Feed prices are the largest component of costs in livestock production, particularly in the poultry sector. Lower feed costs induce producers to rely less on on-farm feed sources (such as grains, hay, pasture and silage grown on an extensive acreage) and increase the density of animals on a smaller property.

Income stabilization is a form of support that is available to all full-time producers in the Valley (Net Income Stabilization Account, NISA). NISA acts to smooth out the income of participating growers so that the surplus of boom years can be safely put away (and not lose value) to supplement income in deficit years. While there is a small element of federal subsidy in the NISA program, it remains largely separated from production levels and does not adversely affect the choice of crops planted.

Crop Insurance is a federal-provincial program offered growers to cover losses due to flood, hail, frost and drought (In B.C. coverage for wildlife damage is available to Peace River Region growers only). Participating growers pay a portion of their premium (50% of an area/sector risk premium) to insure permitted crops up to 80% of average market value (of a three year history). The federal and provincial governments pay the administrative costs of the program and the remainder of the premium equally. The subsidized premium results in an increased proportion of high risk crops (or alternatively, crops grown in high risk fields such as those prone to flooding, flooding and endemic disease), and provides incentive for growers to neglect crops which may be showing signs of stress, or avoid making necessary soil investments. Difficulties associated with administration and monitoring lead to moral hazard problems, increasing the chance of individual crop failures and higher payouts to participants. Crop insurance as it is currently structured alters the choice of crops planted, increasing the

amount of marginal lands put into production. The Crop Insurance Program is under review. Problem areas include adverse selection, area averaging (as opposed to personal history), and monitoring for compliance and abuse (i.e., moral hazard).

Other federal and provincial programs are offered in areas ranging from price supports, capital financing and credit, export and marketing assistance, inspection and grading, environment and energy, to research and development, transportation and tax management. In 1992, Agri-food Development Branch, Agriculture Canada cataloged eighty government (or government sponsored) programs and services offering assistance of one kind or another to the agricultural sector (either exclusively or as part of a larger mandate).¹⁶ The effect of all these programs and services is to support the economic viability of the agricultural sector by lowering the costs of inputs such as feed, and fuel and buildings, information, management expertise and other aspects of production and marketing. The majority of programs were oriented toward supporting production, and not the mitigation of environmental problems associated with expanded intensive agriculture. The AFDB (1992) identified twelve environmentally oriented programs (none of which specifically address wildlife habitat conservation); these were:

- 1) Accelerated Capital Cost Allowance (AACA) Pollution Control Program;
- 2) Canada/B.C. Soil Conservation Program;
- 3) Community Tree Planting Project;
- 4) Environmental Partners Fund;
- 5) Environmental Technology Transfer Program;
- 6) Green Plan, Sustainable Agriculture Initiative;
- 8) Land Management Assistance Program;
- 9) Natural Gas Vehicle Program;
- 10) Permanent Cover Program (PCP);
- 11) Rural Water Development Program; and
- 12) Technology for Environmental Solutions Initiative.

Under the ACCA the total cost of equipment or processes installed for the purposes of controlling air and water pollution can be written off over three years. Eligible equipment includes: manure tanks; impermeable pits, aproned concrete/asphalt pads; slatted floors, hydraulic or compressed air pumps, agitation and pumping equipment; and liquid spreaders (in

16. The *Ag Infotrak* catalogue (AFDB 1992) placed programs into several of 18 categories. Credit/Finance included 25 programs, export and marketing assistance together accounted for 13 programs, stabilization and tax management had 21 programs; environmental programs accounted for 12, and of that 12, only two occurred simultaneously in the other categories mentioned here.

association with the above). The effect of accelerated depreciation is to increase the adoption of these technologies. However, they are not being adopted rapidly enough because less environmentally responsible machinery and infrastructure remains relatively less expensive due to other production distortions in the economy. To encourage the conversion of vehicles to natural gas, EMR Canada has established the Natural Gas Vehicle Program. While specifically aimed at farm vehicles, as long as gasoline and diesel remain relatively inexpensive conversion to NG will be slow. That fuel for farm operators is subsidized (through tax rebates) acts as a disincentive to convert farm vehicles. The Technology for Environmental Solutions Initiative includes the Technology Transfer Program and Commercialization Program were established to subsidize the development, commercialization and adoption of technologies to prevent and/or clean up pollution. The program emphasizes clean technologies, waste reduction and recycling, pollution control and water conservation.

The Environmental Partners Fund was established to promote small scale community composting, recycling and restoration projects. The federal government funds up to 50% of costs for projects organized by voluntary and community organizations. Individual farmers are not eligible for funding, but producer groups can get involved with community groups to organize and initiate projects under the EPF. The Green Plan Sustainable Agriculture Initiative is a \$170 million program to promote positive changes in agricultural and land practices. B. C.'s allocation is \$6.3 million. The areas under review are: agricultural soil resources; water quality; wildlife habitat; air and climate; energy; genetic resources; and waste management. The initiative addresses a wide variety of areas, including agricultural practices, research, education, planning, and policy and program review (which is where much of the funding has gone).

The Rural Water Development program is only available to growers in the Peace River region. Greenfields, PCP and Community Tree Planting Project are discussed in the next chapter. Many of these programs exist because adoption of environmentally sound technologies is hampered by low prices for polluting technologies, or no prices at all. These programs act to mitigate against numerous externalities that persist due to incomplete markets or common property elements in resources. Given that other programs promote poor land practices or polluting technologies, in many ways, these programs act to mitigate against the damage done by other government programs.

The physical infrastructure of agricultural production is largely provided at public expense (much of it is also used by non-agricultural users, with greater intensity and private benefit). The network of roads, dykes, water stations and irrigation structures, have traditionally

been paid for out of general revenues or, more recently, from a combination of producer levies and government funding. This infrastructure permits agriculture to be practised as extensively as it is in the Lower Mainland. It has resulted in the conversion of almost 99% of the wet meadow and salt marsh which covered much of the delta region prior to settlement and has drastically altered the types of wildlife habitat available (Gartner Lee Ltd. 1992; FREMP 1993).

International Trade Agreements

The picture of agriculture emerging is one that benefits from a number of indirect government and consumer “environmental” subsidies. Many of these programs support capital intensive agriculture or act to mitigate against the very environmental damage inductxt by the general set of production support programs. But the nature of agricultural support will change over the next few years due to international trade commitments under the General Agreement on Tariffs and Trade (GATT) and the North American Free Trade Agreement (NAFTA). The purpose of the GATT is to codify and render transparent the rules regarding trade between nations — what constitutes acceptable trade behaviour and domestic support structures for domestic industries, and what can be done to challenge ‘onerous’ trade barriers or ‘unfair’ trade practices. NAFTA, and the Canada-U. S. Free Trade Agreement (CUSTA), is an agreement among national governments affirming the GATT, but further committing Canada to reducing its tariffs on U.S. and Mexican imports to zero (with numerous qualified exceptions). The combination of these two agreements (GATT and NAFTA) has important implications for the structure and delivery of support to the agricultural sector.

In the *Agreement on Agriculture* of the Uruguay round of the GATT (coming to force July 1, 1995) agricultural subsidies and protection are classified as ‘red’ or ‘green’ (GATT 1993). 17 Red programs — essentially, all subsidies to industry not classified as green (see Table 3) — are subject to domestic support reduction commitments. A number of programs, such as crop insurance in excess of 70% coverage, and other forms of ad hoc support will be affected and subject to reductions to meet the 20% aggregate reduction commitment by July 1, 2000.¹⁸ Export subsidies must be reduced by 36% in value, and the quantity of subsidized

17. Most primary agricultural inputs and the outputs of processors and wholesalers are covered under the existing GATT agreement. The *Agreement* instead applies mainly to primary agricultural production.

18. The aggregate measure of support (AMS) is a complex, but codified, process with individual minimum value requirements for inclusion (5% of production value); each product must incur a minimum reduction of 15%, however.

Table 3
GATT 'green-box' programs for agriculture.

★ Decoupled Income Support	★ Domestic Food Aid to Targeted Income Groups
★ Decoupled Structural Adjustment and Assistance	★ Environmental Programs
★ Income Insurance (up to 70 % of a loss)	★ General Services, including: research, pest and disease control, training services, extension and advisory services, and capital investment in general infrastructure
★ Crop and Disaster Relief (up to, but not exceeding, 100 % of the loss, triggered by a 30 % loss)	
★ Public Stockholding for Food Security	

SOURCE: General Agreement on Tariffs and Trade, 1993.

exports by 21 %. The current border protection and price support afforded supply management will be converted to tariffs (a transparent trade measure) and be subject to domestic support reduction commitments.¹⁹ Failure to comply with reduction commitments under GATT exposes Canadian agriculture and industry to costly trade action (countervailing duties) by offended trade partners.

Non-actionable support programs are referred to as 'green-box subsidies.' These subsidies are not actionable or countervailable, nor subject to inclusion in AMS and reduction commitments. Annex 2 of the *Agreement on Agriculture* outlines exempt programs; these programs are summarized in table III. Except for a few high profile support programs to the grains sector and the supply managed sectors, much of the Canadian agricultural safety net falls into the green-box category. In all cases, green-box programmes cannot act to support a primary agricultural product for sale into agricultural markets (they must be decoupled). In the case of environmental programs, objectives must be clearly expressed and support dependant on the fulfillment of specific conditions (including methods and inputs). Payments (or revenue foregone) is limited to the extra costs or loss of income involved in complying with the government program.

Under the NAFTA, agricultural products will lose *all* tariff protection. GATT requires that existing border controls (other than tariffs) be converted to tariffs, NAFTA demands that such tariffs be eliminated. However, the protection enjoyed by some primary producers (supply

19. The expected tariff schedule (ratified April 15, 1994) will look something like the following (Fairley 1994): fluid milk, 284 % or a minimum of \$40.60 per hectolitre; yoghurt, 280 % or a minimum of \$0.55 per kilogram; ice cream, 326 % or a minimum of \$1.36 per kilogram; chicken, 280 % or a minimum of \$1.96 per kilogram; turkey, 182 % or a minimum of \$2.30 per kilogram; eggs, 192 % or a minimum of \$0.94 per dozen. Reduction commitments are for 36 % by July 1, 2000.

managed commodities) can be retained through the use of technical barriers acceptable under the GATT; some articles in NAFTA also safeguard against the deterioration of border protection for supply managed products. Under GATT alone the degree of border protection for agriculture is not substantially eroded (although domestic support to some sectors will be dramatically altered). But NAFTA changes the condition with respect to competition from U.S. and Mexican products by reducing tariffs to nil. Currently, food processors located in Canada face a disadvantage of protected raw agricultural inputs but unprotected output.²⁰ Higher prices are paid for inputs while U.S. imports of manufactured food products enjoy considerably less barriers to import. This feeds back into lower demand for domestically produced processed foods, and in turn to lower demand for domestically grown agricultural commodities.

