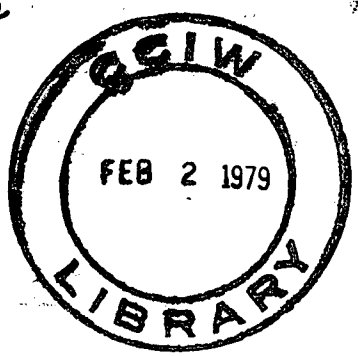

Canadian
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Report No. 6
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OTTAWA, CANADA
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Cat. No. En93-6/1978

ISBN 0-662-02042-1

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PREFACE

There can be no doubt that the dedication of North Americans to the rapid exploitation of the natural resources of a continent has been a major factor in building the high standard of living we enjoy. Whether it be mining, petroleum extraction, forest exploitation, commercial fishing or large scale agriculture, we have been aggressive, ingenious and in large part single-minded. This single-mindedness is reflected also in our governmental administration established to regulate and direct the resource industries and to foster their welfare. Thus we have departments of government dedicated to Mining, Forestry, Fisheries and Agriculture.

We have been slow to realize that the continent's resources are not independent entities but rather manifestations of the geological and biological history of the continent that have together produced a web of interrelationships so intimate that it is not possible to impose a major alteration upon any part of the natural systems without giving rise to consequences on other parts, frequently so remote from the source of the impact as to escape easy detection. This realization has been forced upon us as a result of serious impacts that some forms of resource exploitation have had on the wellbeing of other resources and indeed immediately upon human health.

Because of their unique qualities, some parts of the continent focus or concentrate interdependencies. Nowhere is this more dramatically apparent than in the estuaries. Here fresh water, salt water and fertile land are woven together in a dynamic state. Tidal rise and fall moves salt water in and out of the estuaries and raises and lowers the fresh water in the same cycle. The annual river regimen enriches the low lands with silt and nutrients from upstream. The intermixing of water and nutrients produces rich nursery grounds for fishes, and the anadromous fishes - salmon, smelts, shad, sturgeon, etc. - find a route to their upstream spawning grounds. Waterfowl and other birds in their thousands or millions use the estuaries as resting places in migration, as wintering grounds or as breeding areas.

At the same time, we find in these areas convenient sheltered harbours, log storage areas, opportunities for use as open sewers, and rich and easily tilled soils which are at the same time inexpensive to develop as townsites, airports and freeways.

In estuaries, as perhaps nowhere else, it is obvious that single purpose exploitation has a very low tolerance level.

Here the single-minded jurisdictions of federal, provincial and local governments converge, interact and too often conflict. Numerous expedient administrative band-aid answers to the problems are being tried. None of them has yet succeeded in establishing the administrative machinery required to undertake the effective management of a major estuary with the essential focus upon the constraints set by the estuarine ecosystem.

The Canadian Environmental Advisory Council undertook this study of a select number of Canadian estuaries to establish where we stand in estuarine management, to emphasize the critically important questions and to point to some routes to improvement of our government structures and procedures. We must be assured that these treasure houses of biological resources will not be destroyed, nor their web of interaction leading thousands of miles seaward and inland irreparably broken.

Ian McTaggart-Cowan
Chairman

Acknowledgements

We were assisted by numerous individuals and we relied upon a wide variety of source materials in the preparation of this report.

In preparing the sections dealing with the Fraser River and the Squamish River estuaries we utilized extensively the two reports on these estuaries by Environment Canada, *The Fraser River Estuary, status of environmental knowledge to 1974* and *The Squamish River Estuary, status of environmental knowledge to 1974*. Mr. Gordon Shanks drew together the information from these and other sources and prepared the first draft of these sections.

With regard to the La Have estuarine area, verbal or published information was received from Dale E. Buckley and E. Cranston, Department of Energy, Mines and Resources, Bedford; J.R. Machell and Hugh Hall, Environmental Protection Service, Halifax; Kate Kranck, Bedford Institute of Oceanography; and the Resource Development Branch, Fisheries and Marine Service, Environment Canada. For the Miramichi estuarine area, information was received from Kerry Wilson and Lou VanGuelpen of the New Brunswick Fisheries Department, from the Miramichi Channel Study Committee, from a study of Miramichi resources by the Montreal Engineering Co., from staff of the National Research Council, and from Kate Kranck of the Bedford Institute.

We profited greatly from the comments of Council members as well as from the ideas of many other individuals with whom we talked. Dr. J. Keith Fraser, Associate Secretary of the Canadian Environmental Advisory Council, edited the report and arranged for its publication. The several drafts through which this report progressed were typed and reproduced by the secretarial staff of the Westwater Research Centre, Mrs Jerry Pladsen and Mrs Darlene Nickull. We are grateful to all of these for their assistance.

I

INTRODUCTION

Estuaries and their associated lands have traditionally provided abundantly for the needs of civilized man. Settlements based on estuarine resources have historically been prosperous, leading the hinterland not only in material wealth but in development and cultural values. They were favoured sites for important cities, attracting commerce and industry, and rising to become keystones to political and economic power. Self renewal of the estuarine environment through daily tidal action and through seasonal fluctuations in water flow permitted intensive use of the resources. Only in recent times, as the estuarine ecosystems were confronted with population and industrial pressures beyond their power to withstand or adjust to, their susceptibility to serious deterioration or destruction was recognized. We are now able to devastate this valuable element of the natural environment through uncontrolled and excessive use. Management of resources so that they will remain viable for future generations is of prime importance to mankind in general and to Canada in particular. Fortunately, no Canadian estuary has been degraded to the point of no return, and with reasonable prudence, we will be able to maintain their useability and vitality.

In Canada, there have been a number of piecemeal steps towards management. These have included the control of pollution from some urban areas, the reservation of some delta and marsh lands for particular uses in recognition of their special value, and investigations to determine the probable effects of some proposed developments. There is growing evidence that such ad hoc responses to specific problems are inadequate, and that in the absence of a more comprehensive policy, estuarine resources will be degraded, in small increments, through a number of individual abusive actions no one of which is regarded in itself as constituting a serious environmental threat.

This report addresses the general problem of managing the resources of estuaries and their associated lands. It endeavours to explain why these resources are so valuable and why they are of special importance to Canada. It examines the reasons for our failure to manage them in a manner compatible with the public interest and illustrates the nature of the management problem by describing the situations found in four Canadian estuarine areas. The report then suggests a way in which national leadership can be exercised to develop policies and institutional arrangements so as to manage estuarine resources in a more satisfactory fashion. Recognizing the complexity of the issues, no effort is made to suggest detailed solutions. Instead, a strategy is proposed involving a series of steps which should eventually lead to more effective management practices.

II

THE IMPORTANCE OF ESTUARINE RESOURCES

By definition, *an estuary is the portion of a river that is influenced by tidal action.* The associated lands are primarily deltaic, but they embrace all lands and terrestrial resources which significantly influence the aquatic ecosystems of the lower river. For the purposes of this paper, the term "estuarine resources" includes the aquatic life in these waters, the minerals in the water and in and under the bed of the estuary, the water itself, the soil, minerals and biological organisms of the land, and the useable space immediately above the land and water.

Estuaries are of particular value because of the high level of productivity of their waters, deltas and flood plains, and because of the potential settlement factors of site and location, such as level terrain, the sea/land/river interface and relatively favourable climatic characteristics. All of these factors may not be present though frequently several may combine to make the estuarine area much more attractive for human habitation than surrounding areas.

Biological productivity

The high level of biological productivity of estuaries can be attributed in large part to the nutrients carried downstream and which tend to be deposited when the velocity of flow diminishes as the river approaches the sea. The interaction between salt and fresh water augments this tendency.

> "As fresh water is diluted by sea water, current patterns are produced so that sea water tends to flow into estuaries near the bottom and fresh water to flow out along the surface. This layered circulation helps to concentrate particulate substances heavier than water at the coast. Dissolved substances are also concentrated because of absorption by floating organisms. Once the organism dies, it becomes a particle that sinks and is carried into the estuary in the upstream flowing sea water"[1].

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1 Ketchum, Bostwick H., ed., *The water's edge: critical problems of the coastal zone,* MIT Press, Cambridge, Mass., 1972, p. 8.

This concentration of nutrients, combined with the ability of sunlight to penetrate the shallow water, causes plant life to grow exceedingly well, furnishing a rich food supply for living organisms both in the water and on the adjacent land. Many organisms live directly off plants while others are carnivores. The shallow waters of estuaries are feeding grounds for the young of many species of fish, and serve to protect them at this stage from predators inhibited from entering brackish water. Thus estuaries provide the basis for a large proportion of the fishery resources of the world. Not only must all anadromous fishes pass through an estuary and depend upon it during important stages of their life cycles, but other species, because of abundant food supply, are much more plentiful in estuaries and contiguous coastal areas than in other parts of the sea.

Along the land/water interface of estuaries are numerous transitional areas of sloughs, wetlands and marshes, important habitats for both aquatic and terrestrial life. They provide resting, feeding and nesting grounds for waterfowl and are the home of many mammals that feed on aquatic organisms. The availability of moisture and an abundance of nutrients make many of these areas exceedingly productive of biomass. Beyond this transition zone are found highly fertile soils resulting from centuries of deposition of the silt load of the river. When these lands have been left in a wild state, they are likely to be unusually productive of forests and wildlife. When cleared for agriculture, they yield above average crops.

In short, estuaries and associated lands are an invaluable source of food and fibre, supporting a variety of ecological systems that contain species which cannot prosper in other environments and for which society has a high regard.

Mineral resources

Estuaries and their flood plains which have developed over relatively long geologic time may be significant sources of minerals, attributable to the nature of coastal currents and the organic deposits resulting from the rich biological productivity. "Currents that move and collect sediments along the coast will often sort them according to size and weight. As a result, in many places along the coast, deposits of uniform sized sands and gravels occur. Concentrations of useful mineral deposits may be increased by the same winnowing processes"[2]. Organic material settles to the bottom "where it quickly accumulates and the water and sediments become anoxic. In geological time, such deposits have produced and preserved oil and gas resources which are characteristic of the coastal zone"[3]. This is particularly applicable to

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[2]*Ibid, p. 7.*
[3]*Ibid, p. 9.*

estuaries and their flood plains since they are the most productive areas of the coastal zone. Unfortunately, most of Canada's estuaries are of post-glacial origin and only surficial deposits are of present economic importance as structural materials. The estuaries of a few rivers that occupy preglacial valleys are exceptions.

Transportation

Estuaries were the points where the international transportation network joined the domestic network, where ocean transport met river transport, goods from the interior being transferred from canoes, barges and river boats to ocean-going ships, and goods from abroad transferred from ships to river craft. Often the estuary itself provided a good harbour. Even though river transport has diminished in importance, other advantages of the estuarine location as a transport terminus often remain, including the harbourage protection and the ease of construction of land routes across the level land of the flood plain.

Terrain, climatic and recreational values

The relatively level nature of the terrain associated with deltas and flood plains is advantageous for urban development as well as for the construction of surface transportation arteries. While this level land frequently occurs in the flood plain and is thus subject to flood hazard, its structural value, as well as its proximity to riverine activities, have made estuaries unusually attractive locations for urban centres. Frequently these advantages combine with the more temperate maritime climatic characteristics and the inherent recreational opportunities to stimulate urban-industrial development along an estuary.

Limiting factors

Up to a point all of these advantages can be enjoyed concurrently. With increased utilization of both land and water, conflicts become inevitable and at some stage decisions regarding the optimum use of these natural facilities must be made. Sooner or later, depending on the capacity of the estuary, some actions will result in irreversible changes. Here lies the management problem.

Many European estuaries have lost all their natural capacity except as transportation arteries or virtual sewers. Inordinate sums are being spent to partially restore some of them. At what stage do Canadian estuaries reach this critical point? We do not know.

The importance of Canada's estuarine resources

A large proportion of the Canadian population lives on land adjoining estuarine areas. About 75 percent of the population of the Atlantic Provinces live adjacent to the fresh/salt water interface; in British Columbia, about two-thirds of the people live along estuaries; Québec City is situated close to the inland limit of the St. Lawrence estuary. These concentrations can be attributed in part to the access to international trade, in part to the available fish and game resources and recreational opportunities, and in part to the superiority of delta lands for building and agricultural purposes. On both coasts, estuaries are of critical importance to the maintenance of the nation's marine fisheries, and provide invaluable resting, feeding and nesting grounds for migratory birds and essential habitat for other wildlife.

The following section describes the resources of four Canadian estuarine areas and identifies the problems associated with their use. No two are alike in resources, development, size or condition of stress. In fact, a preliminary study of several dozen Canadian estuaries found none with near identical parameters, though many were approaching the stage of over-utilization, with few data to determine when their critical points might be reached.

III

FOUR CANADIAN ESTUARINE AREAS

The purpose of this section is to provide specific information which will illuminate both the importance of estuarine areas in Canada and the conflicts that arise over the use of their resources. Through this examination of selected estuaries - two on the east coast and two on the west coast - a basis is provided for assessing the reasons that difficulties are being encountered in estuarine management and for suggesting remedial measures. The four estuaries vary considerably in size, physical and biological characteristics and kinds of use. While they cannot be considered to constitute a representative sample, they are indicative of the nature of Canadian estuarine areas and the management problems they pose.

The Fraser Estuarine Area

The Fraser River enters the Strait of Georgia in the southwest corner of British Columbia (Figure 1). It is the largest river on Canada's west coast and drains an area of approximately 233,000 km^2. Its average flow is over 2,830 m^3/second. While salt water penetrates only a few kilometres upstream, tidal effects reach about 40 km from the mouth of the river to the vicinity of Mission.

The river has formed a delta that includes about 330 km^2 of alluvial lowlands. Three arms flow through this delta and in addition the southern portion of the delta is drained by two small rivers, the Nicomekl and the Serpentine. There are about 155 km^2 of tidal flats adjoining the Strait of Georgia known as Sturgeon Bank, Roberts Bank and a portion of Boundary Bay (Figure 1). These flats are maintained by the sediment discharged by the Fraser River which amounts to some 20,000 million metric tons annually.

Physical and chemical characteristics

Because of the moderating influence of the Strait of Georgia the waters of the estuary seldom freeze although they approach 0^{o} in January. During late summer water temperatures rise to between 21^{o} and $22^{o}C$. High oxygen concentrations, which are so important to fish, especially salmon, are typical of the estuary[4]. Levels are slightly lower in the estuary than upstream but are consistently near saturation. Counts of indicator organisms (coliforms) are higher than acceptable standards for a drinking water supply or swimming throughout the estuary[5].

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[4] Dorcey, A.H.J. *The uncertain future of the lower Fraser,* University of British Columbia Press, Vancouver, 1976, p. 23.

[5] Fecal coliform counts have ranged from 775 per 100 ml in the upstream end of the estuary through over 16000 in the North Arm opposite Vancouver to 880 at Garry Point at the estuary mouth. These reflect conditions prior to construction of the Annacis treatment plant. While it will reduce the count in the vicinity of Vancouver, it is not practicable to estimate the amount of the reduction. *Ibid., p. 26.*

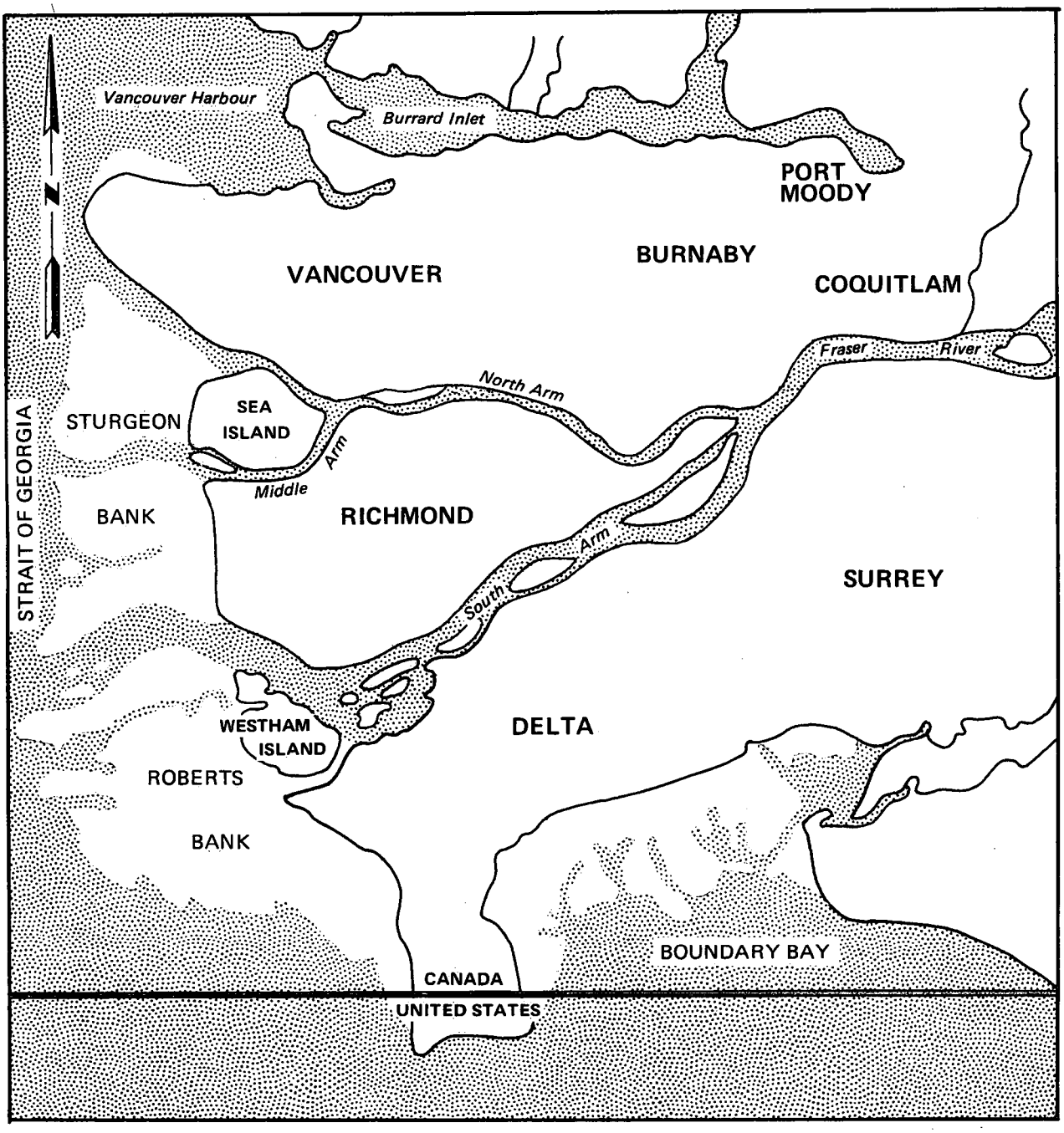

Figure 1

FRASER RIVER ESTUARY – DELTA

BRITISH COLUMBIA

Tests indicate that toxicity from trace metals increase in the estuary; chlorinated hydrocarbons and phenols are below detection limits[6]. The Fraser River carries a heavy load of suspended matter. While this loading reduces the attractiveness of the estuary, there is no evidence that it adversely affects salmon and other species of fish. In fact, it seems likely that the reduction in visibility reduces losses of young salmon from predation[7]. It has been estimated (1972) that about 65,000 m^3 of wood debris enters the estuary from upstream, and in addition over 131,000 m^3 of debris in the form of uncontrolled sawlogs originate from the industry within the delta[8].