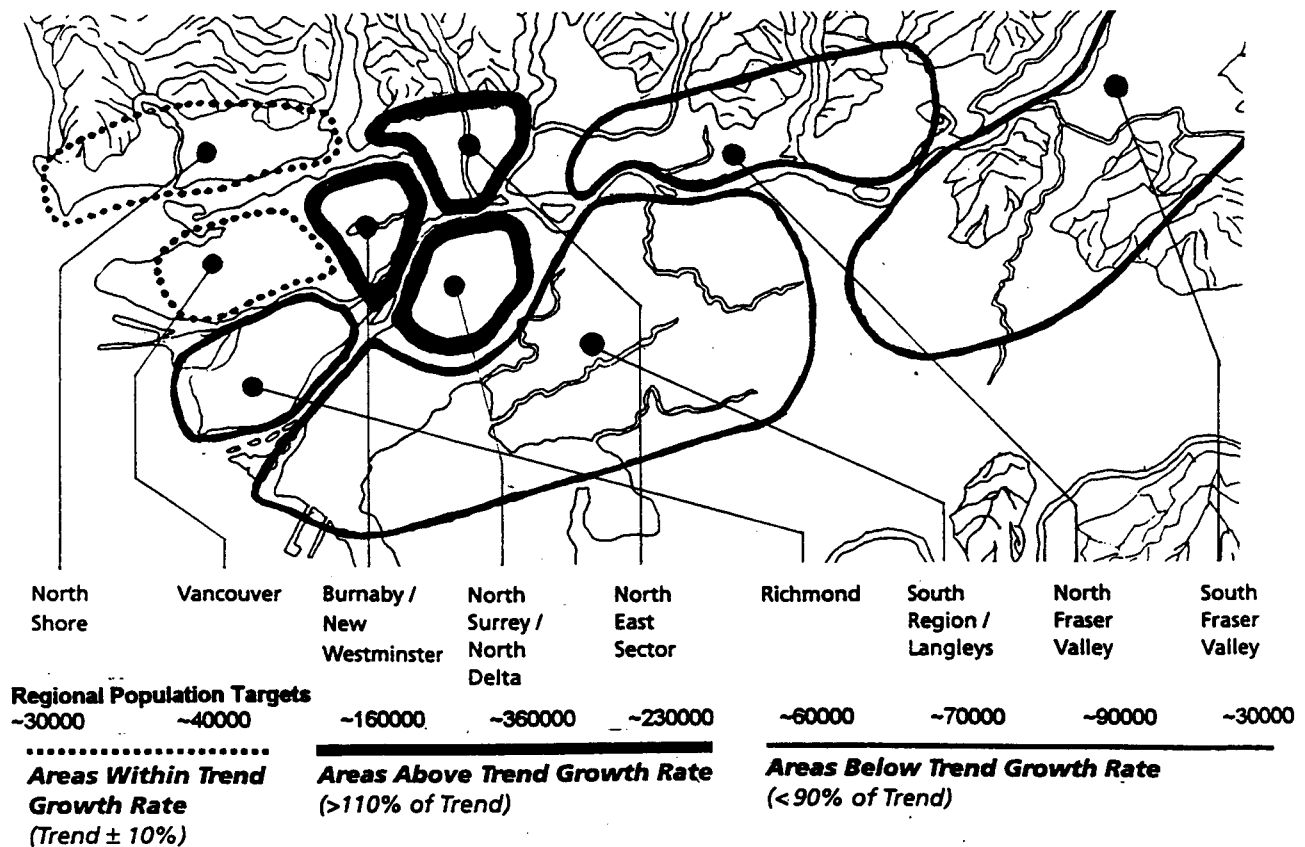
The Urban Shadow Effect

The *urban shadow* is the geographical range of significant pecuniary affect on land prices and land-use due to the presence of a growing urban core. A rapidly expanding urban population can cast a wide shadow. The geography of the lower mainland constrains urban development, exacerbating the intensity of the shadow on lands where development is relatively inexpensive and desirable. Figure 6 shows the extent of the urban shadow; it is by no means confined to the Canadian side of the Fraser floodplain, but extends south affecting development in Bellingham, WA. This section explores the economic causes and consequences of the urban shadow for agriculture and wildlife.

Land, like any resource, will always be put to its best private use by private owners. The activity which renders the owner his/her greatest residual (private economic profit) will dominate land management on private lands.²¹ In a regional context high-density urban-

20. For example, processors manufacturing prepared meals like chicken dinners are subject to domestic prices much greater than their rivals in the United States; they are also subject to restrictive import quotas which are by no means easy to obtain. This places their products sold in Canada at a disadvantage as the relative protection afforded chicken dinners is about twenty-times less. Processors ability to export product into the United States is equally disadvantaged.

21. It is often argued that the actions of the private land owner are disciplined by the market. Externalities reflect the myopia of markets with poorly specified property rights. Public land managers, insulated from markets, are no more disciplined than their private sector counterparts — it is only that the source of incentive and hazard differ. Public land managers are disciplined by the limits of agency mandates and budgets. Too narrow a mandate may render management unaccountable, while a too broad mandate may present the public land manager with too many task masters in the form of conflicting legislation and clients. Inadequate budgets will ensure inadequate management — under-provision of public goods, or poor enforcement of regulations, etc. While problems persist in private ownership, there is no guarantee that administration by public agencies will make the situation better.



Regional population trends are much more stark. Vancouver, Burnaby and the Coquitlam are trending toward another 275,000 persons between 1991 and 2021; North Fraser Valley is bracing for another 100,000, while the greatest concentration of growth is expected to flood into North Delta, Surrey, the Langleys, and South Fraser Valley (610,000 people).

Figure 6

Vancouver's urban shadow, growth trends and regional population targets.

industrial use is 'best-use'. As one leaves the urban core, commercial and residential density declines and more extensive land uses come to dominate the landscape: agriculture, silviculture and unmanaged lands. If land was of equal fertility or development quality a picture would emerge of an urban core surrounded by distinct concentric circles of land use (see Figure 7). As the profitability of one use is superseded by another, land use changes (see Figure 8). In reality the margins between land use are fuzzy; integrated uses are common: forestry and livestock, suburban estates with woodlots or pasture. Nor is land of equal fertility or development potential. Institutions, such as the ALR, contribute to the indistinct nature of a line between land uses. Development and common land uses occurs in pockets where its suitability is highest — this is abundantly clear in the Fraser Estuary where, despite zoning, landscapes are fragmented, disjointed, and where some lands remain underutilized in spite of permitted uses.

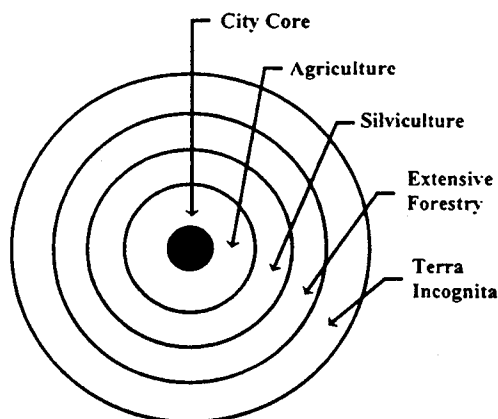


Figure 7
Land use zones.

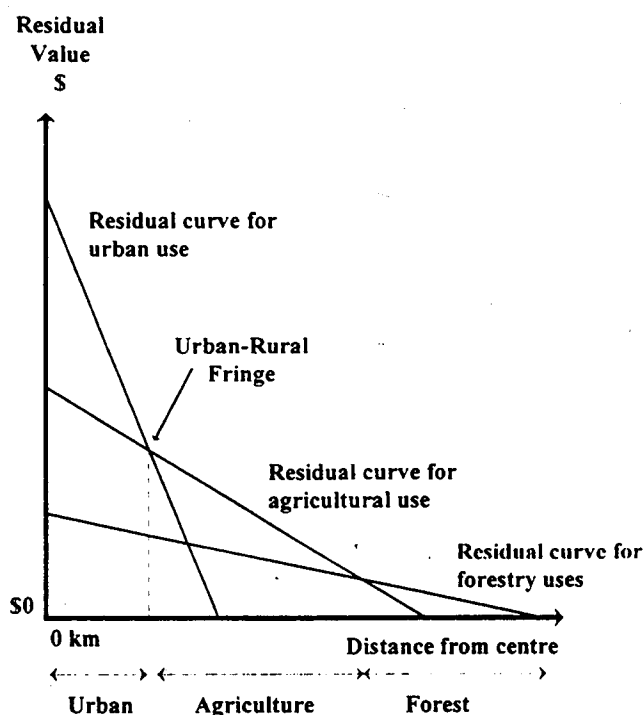


Figure 8
Land use values and margin of land use changes.

As the profitability of different land uses change we observe movement of the margins. If profitability is increasing for one use relative to other uses, then adjacent uses will be squeezed out; if the residual is failing then adjacent uses will squeeze it out. In Figure 9, *uu* represents the residual from land in urban uses, *aa* the residual from land in agricultural uses and *ff* the residual from land in forestry. Assuming the only changes are demands for urban spaces we may observe the movement of *uu* to *u'u'*. The expansion of urban area is from *U* to *U'* and agricultural land use declines by *A-UU'*. In this example, the sprawl of urban development is significant. The loss of agricultural land to urban sprawl is recognized as undesirable and irreversable; this has important implications for the availability of wildlife habitat.

The processes through which urban sprawl occurs are dynamic and complex. A combination of ownership externalities and pecuniary externality force the abandonment of farmland to urban interests and its eventual development. Low property taxes for farm status properties the B.C. exemption requires annual farm gate sales of only \$1500, greenspace and

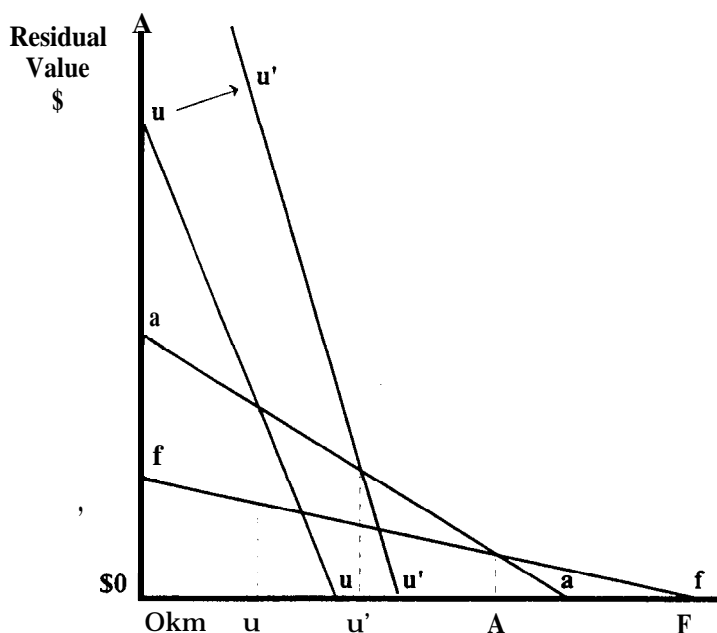


Figure 9
Changes in land use margins due to 'changing urban land values.

the potential to construct large homes lures low-density residential development into the rural fringe, increasing rural land values. Externality "shifting" contributes to this because new residents can lobby to effect land use restrictions on existing properties through political means, obtaining benefits without bearing any related costs. The smells and sounds of agriculture in close proximity to residential areas results in restrictions on acceptable farm practices; increased commuter road traffic, urban infrastructure and rural land fragmentation increase the costs of carrying on most farm operations. Membership in the agricultural community declines as farm families and businesses move to areas where agriculture remains more viable. And so the process continues inexorably until growth in demand for urban land slows or stops. By this time agricultural land may no longer be present, and urban development may have replaced other extensive land uses.