The resources of the area

The physical characteristics of the estuary has provided the basis for a rich endowment of biological resources and a variety of potentials for human use.

The fishery resources of the Fraser estuary have always been of tremendous value. It is the migration route for the largest single salmon run in Canada and one of the largest in the world. Every hour of every day of the year, juvenile or adult salmon are moving along this thoroughfare (Figure 2). It is, however, much more than a means of movement between spawning ground and the sea. It is also a source of food. Detritus formed by decaying vegetation along the foreshore is carried out to sea and helps to feed the adult returning salmon before they take the long trip up river. The juveniles depend on a food chain based on this same source on their trip to the sea, when tens of thousands, especially chum and chinook, feed in the side channels of the marshes near the estuary mouth. Thirty-eight other species of fish utilize the Fraser estuary, including eulachon, surf smelt, cut throat and steelhead trout, white sturgeon, mountain whitefish and Dolly Varden. Herring spawn within the intertidal zone along Roberts Bank and Sturgeon Bank. Shellfish, including Dungeness crab and oysters, are an important resource of the estuary area but the oyster potential has been largely destroyed by pollution.

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6 Dorcey, *op. cit.*, p. 30.

7 Turbidity measured in APHA units ranges between 42 and 66. Benedict, A.H., K.J. Hall and F.A. Koch, *A preliminary water quality survey of the lower Fraser River system.* Technical report No. 2, Westwater Research Centre, Vancouver, 1973, pp. 28-30.

8 Fairbairn, B. and K. Peterson, *Controlling sawlog debris in the lower Fraser River,* Technical Report No. 5, Westwater Research Centre, Vancouver, 1975, p. 7.

Birds constitute the most visible form of wildlife in the estuary. At least 185 species are known to frequent the area. Waterfowl of three continents follow the Pacific flyway and converge at the Fraser wetlands on their way to and from breeding and wintering areas that extend from the U.S.S.R. to South America. Two million ducks, perhaps five million shorebirds, and thousands of other species of birds migrate annually through the area. In addition, some 250,000 ducks, 20,000 snow geese, and a million shorebirds remain to winter on the tidal marshes and agricultural lands of the Fraser Valley. The wetlands of the area support a variety of mammals including muskrat and river otter, seals enter the estuary to feed, and upland areas originally provided habitat for deer and elk as well as many small game[9].

The estuary is sufficiently deep and wide to serve the needs of a major waterway. Large ships as well as small craft move along it and utilize it for protection and transfer of cargo. Since the river carries a heavy sediment load, it is not a good source of domestic water, though it is quite satisfactory for many industrial purposes. The bed of the estuary is an excellent source of sand and gravel.

The delta lands are rich, and even the wetlands, when drained, are good for agriculture. The relatively level terrain simplifies the construction of roads and airports, commercial establishments, industrial facilities and residences. Without protective measures, the delta is subject to severe flooding.

Development and use of estuarine resources[10]

The rich resources of the estuarine area have been extensively developed and utilized. The salmon that use the Fraser estuary are harvested by both American and Canadian fishermen. They constitute the backbone of the commercial fishing industry in southern British Columbia and support an enormous amount of sport fishing activity. It is estimated that the annual income from these activities in British Columbia exceeds $200 million. Large quantities of herring, from 11,000 to 40,000 tons per year, are harvested in the southern part of the Strait of Georgia. Dungeness crab is important both commercially and as the basis for a recreational crab fishery.

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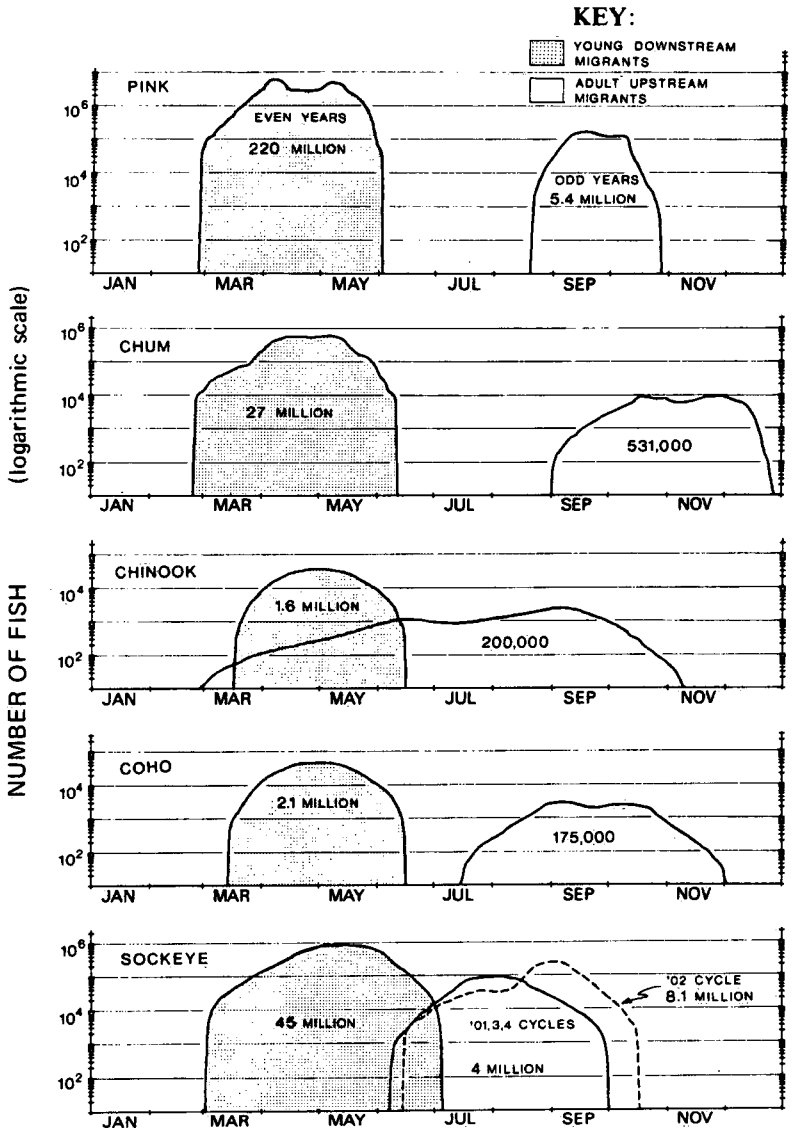
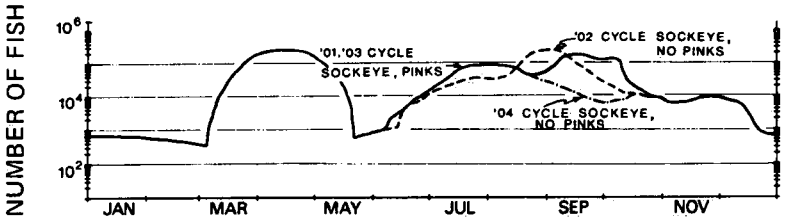
9 The foregoing discussion of biological resources is based on Northcote, T.G., *Biology of the Lower Fraser River*, Tech. Report No. 3, Westwater Research Centre, U.B.C., May, 1974.

10 This section is drawn largely from Hoos, L.M. and G.A. Packman, *The Fraser River Estuary, status of environmental knowledge to 1974*, Environment Canada, Ottawa, 1974.

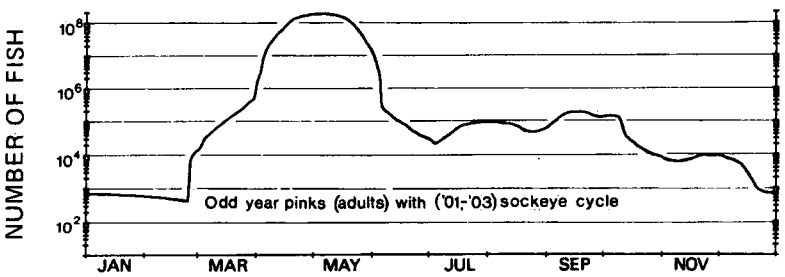
AVERAGE SEASONAL USAGE BY PACIFIC SALMON



AVERAGE SEASONAL USAGE BY ADULT UPSTREAM MIGRANTS, ALL MAJOR SPECIES



AVERAGE TOTAL SEASONAL USAGE, UPSTREAM AND DOWNSTREAM MIGRANTS, ALL MAJOR SPECIES



Waterfowl are hunted extensively; recreational hunting was estimated to have a value of nearly $1.5 million in 1971. Wildlife observation is growing in interest; some 60,000 persons annually visit the Reifel Sanctuary on Westham Island near the mouth of the main arm of the estuary.