In British Columbia the effects of urban sprawl were apparent into the 1970s. In order to prevent the further erosion of the agricultural land base (and overcome the inability of regional and municipal authorities to preserve that land) the Agricultural Land Reserve Program

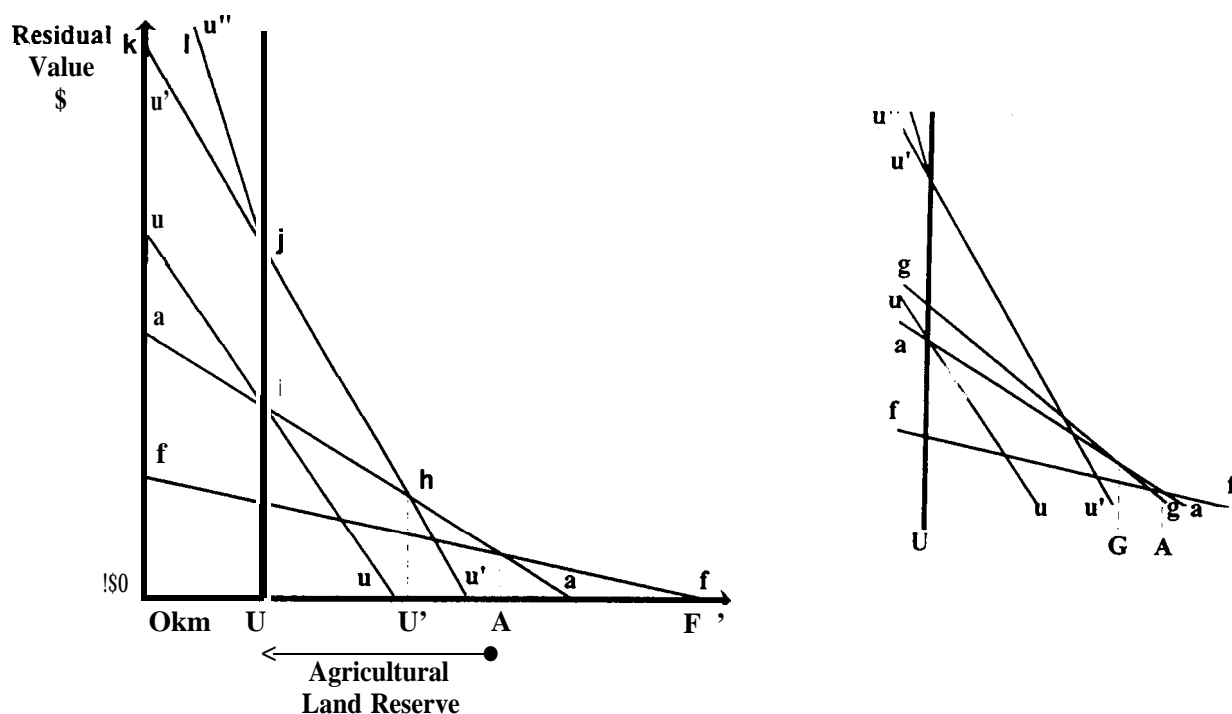


Figure 10

The effects of the ALR on land use (inset: golfing as a permitted use).

was instituted in 1974 (13CMAF 1989). To date the ALR has been effective at excluding urban development from agricultural zoned lands, but it has met with mixed reviews when one considers the ALR's success in keeping that land in full-time agriculture or in the hands of the agricultural community (Man M. Frenc! and Associates 1983; Youds 1989; Hazeldine *et al.*, 1989; Klohn Leonoff 1992). The ALR is not a costless system; it results in a number of important distortions in land allocation (Hazeldine *et al.*, 1989) and windfall transfers among land owners. Nor has the ALR protected the extension of low density urban land uses on agricultural lands — this is particularly true for Langley, Surrey and Richmond (M-km M. French and Asst. 1983; Klohn Leonoff 1992; Langley Township 1991).

Schematically, the imposition of the ALR results in land use changes similar to that shown in Figure 10. Population growth will result in the expansion of uu to $u'u'$ (as in Figure 9), but in anticipation of this the regional authority zones out urban development from area UA ensuring that UU' is not lost to non-agricultural use. This skews the urban residual curve at j (the urban-rural fringe) increasing the residual curve for urban use over the range of land use

where urban development is permitted, OU (area jkl represents the windfall that results). The holders of land in area UU' would have realized an increase in value (an accounting windfall), area hij, but instead this area constitutes an economic loss.²² Thus part of the windfall to land owners in OU has come from the loss in land values experienced by owners in UU'. This does not mean that the ALR results in an increase in net social welfare (area hij - area jkl). The curves in Figure 9 represent the private returns to land, not the true social returns — hence curve aa may be higher or lower, steeper or flatter depending on the level of total subsidy and value of wildlife, open space, etc.

However, not all of area hij will be lost to land owners. As long as the zoning ordinance is perceived to be weak — as it was from 1988 to 1991 with respect to golf courses, and in which it continues to be with respect to small lot sizes and part-time/hobby farms (BCMAF 1989; Youds 1989; Hazeldine *et al.*, 1989) — land speculation will result in turnover of land at values that approach its potential in urban uses (such as golf course or rural estates) and not in the restricted agricultural use. This results in land fragmentation and a separation of ownership and use that has implications for long-term investment in sustainable agricultural practices and available winter food sources for migrating waterfowl (G. G. Runka Land Sense 1990; Klohn Leonoff 1992; Barichello, Porter and van Kooten 1994).

Weaknesses still persist in the ALR Program due to permitted minimum lot size. It was never the intention of the ALR to prevent the sub-division of large agricultural land units — it is considered necessary to facilitate the transfer of land between farming generations. However, the minimum lot size bears no resemblance to maintaining unfragmented production units of sufficient size for full-time soil-bound agriculture (such as field vegetables and dairies). Owners are not bound by the policy should they decide to parcel the land for speculative reasons as opposed to estate reasons.²³ The small minimum lot size policy has led to the

22. This is not an insubstantial loss. From the *Delta Agricultural Study* average losses on 40 acre parcels were felt to be between \$5,000 to \$6,000, and between \$15,000 to \$25,000 per acre for lots under 20 acres (Kohn Leonoff 1992). Where municipal authorities permit the break-up of large contiguous land units they encourage the transformation of field crops to pasturelands (see Langley Township 1991). In some European jurisdictions minimum lot sizes are considerably larger (on the order of 160 acres) thwarting fragmentation and deterring speculation. While this does not keep 'the land' in the hands of all family members, it does ensure that an intact agricultural unit can be passed on to a single beneficiary (there is nothing stopping several children from administering an estate as a partnership — such an arrangement would force individuals with no interest in agriculture to sell their economic interest or let it go without jeopardizing the integrity of the farming unit).

23. The policy encourages speculation as farm families leave the community and sell lands to non-farm owners who capitalize the land through sub-division and the construction of large primary residences.

proliferation of urban estates, particularly in Surrey and Langley (which encourage this use) (Brian M. French and Associates 1983; Langley Township 1991). Rurban estates alter the distribution and abundance of wildlife habitat to favour small broken units of grassy meadows, low density orchards and old-field habitat types over the grain and row crop field type which mimic wet-meadow). Because estate homes are large and rurban use favours low-density livestock housing, a considerable proportion of the land put into this use is lost to buildings and infrastructure (such as driveways, lawns, patios, riding paddocks, etc.). Where large land units have been fragmented fencing, hedges and entryways result in loss of agriculturally productive area and increased production costs, and inducing capital intensive and non-soil bound agriculture (i.e., mushrooms, greenhouses, poultry and hogs). Increased residential use of agricultural land and greater exposure to the rurban edge reduces the opportunity for increased intensification of agricultural operations causing further defection from full-time farming and the further proliferation of urban estates, hobby farms and isolated residential areas.

While the urban shadow leads to high land prices and provides incentive to intensify production, the choices of capital intensive (and non-soil bound) agriculture are limited. Non-soil bound agriculture (greenhouses, mushrooms, feedlots, hogs and poultry) are not acceptable under certain zoning classifications of the ALR. This problem is largely limited to Delta (Klohn Leonoff); but municipal zoning has been used to discourage such operations in Surrey and Langley (new poultry operators are not welcome west of Matsqui). Complaints by Tsawwassen residents has threatened the ability of local growers to obtain aerial spraying services for crops sensitive to vehicle traffic of any kind (i.e., peas and beans). Urban pressures in the McClullen area of Richmond has restricted spraying and fertilizer programs, and increased run-off sufficiently to prevent equipment from entering fields at prime application times. Collectively, this has contributed to a decline in blueberry production from 6 million pounds to 3 million pounds in 1992, and land prices approaching \$100,000 per acre.

The use of agricultural land for golf-course development proceeded apace during 1988-91 when courses were considered outright uses of ALR lands.²⁴ The inset of Figure 10 shows the impact on allocation this policy had on agricultural land use. In addition to the urban shadow (u'u') there exists another high value use: private urban recreational – typified by golf courses,

24. Order-in-Council #1141 /88 brought golf course approval out of the hands of the Agricultural Land Commission and into the municipal planning departments by rendering them outright uses. Prior to 1988, Delta had received a single application for a golf-course on ALR lands; by 1991 (when the OIC was rescinded and a moratorium declared) there were eleven applications accounting for 75% of the land area under review.

curve gg in the inset. In the absence of the ALR area UG would find its way into urban development, and area GA would go to golf courses. Imposing the ALR, but permitting golf-courses, increases the range over which golf course development will occur. Recreational development is first put onto lands with high agricultural suitability relative to those lands which would have suited golf courses in the absence of the ALR.