The arms of the estuary have become major transportation arteries. The forest industry moves rafts of logs to mills located on the estuary and stores thousands of them in estuarine waters while awaiting use. About a half billion cubic feet of logs are moved along the estuary each year[11]. Dockage facilities along its banks are used by ocean-going ships for transhipment of cargoes. In 1973, about 3.7 million tons of cargo moved through the Fraser River harbour facilities. Fishing fleets moor in the estuary and recreation craft make use of numerous marinas.

A variety of industries (forest products, chemical, mineral and fish processing, etc.) are established along the estuary and use the water as a source of industrial water supply and as a receptacle for effluent. Most of the sewage effluent from the Greater Vancouver Region is discharged to the estuary. Sand and gravel for construction purposes are dredged from its bed.

Delta lands, which often required extensive drainage and dyking to control floods, were developed for agriculture by the early settlers. As the Greater Vancouver Region grew, agricultural purposes gave way to urban-industrial development, including highways, railroads and airports. The Vancouver International Airport is located on Sea Island at the estuary mouth.

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[11] Fairbairn, B. and Ken Peterson, *op. cit.*, p. 8.

Figure 2 (opposite)

Cited in Westwater, *Notes on water research in western Canada*, No. 7, 1974. Taken from Northcote, T.G., *Biology of the Lower Fraser River, op. cit.*, pp. 71,73.

Resource use conflicts

The development and use of the Fraser estuarine resources have not taken place without differences arising about what constitutes the most appropriate use. Furthermore, there is widespread concern today that the resources are being degraded in a manner that could result in a substantial decline in the benefits from these resources.

A major concern is the loss or impairment of aquatic habitat. Flood control and land reclamation, as well as the construction of docks and wharves, have greatly reduced the marshland along the estuary. It is reported that 70 percent (220 hectares) of former salt marsh, about 30 percent (6,260 ha) of former tidal fresh water marsh and nearly all (80 ha) of other flooded habitat has been lost by dyking alone[12].

Aquatic habitat is also being modified in other ways. Dredging, training walls and jetties alter the physical characteristics of the waterway and modify water velocities and sediment deposition patterns. Dredging activity can directly affect fish, especially the juveniles. Pollution is a major source of concern. The oyster fishery in Boundary Bay that once supplied half of the province's oyster production has been closed because of pollution. In the main channels of the estuary and at the mouth of the North Arm, there is evidence of increasing amounts of toxic materials residual in aquatic organisms.

The drainage of wetlands has greatly reduced available waterfowl habitat and consequently their populations have declined. Both agricultural and urban-industrial development have reduced the habitat for other wildlife. Legislation has been introduced in British Columbia to prevent unwarranted encroachments on agricultural land, but the pressures remain to convert this land to urban or industrial uses.

As a result of this urbanization, a number of conflicts have been intensified. Waterfowl that utilize wetlands and foreshore areas feed upon farmers' crops. Water pollution adversely affects recreation and wildlife as well as fisheries. Demands mount to reserve more land and water areas for recreation purposes, and naturalists seek more sanctuaries and a reduction in wildlife areas open for hunting.

The management problem

Much of the natural environments of the Fraser estuarine area has been destroyed and cannot be reestablished during the foreseeable future. Those parts which have been degraded could be regenerated if remedial measures were instituted. Yet the Fraser estuary is so large and

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[12] Romaine, M.J., et al., (eds). *An environmental impact assessment of the Vancouver International Airport Expansion Proposals*, p.6.

resilient that it retains substantial potential for supporting the original natural communities of its land and water. Future resource use decisions should balance carefully the benefits from conserving and enhancing the natural estuarine ecosystems against the benefits of development that further modify them. A wise appraisal must take into account the eventual limitations of an estuary even as large and resilient as the Fraser.

It is essential to recognize that the uses being made at present of the Fraser estuary contribute benefits of some type to the people of Canada. The question is whether these benefits exceed forgone benefits from uses precluded by current activities. Have the trade-offs been weighed carefully enough? Has account been taken of long range effects as well as of more immediate returns? The fundamental question in the Fraser estuarine area is whether the resource allocation process assesses the effects of alternative uses before irrevocable courses of action are taken.

The Squamish Estuarine Area[13]

The Squamish River estuary is located at the head of Howe Sound about 64 kilometres northwest of Vancouver (Figure 3). The river system drains a little over 3,600 km^2 and near its mouth it has a mean annual flow of 270 m^3/second. Thus its drainage area is only 1.5 percent of the size of that of the Fraser and its mean flow is only about 12 percent as great. The Squamish delta is also relatively small, embracing a little more than 40 hectares. Being much less important than the Fraser, fewer data are available on its resources and their current use and condition. Nevertheless, available information is indicative of the problems faced in managing the resources of smaller estuarine areas on the coast of British Columbia.

Physical and chemical characteristics

In general, *dissolved oxygen* levels are at or near saturation most of the year. Data on bacterial pollution is scanty but *coliform counts* are likely relatively high. Specific data on *toxicity* is unavailable, though it is evident that a mercury contamination problem exists. Turbidity is relatively high but not as high as the Fraser.

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[13] The descriptive material in this section is drawn primarily from L.M. Hoos and C.L. Vold, *The Squamish River estuary, status of environmental knowledge to 1974*, Environment Canada, 1975.

The resources of the area

The Squamish, like the Fraser, is a salmon stream which supports a significant commercial and sport industry. Estimates for 1972 indicate the annual income from this fishery total over seven million dollars. As with other salmon streams, the estuary is an important transition zone and feeding area for the migrants. In Howe Sound, off the estuary mouth, are populations of shrimp, clams and crabs but these are not being commercially exploited because of pollution.

Some waterfowl use the estuary as resting and wintering grounds. It lies between the large waterfowl areas in the Pemberton Valley to the north and the Fraser estuary to the south and serves as a resting ground for birds moving between these two areas. A noteworthy aspect of bird life in the Squamish estuary is the large number of bald eagles which feed on dead salmon floating downstream. Sightings of 60 to 70 per day of these magnificent birds are not uncommon at the confluence of the Cheakamus and Squamish rivers. Mammal populations appear to be small. The harbour seal is a common resident of the estuarine waters.

The location of the estuary at the head of Howe Sound makes it a convenient point of access to the timber and mineral resources of the interior. The forestry resources of the hinterland are particularly substantial, and the flat delta lands have potential for development as a major port for shipment of forest products to other parts of the country and abroad. While there is some agriculture practiced in the Squamish Valley, the amount of land area associated with the estuary that could be utilized for agricultural purposes is relatively small.

Development and use of estuarine resources

The earliest development, which occurred in the latter part of the 19th Century, involved dyking part of the delta and its use for pasture and hay. The town of Squamish (population 8,368 in 1976) was built on the flood plain (Figure 4) and in 1909 a railroad was built from the delta 24 kilometres north to facilitate the transport of logs to the estuary either for milling in the area or for rafting to Vancouver mills. The major industries situated in the estuarine area are sawmills and a chemical plant. A pulp mill is located at Woodfibre, a short distance beyond the mouth of the estuary.

Port development has had the greatest impact upon the natural condition of the estuary. In 1970, the first stage of a deep sea port was begun. A dock and forest products storage area with approaches was built on the seaward edge, with the approaches blocking the movement of water across the east delta. A training wall was built down the central delta