Weaknesses in the rigidity of the ALR led to speculation on agricultural land. The value of that speculation is represented by the area hij in Figure 10. Speculation leads to changes in the pattern of ownership and tenure. Farming becomes an activity deemed necessary only because of perverse tax incentives (see G.G. Runka Land Sense 1990 and Klohn Leonhoff 1992) and not because of genuine owner interest. Speculation increases the land costs of agriculture leading to intensified use (where permitted) but with declining returns to agriculture (Brian M. French and Associates 1983; Hazeldine *et al.*, 1989).

Implications for Wildlife Habitat

It is plain that, in the absence of changes to the institutional and technological environment of land use, increased concentration and expansion of urban-industrial land removes wildlife habitat from the land-base and degrades what remains. The expansion of the agricultural land base alters the quantity, distribution and quality of habitat types. Wet meadows and forested uplands are replaced by grassy meadows, ecologically impoverished and fragmented woodlots, and feeding areas in grains and field vegetables. The increased intensity of agricultural land use, however, threatens the quality of remaining habitat: marine and estuarine fisheries are dependent on viable stands of marsh grasses, sedges, bulrushes and sub-aquatic vegetation at risk to persistent broad spectrum chemical herbicides.

Wildlife habitat remains abundant in the region, but altered, fragmented and threatened. Habitat is most abundant within the ALR and regional park system. The relationship between available wildlife habitat and land-use is dependent on the type of contact. By far the most common contact type (for available habitat) is concurrent (compatible) use in agriculture. Adjacency occurs at the borders of land-use (such as woodlots, hedges, ditches, pasture and row crops). Linked contacts remain insidious; the impact of this type of contact on wildlife populations is poorly understood (but the object of current research). Agricultural landscapes remain the most important working landscape where wildlife can co-habitate, but growing demands on lands remaining outside and inside the ALR for conversion to urban uses threatens wildlife habitat through the alienating effects of Vancouver's urban shadow.

The agricultural landscape falls mainly in the Fraser Lowlands ecosystem and consists of two economically dependant categories: parkland and wet-meadow substitute. Parklands include pasture and oldfield types and are favoured by small mammals, raptors, herons and other predator species. Wet-meadow substitutes are field vegetable crops and green fallow fields subject to ponding which mimic (to a certain degree) the habitat and food source capabilities of the extensive wetlands that dominated the landscape prior to European settlement and the turn-of-the-century dyking projects. The Coastal/Intertidal and River systems surround and contact the Fraser Lowlands. Many of the wildlife species of concern to land managers (waterfowl and raptors) move between and along these systems and the lowlands. In the case of waterfowl the lowlands augment the food sources of the coastal intertidal zone. Fisheries are affected by development on, and run-off from, the lowlands that affects habitat in the river systems, and which eventually finds its way into the fish nurseries of the coastal-intertidal zones. Extensive river training structures have altered much of the river and intertidal areas of the estuary, changing marsh community structures (this is particularly true for Robert's Bank).

The structure of agricultural markets has led to numerous organizations among farmers that influence the range of viable crops that can be grown in the valley. The presence of processors and critical core of full-time farmers is an important force mitigating against the morale defeating impact of the urban-shadow. The pecuniary effect of proximity to an urban centre depresses agricultural land prices relative to urban land prices. This results in high land costs to owners in the agricultural belt; numerous production, environmental, and infrastructure subsidies act to boost and stabilize the incomes of farmers. To an extent this mitigates against the urban shadow effects and economic losses associated with the ALR; but, the long-term existence of these subsidies is questionable given impending changes in international trade through the GATT and NAFTA.

There exist a number of market and non-market pressures for farmers to intensify land use. Such use has dramatic consequences for wildlife; in particular are the problems associated with agricultural run-off and effluents discharges from livestock operators. Hagan (1990) identified manure disposal and nitrogen loading as the largest single problem involving intensified agricultural land-use. The list of agricultural waste concerns runs the gamut of inputs and outputs: chemical fertilizers, animal waste, pesticides, wood waste, silage effluents, milk parlour effluents, animal mortalities, crop residues and compost. Pesticides are of particular concern because of their preponderance of use and lethality in small doses among charismatic in the higher levels of the food chain (raptors, cranes and herons). Areas of concern are the

Table 4

Estimated run-off and loadings from agricultural areas, 1987.

Reach	A	B	c	D	E	F	G	H	I
Main Stem	89	1650	12	121500	365	1200	243	12	0.36
North km	24.6	1200	12	24700	74	250	49	2.5	0.07
Main Arm	46.3	114	12	44700	132	440	88	4.4	0.13
Tributaries	85	1780	12	126900	379	13000	253	12	0.40
Campbell	37.3	1270	31	40200	120	400	80	4	0.12
Nicomekl	86.3	1520	64	112300	337	1100	225	11	0.34
Serpentine	37.3	1400	21	65800	198	660	132	6.5	0.20
Boundary Bay	86.5	1140	38	95900	288	960	192	9.5	0.29

NOTES: **A** = Land in the ALR, in hectares. **B** = Annual Rainfall, in mm. **C** = Annual Irrigation Level, in mm. **D** = Run-off, in m³ per day. **E** = Biological oxygen demand (the amount of oxygen used in the oxidative decomposition of microorganisms, over five days at a standard temperature; in kg/day, including suspended solids. Frequent high BOD in the Serpentine, Nicomekl and Campbell Rivers has resulted in several recent fish kills. **F** = Fecal Coliform count, in 10¹⁰ kg/day. Boundary Bay, Robert's and Sturgeon Bank have been closed to bivalve harvests since 1962 due to high fecal coliform counts. **G** = Total Nitrogen, in kg/day. **H** = Total Phosphorous, in kg/day. **I** = Loadings of Copper, Lead and Zinc, in kg/day (this is not an aggregate, the same level was reported for each element). SOURCE: Environment Canada, 1992.

Table 5

Estimated nutrient loadings from agriculture, 1987.

Reach	Cattle Population	Nitrogen	Phosphorous
Boundary Bay	2199	43117	31603
Kanaka Creek to Fraser Mouth	1729	61160	5533
Hope to Kanaka Creek	1532	61280	4902

NOTES: This represents quantities of run-off of Nitrogen and Phosphorous in kg/year, the amount that enters receiving waters depends on soil conditions, waste handling practices, and distance between cattle and watercourse. SOURCE: Environment Canada 1992.

Serpentine-Nicomeld rivers, Mud Bay, the North Arm and Crescent Slough where slow moving waters have led to high concentrations of persistent compounds in benthic sediments. This poses a threat to fisheries; however current enforcement is limited to source-point compliance (FREMP 1993), and agricultural run-off is often a non-point source pollutant best dealt with through other mechanisms (Barichello, Porter and van Kooten 1994). The estimated loading of agricultural

run-off at major drainage points are reproduced in Table 4, and nutrient loadings in Table 5. Nutrient loadings in the Serpentine-Nicomekl and Sumas rivers have led to enrichment problems and several significant fish kills (Environment Canada 1992). The overall impact of these contaminants are negative with respect to wildlife, but the specific relationship has yet to be determined.

By far the greatest influence on the agricultural landscape is the urban shadow effect and the ALR. While the ALR has halted the wholesale march of urban sprawl across the valley, it has not protected the agricultural community from urban interests. Remaining weaknesses in the ALR and other political vulnerabilities extant along the urban-rural fringe continue to alter the economic landscapes available to wildlife — in particular, wet-meadow substitutes are at risk to gentrification and the establishment of residential rural estates and hobby farms. Unless institutions change and new institutional arrangements materialize to facilitate tie protection and securement of habitat and agriculture in the estuary, wildlife will be gradually aliented and lost.

CHAPTER 3:

INSTRUMENTS, INSTITUTIONS, LAND USE AND WILDLIFE

In this chapter institutions are defined and separated into specific classes: organisations and economic instruments. There are a number of instruments potentially available to agencies, firms and individuals to obtain protection of wildlife habitat. Several instruments, listed in Table 6, are discussed in relation to habitat preservation, agricultural land use and urban development. The final section describes several agencies and programs (institutional organizations) active in the area of habitat conservation, and the instruments they employ to achieve objectives.

Instruments, Organizations and Institutions

North (1991) describes institutions broadly as the “constraints that structure political, economic and social interaction . . . they provide the incentive structure of an economy. ” For the problems at issue here, a narrow definition of institutions is needed to distinguish instruments from organizations within this broad classification of “institutions.” North (1990) proposes that the purpose of an institution is to streamline the flow of information — that institutions are the environment for information exchange and decision making. If we understand instruments to be the carriers of information, then organizations represent the social environments in which economic instruments operate; organizations provide a structure to human interaction.

There are a range of institutional organizations operating in the Estuary: private and public bureaucracies, lobby groups, economic institutions such as firms (farms, cooperatives and conservation trusts), and formal and informal markets. Institutional arrangements are the product of public choices; created and modified by the collective decisions of members of society to meet social objectives. Once made, these institutions establish the exogenous conditions, or structure, of land-use decisions.

The existence of economic externalities implies, but does not mean, that markets are failing to perform as they could.²⁵ Government response to improve market performance has often been command and control regulations: restrictions, rationing and standards. The alternative to command and control is to employ economic instruments to change the behaviour

25. The persistence of economic externalities can just as easily imply government failure due to scale, poor bureaucratic incentives, successful rent-seeking or externality-shifting.

Table 6

Economic instruments for habitat protection and preservation

*Land Acquisition	* Restrictive Covenants
*Land Transfers	* Conservation Covenants
*Density Transfers	* Political Advocacy, Education and Extension
*Transferable Development Rights	* Changes and Taxes
*Land Use Zoning .	* Standards
*Land Management and Stewardship Programs	* Performance Bonds

of markets and agents. Economic instruments are the mechanisms through which decision information is conveyed or ‘value’ is captured. Since economic instruments convey information for decision making, their defining characteristic is their ability to alter economic incentives to change behaviour. Property, real estate, contracts and financial incentives such as charges and subsidies all convey price or value information used in land-use decision making. Agents, such as BCMOELP, will employ one or more instruments in a strategy aimed at achieving established objectives (e. g., a pre-determined level of BOD at monitored points in the drainage system).

Instruments and Strategies in Habitat Preservation

Currently, strategies to control agricultural land use and conserve wildlife habitat include over a dozen mechanisms proposed or in use. These mechanisms are pursued independently or in tandem with each other. Many instruments are employed simultaneously, largely due to necessity, but often as a series of options available to a particular agent to achieve a wide spectrum of objectives in addition to the preservation of habitat. The mechanisms (instruments) are listed in table 6.