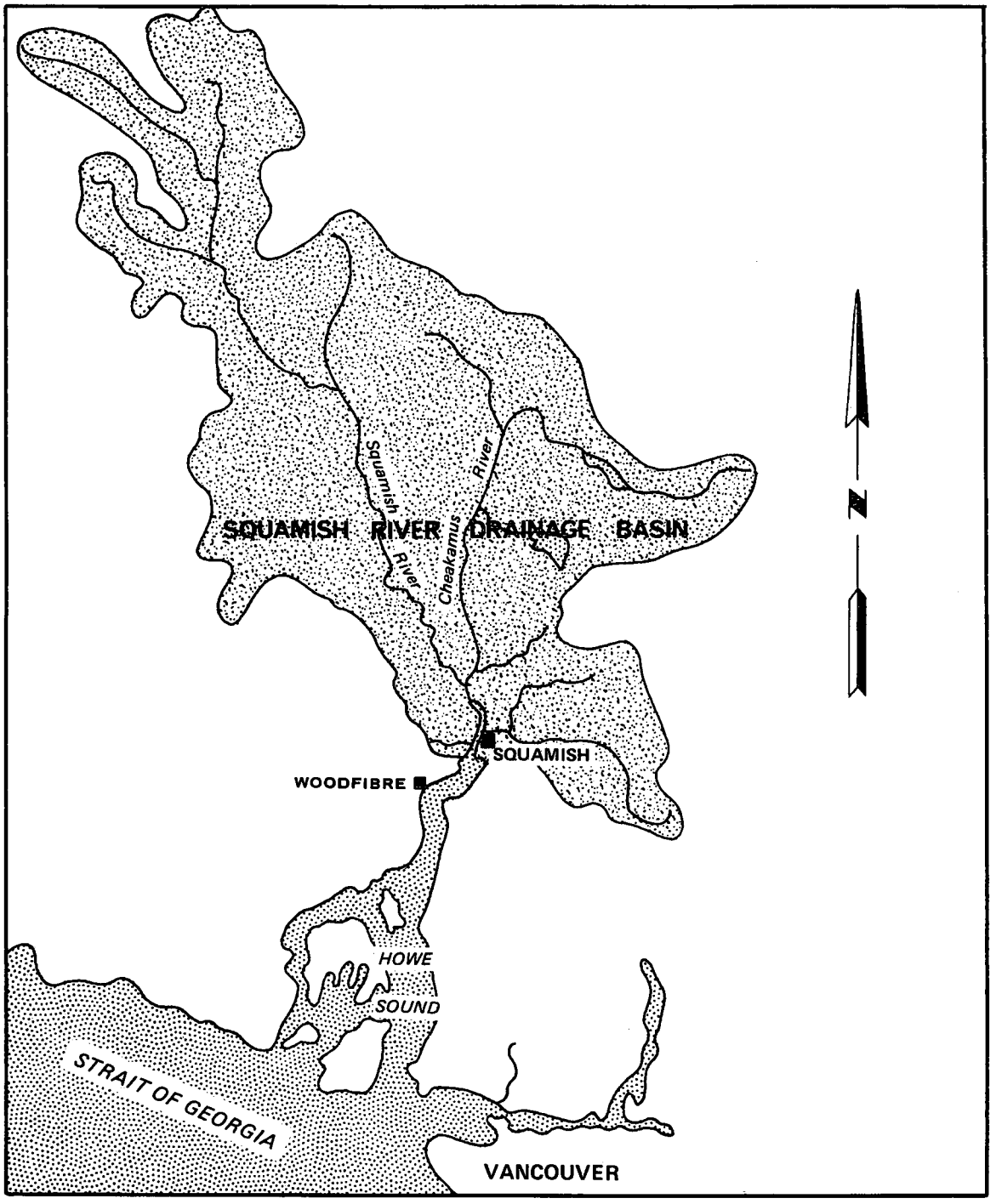

Figure 3

SQUAMISH RIVER DRAINAGE BASIN

BRITISH COLUMBIA

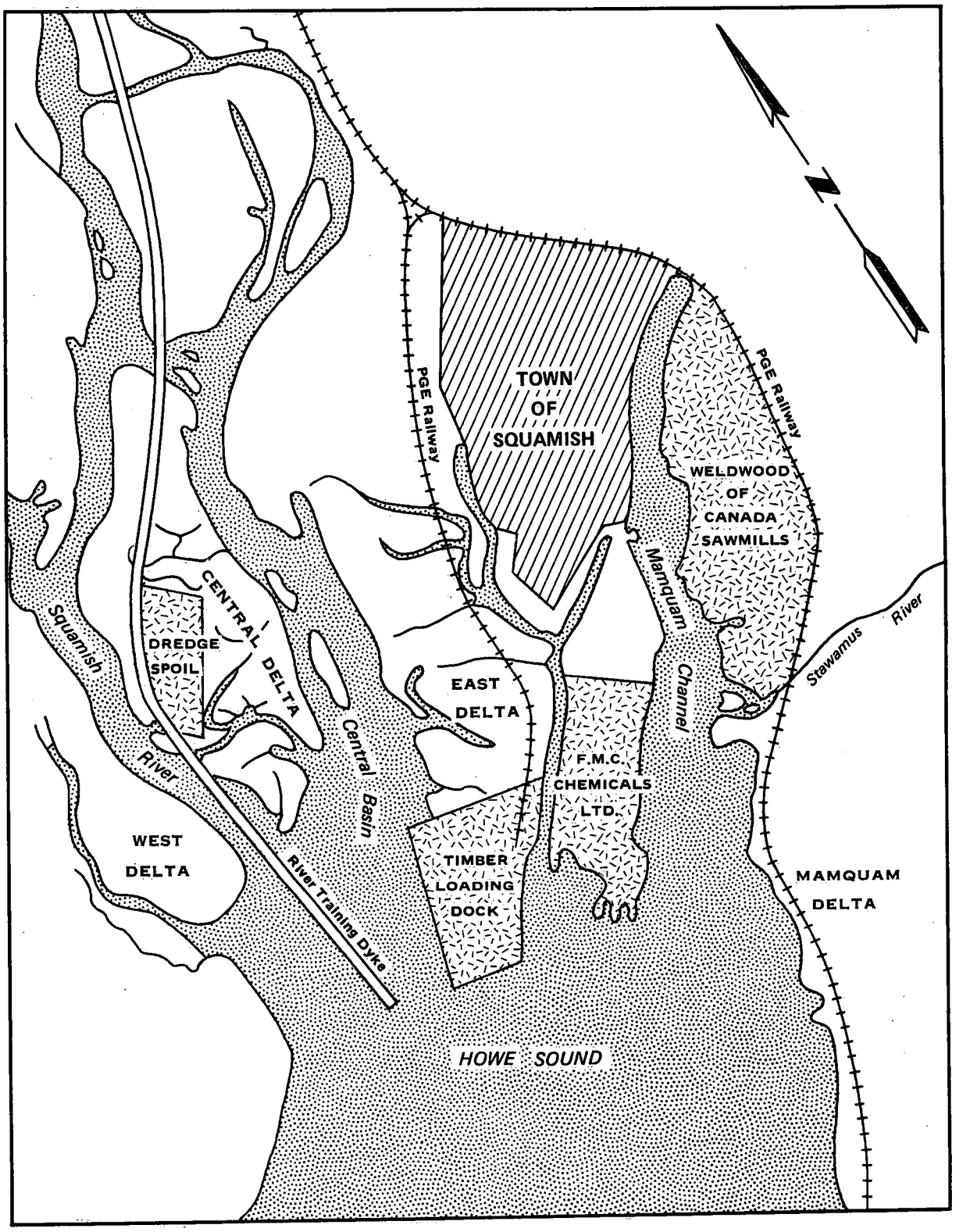

Figure 4

SQUAMISH RIVER ESTUARY – DELTA

BRITISH COLUMBIA

blocking freshwater flow to the east arm of the Squamish River and training the river to the western side of the estuary. Material dredged from the west delta and from the river created 14 hectares of sand fill on the central delta, preparatory to construction of a coal storage dock and loading facility[14]. A 110 metre wide channel was dredged to a depth of 1.5 metres for a distance of 1650 metres north of the river mouth. This channel is used for barge traffic serving the forest industry.

Further development of the port has been proposed. It has been seriously considered as an outlet for the export of British Columbia coal. A bulk terminal involving about 28 hectares of intertidal land and an adjoining 12 hectares of deep sea berths would be required for this purpose, as well as a railyard expansion which would take up 22 hectares of intertidal and flood channel area. In addition, it has been proposed that deep slips for large ocean-going vessels be provided to expand the port facilities available to the forest industry.

Resource use conflicts

The most serious conflicts in resource use stem from dyking, port development and log storage and transport. Pollution of estuarine waters by industry also poses a significant problem. All of these actions impact upon the biota of the area and have serious consequences for the fishery resources and for the birds that tend to utilize the area.

It is difficult to specify precisely what the environmental effects of port development have been. The training dyke has increased the velocity of stream flow; the two barge berths required 17 hectares of land; the dredging of the channel and the landfill reduced the intertidal zone and created a narrow deep estuary. These changes have seriously altered the local biotic communities and biologists estimate that the proposed expansion of the port facilities could have disastrous effects upon the estuarine fish populations. The intertidal area proposed for reclamation plays an important role in the food web. It is a major source of organic matter for phytoplankton and zooplankton of the outer estuary which in turn are important components of the food supply of higher species. Without this source, it is feared that fish populations not only would decline but might completely disappear. In addition, there is some anxiety that further deepening of the channel would release sediment-bound wood debris, increase turbidity and thus further reduce phytoplankton growth.

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[14] Levings, C.D., *River diversion and intertidal benthos at the Squamish River Delta, British Columbia,* Proc. Symp. on the Influence of Freshwater Outflow on Biological Processes in Fjords, 1974.

Log storage and transport result in the deposit of bark and chips on the bed of the estuary and intertidal areas. Leachates from this material alter the chemical quality of the water. These changes, particularly the former, can greatly impair the biological productivity of these waters. There are no data to indicate how serious an effect upon productivity log storage and transport have had but it is evident that substantial areas have been affected.

Sewage treatment plants and the chemical and forest products industries discharge effluents to estuarine waters. No data are available to indicate the effects of sewage discharges, but in 1970, it was discovered that many organisms, including the Dungeness crab, contained high mercury levels. The source of this contamination was found to be a chemical plant located on the Squamish delta and although the discharge of mercury has been substantially reduced, Upper Howe Sound is still closed to all harvesting of shellfish and ground fish.

The management problem

The Squamish estuarine area is experiencing resource conflicts similar to those found in the Fraser, namely incompatabilities arising from existing or potential damages to fish and wildlife resources caused by port development, log storage and transport, and pollution. The question is whether these economically beneficial activities can be accommodated without causing irreversible damage. If not, do the benefits exceed the damages they cause? Under existing decision-making processes, the results of a choice may not be carefully weighed.

The La Have Estuarine Area

The La Have estuary, on the south coast of Nova Scotia, is 17.5 km long and up to 600 m in width (Figure 5). Practically the only drainage is from the La Have River, 88 km in length, which has a drainage area of nearly 1,400 km^2. Mean annual flow is 43 m^3/second, and high flow, in April, is over 128 m^3/second. A narrow navigational channel of about seven metres depth is maintained to Bridgewater near the head of the estuary, which otherwise varies from 20 metres in depth at its mouth to two metres at Bridgewater. The waters are largely ice-covered from late December to March. Tidal influence extends to Bridgewater, but its effect drops off sharply about halfway up the estuary, with flocculation and deposition of fine suspended material occurring over a relatively short distance. The flocculation zone moves seaward during periods of high river flow.

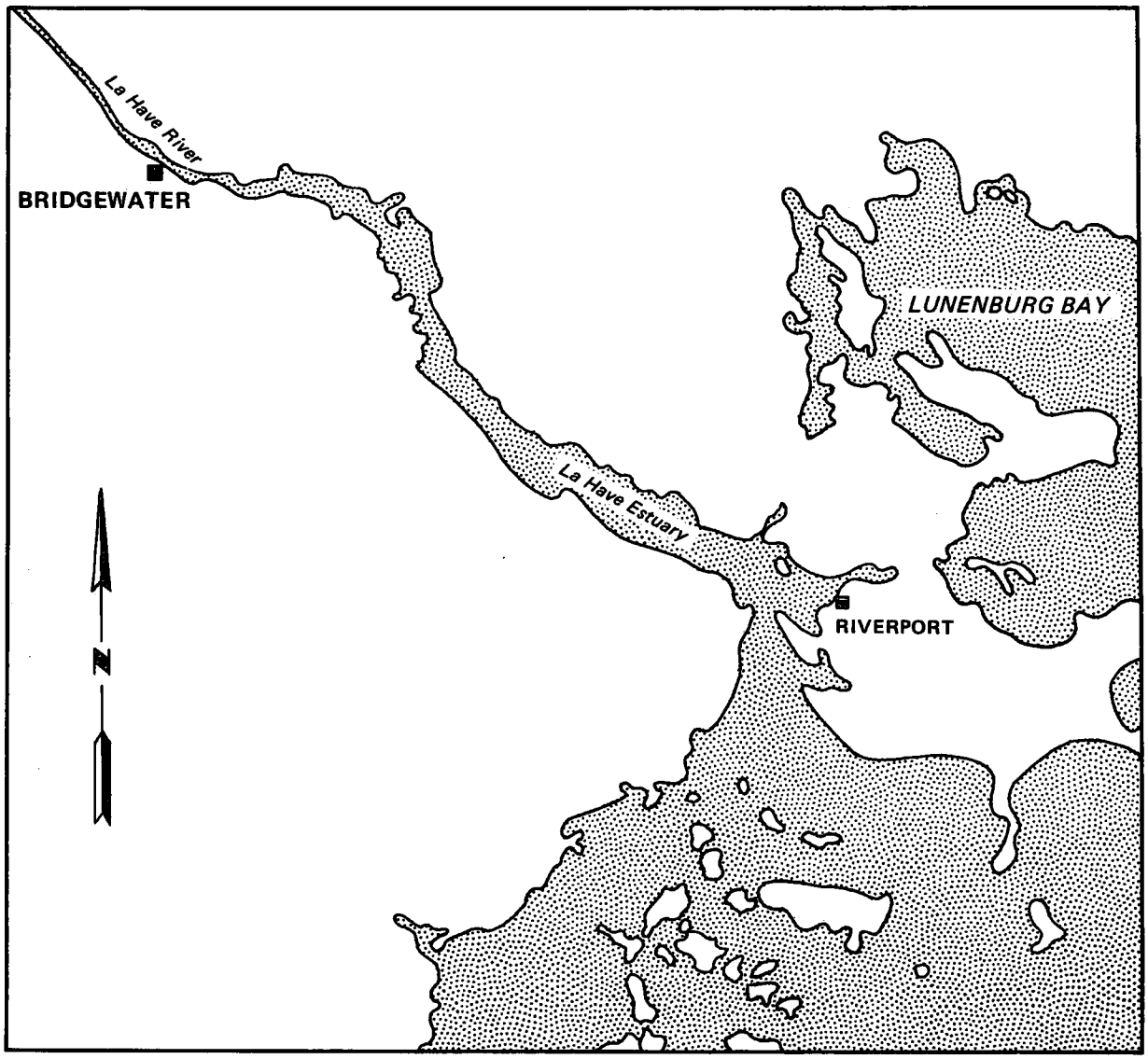

Figure 5

LA HAVE ESTUARY

NOVA SCOTIA

Physical and chemical characteristics

Surface water *temperatures* vary from 0°C to 20°C, bottom temperatures from 2°C to 16°C. *Dissolved oxygen* is high throughout. The river water is highly coloured, has a pH of 6.3-5.9 and a *hardness* of 5-8mg/*l* (Ca CO3 equivalent), with maximum hardness during periods of minimum flow. Bottom *salinity* in the estuary remains fairly constant at about 30 parts per thousand, while near surface salinity under high flow conditions range from 2-16 parts per thousand, under low flow from 25-30 parts per thousand.

The resources of the area

Considerable agricultural land exists along the river valley and on the shores of the tidal zone. Forests cover the balance of the drainage area. No producing mines are located in the estuarine area, but the bedrock largely consists of slates and quartzites known to contain many small deposits of gold and tungsten, with occasional concentrations of other heavy metals. Occasional remnants of younger sedimentary rocks underlie much of the farmland.

The salmon and trout spawning grounds of the La Have River are utilized by sport fishermen. An annual gaspereau spawning sees upward of a million fish crowding the waterway each spring.

In the early days, the estuary was important for shipping, but apart from recreational vessels, it is now used primarily by oil barges. Roads and railways connect with Bridgewater and along the coast and river.

Development and use of estuarine resources

Mixed farming is carried on along the lower river valley and the estuary shores. Otherwise the land use is restricted to timber and pulp cutting, with some local sawmills and secondary industry based on the lumber produced. The only economic use of the estuary as a transport artery is by oil tankers several times a year with loads of 400-500 tons. Lumber products are now moved by rail or truck. The lower estuary is used by fishing vessels mainly based at Riverport and some pleasure craft also make use of the estuary.

Salmon, gaspereau and sea trout are the principal species which enter the La Have River system in order to spawn. Between 1971 and 1974, some 175,000 hatchery reared smolt and parr were released in the river. Data are not available for the returns since 1973, when several hundreds were recorded. Gaspereau passage is estimated at some 750,000 during spawning

season. Sea trout are numbered in the low hundreds only. Considerable effort is being devoted to improving fishways and river passage to extend the spawning grounds to the upper reaches of the river. Data are not available on quantities of groundfish, crustaceans or shellfish caught in the estuary, but an important fishery is based upon several banks immediately outside. No studies appear to have been made of the role of this estuary as a nursery or as a bird nesting area.

The population of the area is over 10,000, two thirds of which is concentrated in the town of Bridgewater. Sailing and pleasure boating are the chief recreational uses, there being numerous summer homes along the estuary and at least one yacht club. There are several small manufacturing plants geared to the needs of fishermen or based on the forest resources, and one major tire manufacturing plant was established in 1971.

Resource use conflicts

The decline in shipping during the past half century has more or less balanced increased population along the estuary so that total pollution tends to have remained constant. The effect of the tire manufacturing plant, which doubled water intake from the river and almost doubled the effluent discharge, has been monitored closely. Bridgewater discharges 1.3 million litres of untreated sewage daily, while Michelin Tire discharges 840,000 litres of filtered and clarified effluent from which heavy metals have been precipitated. Runoff from farms, highways and logging operations has not been measured.

There are significant amounts of copper and zinc in the sewage discharge of Bridgewater and of zinc in the effluent of Michelin Tire factory. However, concentrations of these metals in estuarine waters are less than one tenth of incipient lethal levels. It is not known whether these concentrations would have long term toxic effects. High mercury levels have been found in the bottom sediments of the estuary but the source of this mercury has not been clearly established, though some appears to come from the sewage discharge of the town of Bridgewater. Effluent from a paper mill and its settling pond, from a smelting plant and from a fertilizer plant have been checked but while some mercury has been found, the quantities discovered do not account for the amounts accumulating in the sediments. No studies have been made to determine whether significant quantities of heavy metals are accumulating in the tissue of fish and other biological organisms found in the estuary.

The Management Problem

In contrast to the Fraser and Squamish, the La Have estuary is under little pressure for further development at the present time. While the effects of existing waste discharges are not fully understood,

current levels of pollution do not appear serious and there are no immediate prospects of significant increases. Nevertheless, the high mercury levels in bottom sediments are disturbing and indicate the need to identify the source of this pollution.

While there are no urgent problems requiring attention, several issues need to be addressed, especially if any increased use of the estuary should occur for industrial purposes. It would be prudent to determine whether existing levels of heavy metals are likely to have any long term adverse effects upon the fishery resources of the estuary; if so, methods of control must be devised. Certainly developments should not be permitted that will disturb the bottom sediments because this could release the mercury and possibly increase mercury pollution to dangerous levels. Finally, the question of whether Bridgewater should continue to discharge untreated sewage to the estuary should be carefully examined. What hazards do such discharges create and are they sufficiently great as to justify investment in treatment facilities?