Land Acquisition, and Development Rights

Land may be purchased through the market at prevailing rates by individuals or groups, or it may be expropriated by governments for specified purposes at a value that may or may not compensate the owner fully. Alternatively, the title to the land need not be purchased, only the right to develop the land. The full acquisition of land allows the market to influence the amount of land to be preserved. Incorporated into the value of land is the value attached to further development. The social “opportunity” cost of removing this resource from further development should be reflected in the market value of the land. However, the opportunity value of the land is influenced by municipal and provincial zoning, and may not reflect the true social value of

the land in alternative uses. This is the case of much of the agricultural land in the estuary. Provincial and municipal zoning restrict permissible uses for the land to agriculture, often to field agriculture, depressing the market value of the land (by alienating production alternatives). Land owners have incurred a loss due to zoning, thus acquisition through the market (or by expropriation) would not necessarily fairly compensate them for the value of the land.

Not all farm operators are land owners (many own land, lease land and/or put land out for lease). As was mentioned in the discussion of the urban shadow, some degree of the economic loss can be recovered due to speculation by persons who perceive weaknesses in zoning. In Delta, a combination of expropriation and speculation has left only 1/3 of its farmland in the hands of the agricultural community. The remaining 2/3 is either unused, or leased back to farmers for tax purposes; almost half of this land is leased on terms not exceeding one year (20% more are under 5 years). Such insecure tenure does not lend itself to a long-term interest in the land or other agricultural investment. Further land acquisition (for the purposes of wildlife habitat) adds to this insecurity.

To affect continual full-time farming by landowners and protect or acquire habitat, methods other than land acquisition must be pursued (including very-long term leases extending beyond 15 years) (Klohn Leonoff 1992). Non-farm owners lease at rates that exceed those that would prevail in the absence of speculation. High lease rates lead to a further deterioration in farm practices as producers attempt to recover as much of the residual as they can through short sighted management, shoddy (but inexpensive) environmental practices (such as exceeding recommended fertilizer loadings, postponing ditch or impoundment maintenance), and increased livestock densities. This plays directly against wildlife populations, placing them at greater risk (see Bohn 1993a, 1993b, 1994; Lee 1994).

To ensure that the loss of value incurred through zoning was captured by the land owner while still restricting the use of the land, municipalities and other government bodies could purchase, or create a market for the purchase of, development rights. Development Rights Purchase Programs (DRPs) are active throughout New England, Maryland, New Jersey, Pennsylvania, California, New York, Washington and North Carolina (Klohn Leonoff 1992). The purchase of the right to develop does not remove the need for zoning. By compensating the land owner, the community benefits from restricted land use and the land owner benefits by receiving the value of the lost opportunity that would otherwise occur if zoning laws were the only mechanism otherwise employed. Development rights need not necessarily be purchased and held by municipalities or other government bodies.

There is no reason why groups and individuals concerned with the conservation of land for wildlife or agriculture could not purchase and hold these same development rights. The greater the number of participants competing to purchase development rights (buyers and sellers) the less scope there is for strategic behaviour on the part of individual buyers and sellers to distort the value of these rights. Such a market could reveal how much society values the wilderness and agricultural resource. In order for the optimal balance between urban, rural, and wilderness lands to be established the social value of each resource needs to be known. By allowing purchasable development rights, a market for wilderness and other land characteristics is created and a dynamic balance between land uses derived as social needs change.

The use of tradeable development permits also accommodates distributional concerns about the effects of rent-seeking through restrictive zoning, and other land use restrictions. The use of development rights to control land use is not new to the region; density transfers have been used in Surrey and elsewhere to compensate land owners for losses which result from zoning. Density transfers allow a land owner to trade lost potential development on land in one area for further development in another. However, the practice is limited to land parcels owned by the developer. Essentially, a market instrument exists, but municipal policy has confined it to the fm. The density transfer acts to move profitability from one parcel to another, but such a transfer is useless to a land owner without other lands where further development is permitted. By allowing these development rights to be transferable and vendible outside the fum, a ready market for development rights could exist and the social value of conservation established.

While land acquisition and development rights are able to conserve land for alternative uses, as an instrument they fail to address all the externalities associated with land use. Land acquisition and purchasable development rights will only segregate land parcels and uses; problems may remain where adjacent land uses are impairing the quality of conserved habitat. Recall that the marketplace assigns prices to inputs and final goods, and that these prices will determine how land will be used. The spill-over effects of agricultural production, the externalities caused by run-off, chemical/waste residues, and green space remain unaddressed. Reduced choice in production technologies and a declining agricultural land base will lead to an intensification of agricultural regimes — increased use of chemicals, fertilizers, and the cultivation of land. Under existing technologies, a more intensified agriculture will result in increased negative externalities associated with agricultural production.

Restrictive Covenants and Conservation Easements

Land acquisition and transferable development rights alone will not necessarily ensure that ecologically or agriculturally important lands remain conserved. Without further restrictions attached to land deeds, the quantity and not the geographic distribution of resource lands will be established. Restrictive covenants and easements ensure that restricted land use remains intact indefinitely, or for some contractually arranged period of time, such as is done under the U.S. Small Wetlands Acquisition Program (Sidle and Harman 1987). The purpose of a restrictive covenant is to bind current and future land owners to specified land uses. The transfer of land between ministries and branches is often accompanied with covenants binding the new holder to certain permitted activities. The same legislative authority binding private land holders has only recently been permitted under changes to Section 215 of the B.C. Land Title Act, enacted July 1994. Section 215 covenants will permit land and conservation trusts, and other economic agents approved by the Minister of Environment, Lands and Parks to hold restrictive covenants without necessarily owning adjacent real property.

Prior to the amendment, restrictive covenants were legal instruments that bind adjacent land owners to protect some aspect of their land (e.g., water access, forest buffers and wetlands). They require that the holder of the covenant monitor and enforce his/her right. Richmond has used restrictive covenants through the development permit process to protect environmentally sensitive lands, and includes mitigation penalties in the event of non-performance on the part of the restricted party (the developer or his/her successor) (City of Richmond 1992). It is increasingly expensive for the Crown and municipalities to monitor and enforce the many covenants it holds, dispersing this responsibility to those who hold an interest in enforcing the covenant, makes this instrument practical and useful. Permitting non-government agencies (such as community land trusts) to hold non adjacent conservation covenants will have far reaching implications for private conservancy. Community groups and trusts could enlist voluntary preservation or compensated conservation measures from land owners presently driven by market forces into poor wildlife/stewardship practices. Since covenants can be modified by mutual agreement, they are a dynamic instrument that can adapt to changes in community standards, conservation demands and agricultural production technologies.

Land that has been acquired can be leased (rented or contracted) back to a tenant. Incorporated into the lease agreement can be easements on the property, restrictions on activities, or include conservation obligations. The Canadian Wildlife Service employs easements,

restrictions and obligations in its land use contracts on Westham and Reifel Islands. Cropping practices, crop choice and crop rotations (elements of restrictive covenants) are mutually agreed to in a comprehensive land-use plan governing the Alaksen Wildlife Management Area. Use of specified portions of a land parcel (the easement) is restricted to exclude adjacent habitat from disturbance. Conservation obligations (such as ditch excavation, fencing, clearing, etc.) are also employed. The contracts amount to one-year cash rent agreements; but the close relationship between the CWS and local growers lends the contracts many elements of longer term leases.

Through lease back arrangements the previous owner will have been compensated for the loss of opportunity (through the compensated transfer of title). Any subsequent lease rate will reflect the degree of restrictions attached to the agreement (e.g., the lease rate will reflect the market value of permissible activities and conservation obligations). When combined with the purchase of development rights, or acquisition, easements and covenants can ensure that the land owner is compensated for the restriction on use (whether the restriction still permits agriculture or forbids development at all).

Municipal and Provincial Zoning

Zoning has and continues to be an effective method of enforcing a desired geographical distribution of permitted land use activities. However, zoning arbitrarily assigns development rights, and distributes the surpluses associated with land development. The arbitrary assignment of development rights has three major impacts: 1) it does not fairly distribute the surplus associated with development (there are definite winners and losers), 2) it invites speculation, and rent-seeking activities associated with re-zoning, and 3) planning is not a dynamic process capable of reflecting the changing needs and preferences of a growing community. Development within zoned areas still requires permits and municipal approval. Planning departments, in conjunction with regional planning agencies such as the FREMP and the GVRD, are increasing the restrictions placed on development. The Ecologically Sensitive Areas initiatives (ESAs) of the municipalities involves an approval process that can protect sensitive land areas and habitat.²⁶ Richmond includes restrictive covenants where possible to ensure performance by developers. Sturgeon Bank (an ESA) is enjoying protection by cabinet and the municipality that constrains the options of the few private and crown land holders outside the dykes.

26. ESA protection through a development permit process is legislated through community planning sections of the B.C. Municipal Act (City of Richmond 1992). To be effective, ESAS require natural area inventories. To date extensive inventories have been conducted by Richmond, Surrey, Langley, FREMP and the GVRD.

Current zoning, and associated tax regimes, in the region suffer from lethargy, a lack of coordination between the different municipalities and the province, and they do not consider private non-commercial uses of land. Together these deficiencies discourage private conservancy by penalizing the land owner choosing to set aside land for non-consumptive use. Zoning can be effective, but it reflects the static preferences of an existing community — development along zone boundaries can exacerbate externalities, and may result in irreconcilable conflicts if the zoning process is too rigid. Transferable development rights are a way of overcoming this rigidity.

Land Management and Stewardship Programs

Agricultural extension programs have demonstrated that producers are willing to change their management practices when it can be shown that returns/revenues can be increased (Cowan 1985). Land management and stewardship programs can be used to influence the management of land through education and compensation. The Greenfields project, Small-Scale Forestry Program, the rent rebate offered by BCMOTH in South Delta, and the soil conservation program show that with sufficient financial incentive land owners are willing to modify their management practices to accommodate wildlife and the greater needs of the sumounding community. These programs acknowledge the external benefit that land stewardship offers society, and the existing property rights associated with land ownership. By compensating producers for activities that benefit others, these programs act to shift a portion of the burden of conservation from sole beneficiaries (urban and non-agricultural rural residents) to those who would otherwise bear the burden of providing the benefit (by withholding production or development). These programs address the external economies associated with good land stewardship.

The Small-scale Forestry Program addresses other problems associated with markets and stewardship. In particular, the program offers professional expertise and re-forestation funding to help make improved forest practices more accessible to small woodlot owners (Forestry Canada 1991). The program is popular in South Vancouver Island and the Fraser Valley — however, participants are few west of the Langleys and south of the Fraser River.²⁷

27. The Lower Mainland is a high-risk area for the program. The Small-Scale Forestry Program contracts (as opposed to covenants) its participants to a forest management plan for 15 years (violators must return all the Crown's investment). In land areas where there is high ownership turn-over and where land values act against silviculture, program administrators must be fully convinced that any Crown investment (or participation) in reforestation and silviculture (which can reach \$30,000) is not to be compromised by adverse changes in ownership.