The Miramichi Estuarine Area

Physical characteristics

The Miramichi estuary, some 420 km^2 in area, is funnel-shaped with an ocean frontage of 22 km on the east (Figure 6). Access to the sea is blocked over three-quarters of its extent by a sand bar beach extending south from the north margin, and by three sand bar islands. Two navigable channels exist, the northerly one between the bar beach and Portage Island, and the southerly between Portage Island and Fox Island. Narrow openings, not navigable, occur south of Fox Island. Water covered sand bars lie east of the island and pose some navigational difficulties. A navigation channel of 6.5 m depth is maintained to Newcastle, more than 80 km from the estuary mouth. Tidal effects extend over 80 km upstream. Mean tidal range is 1 m, with spring tides to 2 m upstream or 1.6 m near Portage Island.

The drainage area includes the valleys of the N.W. Miramichi River and the S.W. Miramichi River and their tributaries, covering 11,300 km^2, together with the basins of smaller streams entering from both north and south of the estuary, for a total of 13,700 km^2. Average flow is estimated as 270 m^3/second, with a high of 800 m^3 in May and a low of 82 m^3 in February.

Offshore currents are generally north to south. It is estimated that 100,000 tons of material are moved each year. A clockwise counter current is apparently responsible for the offshore shoals. Distribution

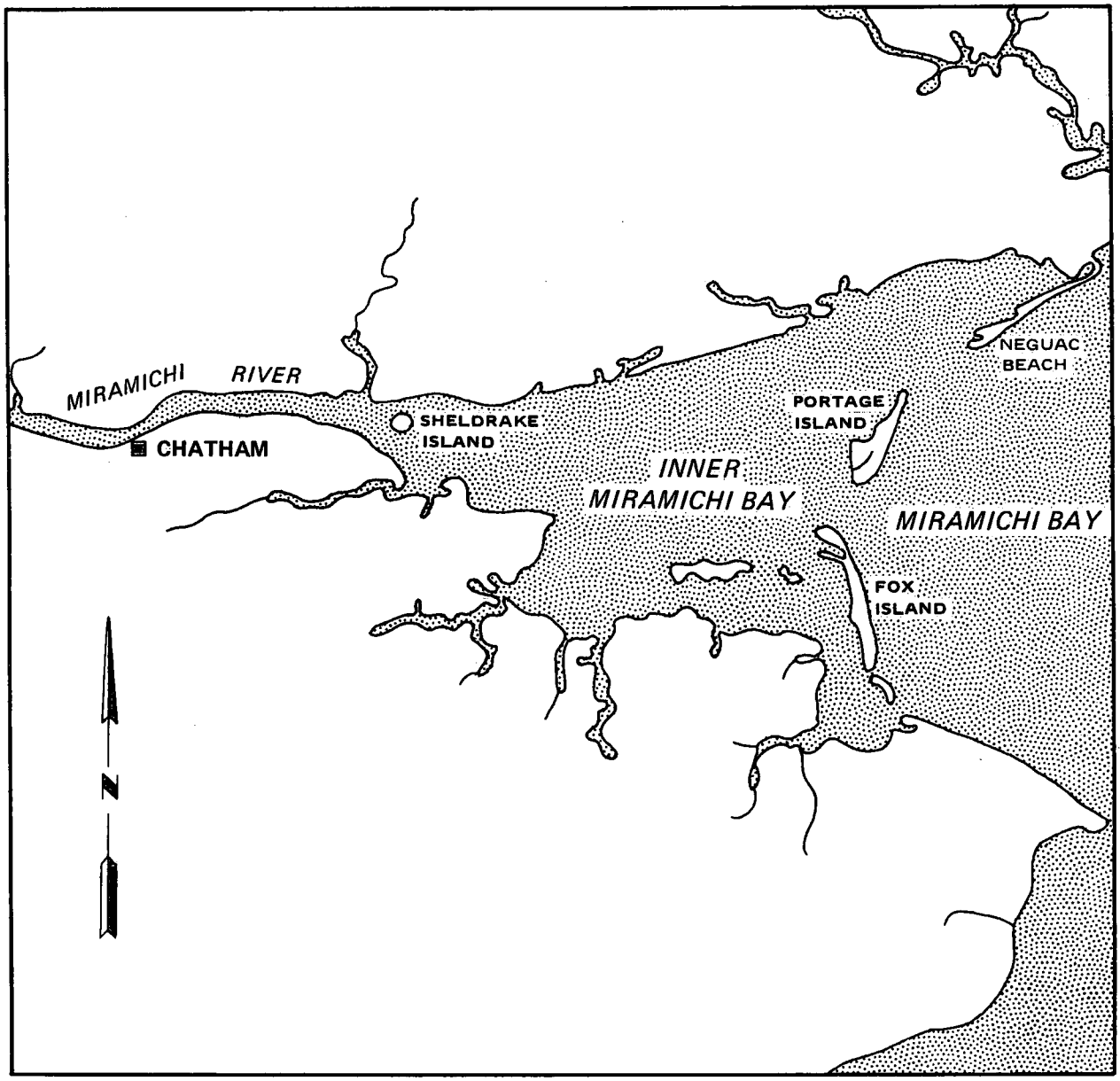

Figure 6

MIRAMICHI ESTUARY

NEW BRUNSWICK

of sediments within the estuary shows the effect of flocculation at the salt/fresh water interface with zones of fine silt where interface precipitation is dominant. Combined tidal, wind and current movements result in unsorted sand, silt and fine gravel covering the balance of the area. Vertical salinity gradients are marked along the channels, with differences of 5% to 10% between upper and lower water levels. Otherwise salinity grades from 3% at the tidal limit to 27% at the estuary mouth. Ice cover is usual from December to April. Dissolved oxygen may be critically low during periods of low water over much of the estuary.

Resources of the area

This estuarine area is biologically the most productive portion of New Brunswick's east coast. The Miramichi is a noted salmon stream, with both sport and commercial fishing industries. Smelt, tomcod, gaspereau, eels, flounder, herring, mackerel, shad and striped bass are commercial species. Crabs, lobsters, oysters, clams, mussels and quahogs abound. Irish moss is harvested.

Agricultural possibilities in the valley are moderate. Forest resources have been the mainstay of the inland area. These are now supplemented by base metal mining within the watershed. While the natural waterway is too shallow for large ships, and entrance to the estuary is narrow, it is capable of handling ships of up to 5,000 tons. It provides an ideal base for fishing craft. The comparatively warm waters make it excellent for summer recreation.

Development and use of estuarine resources

Newcastle is one of the more important New Brunswick ports, served by some 140 ships each year which carry 600,000 tons of cargo of which about half is for export. Chatham is much smaller with about 30 vessels, all in coastal trade, carrying 100,000 tons each year. The 6.5 m channel limiting depth necessitates the use of relatively small ships, resulting in considerably higher freight rates for export business than would be the case if larger ships could be used. The largest ship to call regularly is about 7,000 tons, and its maximum load appears to be about 5,500 tons. A recent North East New Brunswick transportation study indicates that the reduction in costs would be from $4.50 per ton(to Western Europe) to $2.20 per ton if 15,000 ton ships could be used. It is difficult to estimate the value of this shipping to the local economy.

Approximately 350 fishing boats are based in the estuary, manned by 650 fishermen. Obviously this represents an important segment of the regional economy. Use by pleasure craft is normal for the Atlantic seaboard, the tourism value being largely based on upstream salmon fishing.

A wide variety of fish, shellfish and crustaceans are caught in the estuary. Salmon and shad commercial fishing is at present banned in an effort to build stocks, but smelt, tomcod, gaspereau, eels, flounder, herring, mackerel and striped bass are taken commercially. Crabs and lobsters are important as are oysters, softshell clams, mussels and until recently, quahogs. Total value ran about $2,000,000 per year, but has dropped because of the salmon ban. Irish moss is also harvested in quantity, with an annual value ranging up to $900,000.

Fishing catch has been far from consistent. The peak year for salmon, just prior to closure, was over 800,000 pounds worth nearly half a million dollars. Lobsters have dropped from 1.5 million pounds in 1952 to a relatively constant 600,000 pounds during the past few years. The big drop is to the south of the estuary and it has been theorized that dredged material, dumped offshore and carried south by currents, has harmed lobster breeding grounds at the entrance to the estuary. Smelt fishing value is relatively constant at slightly below $100,000. Cod, mackerel and gaspereau each contribute an amount in the tens of thousands. Eel production has increased and is now worth over $30,000 annually. Oysters were hit by the Malpeque disease in 1955 with their value dropping to negligible from $175,000 per year. During the last few years the resistant types are coming back and their value in 1975 was some $39,000. Important new oyster potential is anticipated in various parts of the estuary where fishing has not yet been resumed because of pollution. Value of clams and mussels stay relatively constant at $40,000 to $9,000 respectively. Sea trout are largely caught by anglers above the estuary proper. There is undoubtedly a large unreported catch of some species, either by poaching in off seasons or by individuals for their own use.

Apart from oyster culture, no effort seems to have been made to maximize the carrying capacity of the estuary, although closed seasons and fishing bans on diminishing species serve as conservation measures.

By far the largest portion of the annual forest harvest is processed at mills near the head of the estuary. Probably half the population in the estuarine area is dependent on some of the forestry industry.

Mining operations in the Miramichi watershed commenced in 1954 and have since that date contributed significantly to the economic base of the area.

Much of the Miramichi water is leased to individuals or clubs for salmon fishing. The resultant tourist influx is a source of income for guides, provisioners, and transportation vendors.