Land transfers

Land transfers occur within and between provincial ministries with crown land surplus to ministerial needs. Surplus lands are transferred to Crown Lands for later disposal. Other crown lands can be transferred between branches and ministries with specified land use restrictions. Such lands are held under ministerial permit indefinitely, and can be used to create wilderness refuges, parks, etcetera. Crown land is come by easy enough, expropriation can always be used to add needed lands to the inventory (but can increase the uncertainty of ownership and lead to insufficient investment and maintenance of surrounding or potentially expropriable lands).

The BCMOTH used this process to acquire lands needed for the construction and future expansion of the Robert's Bank Superport; lands which are now in surplus and leased to the previous owners. The expansion of the Vancouver Airport will require the securement of a specified area of habitat to replace that lost to development on Sea Island — expropriation and land transfers in the Boundary Bay area are one way of meeting this requirement. Land transfers, without changes to tenancy, are neutral; but the use of restrictive covenants and conservation easements on new lease arrangements following a transfer are not. If land transfers are used to achieve conservation goals in this manner, agricultural tenants may suffer from a reduced land base and production choice, and higher costs associated with restricted activities (such as spraying or chemical use).

Charges, Taxes and Standards

Subsidies, taxes, charges, performance bonds are economic instruments that attempt to replace all or part of a market; standards are (politically determined) quantity based instruments, unlike the former group, which are price oriented instruments. They address problems and conflicts where markets appear to have failed. Taxes and charges, like subsidies, provide financial incentives to change management behaviour. They can be used to discourage bad practices and promote good practices, or if poorly conceived, they can do the opposite. Current taxation discourages private conservancy by taxing potential land use (under existing zoning) and not actual land use. Standards and regulations can also be used to “force” behaviour which markets discourage. To overcome the discharge and run-off problems from urban development, the District of Surrey requires new developments to construct community detention ponds. These ponds contribute positively to land values (through costs and positive externalities). Additionally, unit charges apply to new developments to cover the additional expenses of

drainage. Charges vary from \$3500 for standard lots, and \$10,000 for larger rural lots (not insignificant amounts). Such charges depress the speculative value of unserviced lots (such as those in the ALR).

Cross-compliance (conditional subsidies based on performance standards) can be used to codify and “force” acceptable land management while at the same time compensating the producer for the increased costs (the market disincentive) associated with compliance assuming a degree of self-enforcement. Preferential property tax status is assigned to farmed lands in the ALR. As such, it is important for non-farming residents to cash-rent lands into agricultural production (horse/hay farms, etc.) when such lands would otherwise be allowed to “deteriorate” into old-field habitat, or be kept as private, exclusive, parkland.

Where environmental degradation is the potential consequence of agricultural activities, performance bonds can be employed to ensure that the potential costs of such activities enter the decision environment of the grower. Agricultural loadings into the marine environment are currently not costed. The mudflats and marshes act as a big sink for a number of polluters, of which agriculture is but one of many (Environment Canada 1992). Municipal and industrial polluters are easily monitored as point source polluters, while monitoring of agricultural run-off poses a number of difficulties. However, agricultural areas (drainages) can be monitored, and individual or community-based performance bonds enforced. The objective of a performance bond is to ensure against environmental damages from risk activities (such as agricultural chemical use).

Currently, a grower may engage in an activity that *may* cause environmental damages in excess of his/her net worth if the private benefits are great enough. By requiring the grower to post a bond in the amount of the potential damages from the activity, the grower must balance the private gains from an activity (say higher cattle densities near active nesting areas, or machine activity near a Heron colony) against the carrying charges of the bond. Banks, trusts and other lending agencies (the bond guarantors) would gauge the risks they would be carrying on behalf of the farmer. Through such bonds the social costs associated with an activity come to bear on the decision environment where before they were absent. For community related agricultural activities (such as agricultural chemical use in a watershed), community bonds posted collectively by all participants can be enforced — monitoring of activities such as pesticide use, is already underway by federal and provincial agencies.

Charges and taxes on activities can similarly come under the purview of community risk. Drainages can be monitored for levels of pollutants, and communities of land owners equally

held responsible for violations of standards and any damages and fines that result. The incentive for individuals to cheat the system is lessened as all bear the risk of one person's defection. Self policing would be inevitable. Such fines and taxes must be charged the owners of land, so the risk of associated activities feeds into lease and rental rates and restrictions.

For such institutions (bonds, charges and taxes) to work a considerable body of knowledge concerning the impacts of various activities on social welfare must be established and continually upgraded; enforcement of standards for the purposes of tort (liability), subsidy or taxation also carries with it large information demands. The infrastructure to implement regulations can be quite large, and must be able to adapt quickly to changing technologies and social preferences to be effective as time goes on.

Political Advocacy, Education, and Extension

Advocacy, education and agricultural/wildlife extension are *not* economic instruments as defined for the purposes of this study; they are mentioned for completeness. They represent a class of strategic economic behaviour that uses political and economic institutions to achieve specific socio-economic objectives of a select group. For example, the Burns Bog Conservation Society employs political advocacy at the federal, provincial and municipal level in seeking to preserve the Bog from further development, industrial and agricultural use, while at the same time producing educational videos espousing the ecological significance of the Bog. The Richmond Nature Park (a pocket of wilderness in a sea of development) operates an important interpretive centre on-site, and encourages community use of the facility and parkland to better understand bog dynamics (s= Doyle *et al.* n.d.; Cooney *et al.* n. d.).

Education of the public and media is used to affect changes to community attitudes and preferences. These changes in turn will affect how urban and rural residents interact and seek to accommodate land use. The use of moral suasion without financial incentive (e.g., increased returns) has been shown to be ineffectual in promoting better land stewardship and alternative land management practices (van Kooten and Schmitz 1992). An additional task of the Greenfields Program is to educate growers about the economic merits of cover cropping (extension). In a survey conducted at the inception of the program (in 1991) one half of Delta farmers were participating (changing behaviour in the presence of incentives). Fewer than 1/10 had permanently changed their farming practices because of Greenfields (i.e., change attributable to moral suasion). In a more recent survey (December 1994), when asked what aspect of the Greenfields Project was most worthwhile, the most common response (81% of

respondents) favoured the financial incentives of the program, with one dissenter (6%).²⁸ For extension to succeed in the long run, the new methods must provide increased returns; therefore, more efficient cultural techniques, or compensatory programs such as Greenfields, must be provided.

Political advocacy can be used to appropriate a surplus associated with conservation or development while placing the burden onto others (a form of “externality shifting” discussed in chapter 1). The imposition of zoning, regulations, or standards (such as the Waste Management Act or Agricultural Codes of Practice) are the result, in large part, of political advocacy by one party or another. The distribution of the surplus can be dramatically altered through political institutions — who pays the costs of conservation or development will depend on the political influence (the degree of rent-seeking) of those who have a stake in the surplus. If institutions can be created (such as zoning, or restrictive standards) that shift the burden of conservation and development onto another party, incentive will exist for the beneficiaries to seek those solutions which appropriate the greatest surplus with the least cost to themselves. Under such circumstances, it is unlikely that the socially optimal balance of urban lands, agricultural lands, and wilderness can be reached. Continuing with the example of Bums Bog Preservation Society, while some residents of Delta and the Lower Mainland will presumably benefit from preserving the Bog, *all* residents would bear the costs of any compensation due Western Delta Lands Inc. (WDL). Alternatively, by permitting WDL to develop the lands as urban residential, there would be a windfall to WDL, and a pecuniary effect throughout Delta (an increased tax base, lower scarcity value in housing, and an externality borne by those who lose the view of the Bog and the existence values represented by it in its current state).

28. Thirty-one evaluation surveys were mailed to participants, generating 16 responses, for a 52% response rate. All respondents considered Greenfields a valuable program (survey question #16). Two other top responses concerning worthwhile aspects of the Project (survey question #2) were the role of the Project in fostering better communications between farmers and wildlife agencies, and between farmers and the general public (75 % and 63 %, respectively) (Ihqmstee, personal communication). The newsletter of the Project contains information on Project research results, program changes, extension, conservation and natural history information.

Public and Private Agents in Land Preservation

Private and Public (Government) Conservancy

Conservancy takes place in many ways and many forms, either through the actions of individuals, organizations, or government agencies. Public conservancy occurs by the singular, unilateral mandated action of a government agency. In the case of organized conservancy, the distinction between public and private is blurred, with committees such as the Pacific Coast Joint Venture (PCJV) consisting of both private groups, such as Ducks' Unlimited (DU), as well as various government agencies.

Private Conservancy. The private conservation of land can be achieved through many means, including conservation easements, restrictive covenants (Kwasniak and Hudson, 1992), and density swapping. Each requires the proper legislative and policy environment to be effective. Current zoning and land legislation in British Columbia does not promote land conservancy by the private individual. By restricting future land use, the market value of a parcel of land is reduced. The individual seeking to restrict future use will incur a penalty (the lost value of development). There are no tax incentives/breaks for such voluntary write downs of land value.

Disincentives to individual conservancy have prompted private groups and organizations concerned with land preservation to be formed. These organizations are capable of absorbing the lost revenues associated with restricted land use. The Pacific Coast Joint Venture is an example of a (largely) privately administered conservancy group. Government funds/personnel are often involved with organized conservancy groups, blurring the distinction between private (voluntary) conservation and public (involuntary) conservation. Government participation in these groups does not mean their resources are unlimited. Land acquired for preservation or restoration is not always the most threatened or significant — largely because of the sheer expense of land acquisition.

Important conservancy groups, other than the PCJV, active in the estuary include Ducks' Unlimited, The B.C. Nature Trust, and the Pacific Estuary Conservancy Program (PECP). Each of these groups facilitates conservancy. Ducks' Unlimited will acquire land for recreational purposes,²⁹ while the PECP does not limit the purpose of its land acquisitions.³⁰ The B.C.

29. In B. C., DU has acquired land principally for waterfowl conservation purposes. While individuals may enter DU projects, such as Serpentine Fen, use is limited to non-consumptive recreational activities (e.g., birdwatching, photography, etc.). Consumptive recreational use occurs in the U.S. where waterfowl hunters enjoy the benefits

Nature Trust facilitates the transfer of management and administration of freehold lands to the Crown under restrictive covenants.

Because of the costly nature of private conservancy, a number of advocacy groups exist to lobby municipal, provincial, and federal bodies to place land into refuges, or to limit/freeze future development in controversial areas. It is through such advocacy that restrictions on land use and development are established at the regulatory level, and the economic surplus associated with wilderness preservation is divided. This is particularly evident at the municipal level when rezoning, density issues and development permits spark the spontaneous formation of neighbourhood groups. The Burns Bog Preservation Society is an example of an organized group opposed to development of land in North Delta, and advocate a park designation for Burns Bog. As the principal land owner in Burns Bog, Western Delta Lands Inc. has much at stake in maintaining its rights to develop land that is classified industrial.

Public Conservancy. The ability of the Crown to set aside land for specific land uses is set out in the B.C. Land Act. Crown land may be transferred between branches, ministries, or governments, and restrictive covenants regarding land use attached to the transfer of management and administration. The Crown also retains the right to restrict land use on private property; the establishment of the ALR is an example of such restrictions. The Crown may also expropriate land as it sees fit. Each of these mechanisms can be, and has been, used by the Crown (and municipalities) to preserve/conservate land for wildlife. The Crown is, by far, the largest land owner in the estuary. It uses its contractual authority to provide incentives to cover crop, restrict land use, restrict crop and/or production choices, etcetera.

It is also within the power of governments to use alternative mechanisms to distribute the costs and benefits associated with wilderness preservation. Subsidizing land stewardship from the tax base transfers funds from those who benefit from conservation to those who must bear its costs, the land owner. Funding by the federal government of the PCJV and PECP is an example of such transfers. In the United States, cross-compliance in farm production programs

of DU investment in land conservation in B.C. (e.g., increased duck harvest levels).

30. The PECP'S goal is to promote the conservation and enhancement of coastal wetlands for fisheries and wildlife. Funding and support comes from the Nature Trust, DU and Wildlife Habitat Canada, as well as the BCMOELP, CWS and DFO (PECP 1993). To date the PECP has acquired about 1200 ha along the BC coast (mainly near Nanaimo) and secured another 1200 ha of adjacent intertidal areas. In the Lower Mainland the PECP is actively involved in projects at Harlock Island, Bounday Bay, The South Arm Marshes, and Widgeon Marsh (Pitt Lake).

helps ensure land conservation and habitat retention while at the same time compensating for land conservation. The BCMOELP has been using the Habitat Conservation Fund since 1981 to provide support to private conservation agencies (Habitat Conservation Fund, n.d.).

Examples of direct public conservation (apart from parks development) are few. Following the success of the B.C. Waterfowl Society and Ducks' Unlimited increasing the 40 ha refuge site on Reifel Island, Delta, the B.C. government designated the adjacent 680 ha of foreshore a game reserve. This, in turn, was followed by the 1972 purchase of the Reifel farmstead and the establishment of the Alaksen Wildlife Management Area (The Alaksen WMA is part of the network of Ramsar sites across Canada). Adjacent to Ladner Village is another example of public conservancy: Ladner Marsh. Once a sewage settling lagoon, it was rehabilitated in 1990, and restored to the estuarine cycle of the river foreshore.

The Fraser River Estuary Management Proggm (FREMP)

FREMP is a cooperative agreement managed by Environment Canada, the Department of Fisheries and Oceans, the North Fraser Harbour Commission, the Fraser Harbour Commission, BCMOELP, and the GVRD to coordinate development and planning in the Lower Estuary and foreshore. Its goals are broad: to achieve sustainable socio-economic development through ecosystem conservation and integrated management that encourages multiple use, promotes integrated decision making and establishes informed management processes. Wildlife conservation is an important component of FREMP's activities (although it does not actively conserve anything itself). Fish and wildlife targets include: 1) to maintain and improve, where possible, the existing habitat base to support viable populations of fish, wildlife and plants; and, 2) secure legal protection for habitat in areas with high ecological significance.

The Greater Vancouver Regional District (GVRD)

In 1990, the GVRD began the "Creating Our Future" process. The result of this consultative process were 54 "regional actions" which could be taken by municipalities and individuals to achieve one of five goals: 1) maintaining a healthy environment, 2) land resource conservation, 3) adaptations to changing demographics, 4) economic health, and 5) regional management (GVRD 1990). These actions and objectives have been brought together in the "Livable Region Strategic Plan", the leading component of which is the "Green Zone" (GVRD, 1992a).

The Green Zone is modelled after similar plans in Toronto, Seattle, Portland, Oregon, and San Francisco (GVRD 1992b).³¹ It classifies land into four categories: 1) community health lands, 2) ecologically important lands, 3) outdoor recreation and scenic lands, and 4) renewable resource lands (GVRD 1992a). Agricultural lands figure prominently in the last three categories, and are often users of the first category (which includes wetlands, undyked historic floodplains, and sensitive soils).

Although the specific implementation strategy for the Green Zone is still under consideration, the Zone's objectives and implementing tools are known. The Green Zone seeks to identify and quantify the amount of wilderness and rural landscape necessary to maximize social welfare. The demarcation of a "green line" will confine urban expansion and lands available for alternative uses (GVRD 1992b). Additional "lines" will have to be drawn delineating wilderness refuge, recreational (accessible) wilderness, and productive agricultural lands. Instruments being considered include: public education, land acquisition, acquisition of development rights, density transfers, regulatory frameworks (zoning) and the provision of incentives for private stewardship (compensatory programs) (GVRD 1992a).

The Boundary Bay Area Study (Lead Committee and Working Groups)

The Boundary Bay Area Study (BBAS) is a community and inter-governmental study of land use and environmental amenities around Boundary Bay. "The purpose of the study is to recommend strategies, guidelines, and actions for use by governments and individuals which lead to an acceptable mix of environment, agriculture, recreation and tourism, and development interests in the Boundary Bay Area" (BBAS Committee 1992). The study is an attempt to use an integrated and balanced approach to planning which includes considerable public and stakeholder involvement. The objective of the study and its components is to provide

31. The GreensPaces program of Metro Portland, OR is an agency existing to coordinate development in the metro area, cataloging ecologically sensitive areas, developing management plans, coordinating enforcement of existing environmental legislation, and directing funds for restoration and securement. In many ways the program resembles the GVRD and FREMP in objectives and limitations. Community planning in the Greater Toronto Area (GTA) suffers from stressed communities, a regional body of 30 local and 5 regional authorities, and no supra-regional zoning authority (ala the ALC). Coordinated research into natural areas protection since 1989 has helped build several points of consensus to bring GTA authorities closer together, including the province of Ontario. The GTA intends to use the Ontario Planning Act to implement the majority of natural area protection — acquisition is not a preferred option — and private land stewardship. In Seattle, King County has been able to float bonds to engage in a development rights purchase program to secure a greenbelt about the city. The bond issue was \$117 million. Other aspects of the Seattle program include development regulation, acquisition, land dedication, transfer and consolidation. San Francisco's Greenbelt Alliance Program has only just begun, cataloging green-space and an urban containment boundary.

information, identify and analyze alternatives, pursue public discussion, and recommend appropriate strategies to be implemented through existing bodies and institutions.

There are six components of the study. A literature review by the UBC Centre for Human Settlements (Melliship 1991) examined studies, position papers, white papers and reports published between 1975 and 1990 that deal with natural and spatial environmental issues (loosely defined to include the social, economic, manufactured and natural environments, in the Boundary Bay area). The *Delta Agricultural Study* (Klohn Leonoff Ltd. 1992) reviewed agricultural problems in the municipality of Delta, and made recommendations for an integrated framework strategy to protect farmland and promote viable agricultural development in the face of urban encroachment and increased wilderness protection. A wildlife habitat study by CWS (Butler 1992) inventoried populations and recommended a required land area for protecting and maintaining critical bird populations while minimizing conflict between different land uses. A foreshore planning study (not yet completed) which considers the estuarine and marine ecologies of the study area, habitat and species utilization, human and wildlife land use demands, and identifies environmentally sensitive areas, recreation and commercial areas of the foreshore. This component will also recommend the designation of wildlife management areas, and acceptable management strategies.³² The *Delta Rural Land Use Study* (Norecol, Dames & Moore, Inc. 1994) reviews municipal land use policies and programmes affecting the rural areas of Delta, making recommendations for environmental management of land use, recreation and community development. The ongoing development and implementation of the Environmentally Sensitive Areas (ESA) project of Surrey District will be used as a basis for environmental management in the municipality and adjacent Boundary Bay area.

The recommendations put forth by the component studies will be synthesized into common strategies through public review sessions. The general strategy for conservation which results will, once endorsed by the different levels of government, be implemented. This process involves extensive representation of many interests: governments, landowners, community and conservation groups, business and private individuals. The strategies which will evolve from the process will reflect the common interests of all parties involved and their political acceptance.

32. Some of this material is considered in the following: FREMP 1990; Ward, Moore and Kistritz 1992; FREMP 1993; McPhee and Ward 1994; Norecol, Dames & Moore, Inc. 1994.

Pacific Coast Joint Venture (North American Waterfowl Management Plhn)

The Pacific Coast Joint Venture (PCJV) is an international subsidiary component to the North American Waterfowl Management Plan (NAWMP). One of the NAWMP goals is to maintain and enhance the habitat values of areas identified as internationally significant to waterfowl (Environment Canada 1986). The PCJV is that arm of the NAWMP responsible for protecting wetlands and uplands from Northern California to Northern British Columbia (PCJV n.d.). In the estuary, the Joint Venture's focus area is the Boundary Bay eco-system, a wide swath of wetlands and uplands in South Delta and South Surrey from Westham Island to the Surrey Flats; it does not however limit itself to this area.

The Joint Venture is an amalgam of several groups concerned with the preservation of the land resource for wildlife, principally waterfowl. In B.C. the PCJV is largely directed by: Canadian Wildlife Service, Ducks' Unlimited (DU), Pacific Estuary Conservation Program, B.C. Nature Trust, Wildlife Habitat Canada, Wildlife Branch and Crown Lands (BCMOELP), Agriculture Canada, and a representative from B.C.'s native community. Funding for the PCJV comes from individuals and governments in Canada and the United States. Because the U.S. Fish and Wildlife Service is willing to match each dollar raised by private groups in the U.S. (mainly Ducks' Unlimited) for waterfowl habitat preservation, there is a large transfer of income from the U. S to Canada for the preservation of wintering (and breeding) habitat.

In this region, the PCJV has well defined habitat and population objectives as well as educational and recreational goals (PCJV 1992), including: 1) to protect as much tidal wetland habitat as possible;³³ 2) secure non-tidal wetlands which serve as important staging, feeding and/or roosting areas for waterfowl; 3) to identify the area of land required to maintain adequate upland habitat for waterfowl and other wildlife and ensure that this area is maintained as farmland or natural upland;³⁴ and, 4) to maintain existing waterfowl populations and enhance those populations where opportunity exists. Educational and recreational objectives have not yet been identified to the satisfaction of the stakeholders involved. However, given the mixture of groups, these goals will include: 1) extractive and passive recreational opportunities; 2) environmental information/education of media and public; 3) recruitment and political advocacy; and, 4) agricultural land stewardship extension.

33. Foreshore objectives are: 24,600 acres in Boundary Bay (100% of the land area); 28,500 acres at Robert's Bank (98%); 19,025 acres at Sturgeon Bank (97%); and 1475 acres in the South Arm Marshes (82%).

34. Upland objectives are: 12,700 acres in Boundary Bay (22% of the land area); 9,100 acres in Robert's Bank (75%); and 420 acres in the South Arm Marshes (100%).

These goals and objectives are to be achieved through habitat securement (either by land acquisition, restrictive covenants, conservation easements and land transfers), enhancement and restoration projects, land management programs, demonstration farms, political advocacy, and directed education programs.

The Greenfields Project

The objective of Greenfields is to disperse migratory waterfowl wintering in the Boundary Bay eco-system. In dispersing waterfowl through cover cropping, crop depredation from feeding birds will be reduced, soil integrity will be maintained, and soil quality enhanced. The program promotes winter cover cropping; and is actively engaged in planting and crop management research to determine feeding patterns and optimal planting regimes. By providing seed costs as a subsidy to farmers, the program helps establish winter cover to ameliorate soil and crop damage by birds and farm equipment operators. However, the program is hampered by limited funding, the feeding habits of certain species (namely Widgeon, which flock feed in an unpredictable pattern), and tenancy agreements which prevent or discourage the planting of winter cover due to tenure considerations and the uncertainty of future use.

Other Winter Cover Crop and Lund Improvement Programs

The Canada/British Columbia Soil Conservation Program was a two year joint federal-provincial plan to research and develop soil management techniques that maintain and/or enhance productive soil quality. Management techniques include crop rotations, mulches, and winter cover. The Land Management Assistance Program (LMAP) was a two year joint federal-provincial assistance program to promote agricultural land improvements which lead to increased water quality in adjacent waterways and wetlands. LMAP subsidized the construction of infrastructure such as dykes, drainage systems, and livestock fencing. Both the LMAP and C-BCSCP have come to a close.

The provincial Ministry of Transportation and Highways is a large land owner in South Delta. Recent criticism of tenancy agreements led to the establishment of a rent rebate for the planting of winter cover. The rebate amounts to a subsidy covering both the costs of seed and of seeding without acreage restrictions, and has received widespread subscription.

CHAPTER 4:

IMPLEMENTATION AND FURTHER RESEARCH

The economic review of agriculture and wildlife interaction has outlined the existing and potential uses of economic instruments as an alternative to command and control regulations in the area of habitat conservation and preservation. The report outlined eleven broadly defined economic instruments; of these eleven, all but three are currently employed (transferable development rights, conservation covenants, and performance bonds remain unemployed). Zoning, acquisition and advocacy are the most widely employed instruments to effect changes in land-use patterns.

There are currently three broad planning exercises within the Lower Mainland: the GVKD 'Livable Region Strategy', the Fraser River Estuary Management Program, and the Boundary Bay Area Study.³⁵ At the core of these planning exercises is an acknowledged need to direct urban growth and preserve the green landscapes and wildlife habitat that is still abundant. However, these programs, like all planning exercises, rely heavily on the ability of municipal planning departments to map out and regulate much of the future landscape. Planning exercises are not very adaptive — they cannot change land-use patterns easily without being arbitrary and discriminatory.^{3b} This is particularly true when changes to existing zoning regulations take surpluses away from landowners. The un-adaptability of the planning process highlights a key problem in centralized regulation of land use that can be overcome by an expanded use of property oriented instruments.

In the eleven instrument groups listed in Table 6, all but political advocacy, education and extension take advantage of property rights in a substantial way. As mentioned, property permits an individual or group to own or realize some of the benefits of a 'thing.' In the past,

35. The Fraser Basin Initiative is a recent creation of the BC Government that is attempting to coordinate broad agreement on future land and water resource use throughout the Fraser River Drainage Basin. The Georgia Basin Initiative (GBI) is a part of this larger exercise which is focusing on the Georgian Basin Eco-province (an area which extends from Hope, west to Victoria and north to Campbell River. The GBI will be focusing largely on the Capital Regional District and the Lower Mainland, where environmental problems are particularly acute.

36. The current public process appeals to those who can "shout the loudest" to council in order to push development, or hold it up in quasi-political processes in order to stay or promote a particular course for neighbourhood change. A system of TDRs and other flexible property instruments would democratize and decentralize the process, empowering developers and residents alike.

land acquisition has been the traditional way to acquire habitat on a long-term basis. The ownership of land grants its owners the greatest authority to control land-use. It is, with respect to the Lower Mainland where concurrent use is possible, the most expensive option. But it is not the only means by which habitat can be secured, nor is it singularly the most complete option. This report highlights ample examples showing that numerous land-uses are necessary to offer a complete range of concurrent and discrete wildlife habitats and social landscapes.

It is conceivable to acquire by purchase, bequest or moral suasion only that portion of the bundle of rights associated with property necessary to secure habitat. Land acquisition obtains the entire bundle of rights, and it is not inexpensive. According to a 1991 BCMOELP report, the PCJV habitat objectives, the GVRD Livable Region Strategy and sewage upgrade together will cost about \$350 million each (or over \$1 billion together). In Fraser River Action Plan Sub-committee reports for 1993, it is pointed out that budget reductions will force the use of alternative strategies to achieve habitat and environmental quality objectives. Private agencies, while enjoying great financial flexibility, face similar hurdles, so least cost alternatives must be sought and employed. Among the economic instruments discussed, a least cost strategy may best be achieved through a system of tradable development permits, conservation and restrictive covenants and performance bonds. There are elements of institutional reform that contribute tremendously toward improved stewardship of the land base which fall outside the mandate of this report, and which form a part of larger questions of social reform and the role of government budgeting of debt and deficit spending.³⁷

At the beginning of this report much was made of the role of unpriced benefits and costs in agricultural and urban land use. These costs and benefits were characterized as ownership related *economic externalities*, suggesting that some property rights are overspecified and others remain incomplete. The expanded use of property oriented instruments will go a long way toward alleviating some of these externalities, and some transactions costs. Those externalities that are non-point source (such as agricultural run-off) may require the use of community property, or community risk (e.g., community-wide charges and subsidies or performance bonds). It is important that the full range of instruments be available to all parties engaged in habitat conservation. A diversity of species, habitats and regional landscapes requires that a

37. For recent literature on this issue see: O'Toole 1994; Richardson 1994; and Scott and van Kooten 1994. Problems with government indebtedness should not be overlooked. The discussion of institutional agents documents a tremendous amount of public involvement in the financial viability of conservation groups, trusts and programs. The ability of government to fund these programs, as well as larger political commitments such as health care and social assistance is limited; and recent cutbacks may only be the harbinger of much greater future reductions.

diversity of flexible instrument choices be available. A greater employment of economic property instruments will render the price/value of species, habitats and landscapes increasingly transparent, effecting greater efficiency in the allocation of land resources in the region.

Securing habitat by means of land acquisition, covenants and easements requires more than ecological assessment of habitat requirements. Habitat objectives within public agencies and other conservancy groups have been based largely on expert opinion. They take little consideration of the economic value of the habitat, or of habitat and wildlife in general — just that its valuable. To determine an optimal balance of greenspaces, wildlife habitat and other land-uses, it is important to know the value of land in these uses. As noted above, greenspace and wildlife lack markets to inform participants of their value. But this does not preclude valuing them, nor should it exclude their relative values from the decision making process. The scarcity of public and private dollars demands that the economic value of habitat objectives be determined. Are the current objectives too high or too low? To what degree can habitat/landscapes be substituted to achieve an optimal balance? Which lands are economically best suited for wildlife compatible land use, or dedicated wildlife habitat? What impact will charges, taxes, performance bonds, and other economic instruments have on the optimal allocation and distribution of habitat and landscapes? These questions cannot be answered until the value of wildlife, habitat and greenspace is determined.

The implementation of a system of tradeable development permits will require a great deal of coordination among regional planning authorities, as well as a devolution of power from the bureaucracy to citizens. Regional authorities must agree on a comprehensive plan that includes development zones (much of this planning is already underway). Within these development zones minimum and maximum “density limits” must be made explicit and binding. A minimum density limit would constitute that level of development permissible without additional permits purchased elsewhere. The maximum density limit would constitute a ceiling on development in combination with TDRs purchased from low density areas (or out of a density pool). Governments must be bound by the zoning restrictions to the same degree as private agents (even for mundane public goods such as roads and bridges); additionally, variances cannot be granted, else the usefulness and value of a system of TDRs be undermined by political philandering and nepotism.

The most important component of a system of TDRs is the initial allocation and distributions. In the first and subsequent chapters, discussion emphasised the distributional consequences of reserving land through zoning processes such as the ALR; zoning (and other

forms of land use regulation) results in a transfer of surplus from one group to another, who capitalize the surplus into land values. The initial allocation of TDRs is a simple exercise relative to deciding on its distribution. The initial allocation is simply the maximum allowable aggregate density less the minimum aggregate density. Several strategies exist with respect to the distribution of this density pool. Regional authorities could hold the entire pool (in some single agency or within regional/municipal departments) and sell it to the highest bidder, or they may distribute it to the citizens. Given the discussion on the economic impacts of lost surpluses (lost option and quasi-option values), there is ample justification for an initial distribution among existing land owners based on acreage owned. However, which method is chosen will depend on the transactions costs involved; further economic research may reveal some surprises.

Legal economic instruments such as restrictive and conservation covenants have been the subject of ongoing research at the West Coast Environmental Law Research Foundation (see Loukidelis 1992, and Findlay and Hillyer, 1994). However, it is apparent that further forms of property rights applicable to resources such as environmental amenities, recreational landscapes and wildlife be explored. Methods of encouraging Section 215 covenants can and should be explored, since there are elements of public goods externality associated with such covenants. The role of public agencies in funding and participating in conservation groups and land trusts should be reviewed to avoid duplication and excessive subsidization of effort.

Existing ownership patterns (i.e., public ownership of wildlife) are not immutable, and where scope exists to expand and encourage private ownership alternatives, the efficiencies that would result may be great. Research in this area should continue, focusing on alternative institutional structures for the ownership of fugitive resources such as migratory wildlife, or open access resources such as water. The role of community ownership and community responsibility (viz., performance bonds and group frees/subsidies) with respect to the stewardship of land resources should also be explored in light of alternative ownership patterns and institutional structures.

Much of the analysis highlighted in this report has been conducted in isolation. There exists a need to explore alternatives which are employed elsewhere but which remain unfamiliar in British Columbia. The Georgia Basin is not alone in dealing with urban growth in an agriculturally dominated estuary. Similar processes are ongoing in the U. S., namely San Francisco, San Diego, Mississippi delta floodplain, and Chesapeake Bay area. Experiments and pilot projects that test the applicability of institutional and instrumental alternatives in BC should be given some priority.

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