Resource use conflicts

There are two major areas of conflict with regards to use of the estuarine resources. One, *pollution*, is a constant threat and has necessitated closing of large areas with shellfish potential. The other, *dredging* to enhance shipping facilities, has been a minor threat to date, but plans for developing a new eight metre channel as far as Newcastle could seriously alter the aquatic environment of the estuary.

Pollution in the estuary comes from several sources. Pulp mills are responsible for at least 30 tons of suspended solids per day, estimated as 50% of the total load. Mills also discharge a heavy load of resin acids. As critically low dissolved oxygen levels exist during times of low river flow and high temperatures, this load with its BOD demand is serious.

Weathering of development rock at a major base metal mine in the Miramichi drainage area was a problem for some years due to leaching of Cu and Zn. Fortunately pulp mill acid discharges declined in toxicity rapidly and salmon were able to avoid any undesirable concentrations. Discharge water from the mine is now at least as pure as the intake water and is monitored constantly.

Bacterial pollution from the larger municipalities necessitated closing of large areas to shellfish production. Treatment facilities installed during the past six years are alleviating this condition. High concentrations of pesticides could be expected from regular spraying for spruce budworm. In actual fact, the bottom sediments contain less DDT than is the norm for Northumberland Strait.

It is remarkable, for an area so dependent on commercial and sports fishing, that there are no systematic water quality data over a significant time span, nor does there appear to be information on the effect of heavy metals on shellfish, closed areas being due entirely to coliform bacteria count. It must be assumed, however, the reduction in the toxicity of waste discharge from each source, the overall pollution level has declined. On the whole, geochemical changes do not appear to have had a significant effect on fish or shellfish populations, but there has been a significant drop in lobster populations along the coast to the south of the estuary as compared to the north. The decrease has been attributed to locating soil dumps from dredging at points where south-moving currents carry the material over lobster breeding grounds rather than to chemical changes in water quality.

Dredging now being considered could drastically alter the biological productivity of the estuary. Studies by engineering and economic consultants concerning the transportation problems of northeast New

Brunswick show that there is a decided economic advantage to the area by opening and maintaining an eight metre channel to Newcastle, permitting the use of 15,000 ton ships for handling pulp and metal concentrates. If dredging costs $6,000,000, annual maintenance $600,000, and environmental problems can be solved, a saving of $15.2 million over the next 20 years is postulated. Should such a channel be opened, at least one of the pulp mills can step up production by 25%. Additional mine production, with concentrate shipments through Newcastle, is also planned but does not appear to be dependent on the deeper channel. Cheaper freight rates would, of course, be an economic incentive for such production increase.

The next least costly alternative would be to neglect Newcastle entirely for export shipments, concentrating all major traffic through Belledune where a 10.6 m water depth is available without dredging. This routing would involve road transport of more than half a million tons of cargo from the Newcastle area to Belledune, a distance of about 113 km, but would save up to $6.7 million over a 20 year period, as compared to the present situation.

In other words, dredging of the estuary to Newcastle would result in a net economic return of $15.2 million over the next 20 years whereas use of Belledune would provide a net return of only $6.7 million over the same period.

The management problem

Federal and New Brunswick governments are jointly sponsoring the studies on transportation in northeast New Brunswick, the Miramichi River Navigational Channel study, and studies of the sediments in the estuary. For the two former studies, a steering committee, chaired by the Ministry of Transport, and a working group chaired by the Department of Public Works, were established. Fisheries were specifically excluded from these studies. Staff from the Bedford Institute undertook physical and chemical studies of sediments, and some of these results were incorporated in the navigational and transportation reports.

There would seem to be a lack of full coordination of all aspects which would have a bearing on the future of the Miramichi estuary. Transportation has been studied as an entity, with benefits to the local economic structure of shipping from estuarial ports stressed to the partial exclusion of other considerations. Dredging costs and feasibility have been more thoroughly studied, both in the field and by an elaborate model at the National Research Council in Ottawa. The effect on local fisheries of such dredging, and the possible detriment to coastal fisheries south of the estuary if the spoil is dumped into Northumberland Strait has not been calculated. It is assumed that movements of migratory fish will not be hampered significantly.

Water quality data are very sketchy. Though extensive shellfish areas are now closed because of high coliform counts, plans to eliminate such contamination seem to have been neglected. Technical personnel in both the provincial and federal Departments of Environment believe that conditions are improving but lack the resources to ensure that this will continue. According to the provincial Department of Fisheries, no data have been assembled concerning the management of spawning species in the Miramichi waters.

The Miramichi is an estuary which urgently demands an integrated resource management effort. The reported economic advantages of deepening the estuary for navigation purposes must be carefully weighed against the possible adverse effects upon the fishery industry, tourism, and the biological environment in general. Pollution problems are evident but a great deal of uncertainty shrouds the question of how serious pollution actually is and the most appropriate means of controlling it. Existing investigative and planning efforts appear uncoordinated and inadequate. Some means of mobilizing the energies and resources of federal, provincial and local governments to address these problems in an integrated fashion is urgently needed.

The Four Estuaries: Some Implications

The four estuaries that have been described illustrate both the importance of estuarine resources and the nature of the problems being encountered. While they differ widely, some important implication for management can be drawn from these four situations.

In each of the four areas, the regional economy is highly dependent upon its estuarine resources. The way in which these resources are managed will have a great deal to do with the future prosperity of these regions. Since the commerce, fisheries, tourist business and other activities based upon estuaries constitute such an important part of the national economy, the management of estuaries has implications for the national economy which cannot be considered insignificant. It is worth emphasizing that wise management of estuarine resources is not simply a matter of conserving biological resources for the sake of diversity recreation and aesthetic values, although these are important considerations as well. The investment of enormous sums in transportation facilities may be involved, the jobs of thousands of fishermen may be at stake, and the efficiency of economic institutions in major industrial centres may be at issue. Estuarine management can be neglected only at the risk of large economic loss to the nation.

It is also important to note that all three levels of government - federal, provincial and local - share major responsibilities for estuarine resource management. It is evident that governments cannot leave the task entirely to the private sector. It is equally evident that under the Canadian constitutional framework, no single level of government has sole or dominant jurisdiction. Estuarine resource management involves navigation, fisheries, wildlife, pollution control, agriculture, recreation, tourism and many other activities. Every Canadian knows that responsibilities which transcend these activities require inter-governmental attention.

A recurring theme through these four examples is a lack of information on which to base sound decisions. This suggests the need for research and investigation to answer questions that decision makers face. Of equal importance, it suggests the need for a strategy for proceeding in a responsible fashion in the face of uncertainty.

A final point is that these cases indicate that the urgency of the problems that must be dealt with vary from estuary to estuary and within each estuary. This offers the opportunity to devise priorities for dealing with estuarine resources nationally, provincially, and within each estuary. Staff and facilities are never sufficient to do everything one would like to do. Priorities can be established for working on estuarine problems by identifying the relative urgency of the issues that exist.

IV

BASIC DIFFICULTIES IN MANAGING ESTUARINE RESOURCES

Simply stated, the basic problem in managing estuarine resources is one of allocation among competing potential uses so as to provide the greatest social benefits. In many cases, the decision to allocate a resource to a particular use is irreversible. For example, if a marsh is filled and used for urban development, it is extremely unlikely that it can ever be a marsh again; if the feeding habitat of fish is modified to provide harbour facilities, the fishery may be destroyed for centuries. These are grave choices, for the opportunity to change the decision may not occur. We must resolve to select allocation processes which incorporate thoughtful consideration of the irrevocable nature of our decisions.

In our society, we rely to a large extent upon market forces to apportion resources among competing uses. Several characteristics of estuarine resources severely limit the capability of the market system to allocate these resources wisely. It is worthwhile noting these limitations because it helps us to understand why government is so deeply involved in managing estuarine resources and the nature of the task that government faces.

The limitations of the market system

There are four aspects of many (but not all) of the resources which cause the market system to fail in allocating them according to the public interest.

First, estuarine waters, fisheries, wildlife, and some land resources tend to be treated as common property. No single organization or individual "owns" the resource so that it is subject to use by more than one user. One use may have effects on other uses - as when a toxic discharge adversely affects fishery uses - which can lead to what Garrett Hardin has called the "Tragedy of the Commons"[16]. Since under an unregulated market system, one user does not take into account some of the benefits he creates and damages he causes, he is not motivated to use the resource efficiently. Also, he may have an incentive to over-use a resource because of a fear that if he does not, some other user will.

Second, for some economic activities based upon the use of estuarine resource, economics of scale are so great that it is uneconomic to have a number of competitive enterprises. For example, it would be highly inefficient to have competitive navigation channels, sewage facilities, water services and similar utilities. These are therefore referred to as natural monopolies. If the prices placed on their services are to reflect society's values and if they are to meet acceptable standards of service, some substitute for the market must be found to establish prices and regulate their performances.

Third, some of the goods and services - the benefits - provided by estuarine resources are not priced by the market or else it is generally accepted that the market price does not adequately reflect their social value. These goods may be bought and sold but the prices established by the market may not be regarded as an adequate measure of value. One example is outdoor recreation opportunities which are widely assumed to have a value greater than the prices that would be established by market forces. Another example is agricultural land in rapidly urbanizing areas which are often regarded as having a greater benefit for future generations as agricultural land than is indicated by market prices. In the case of flood control services, the market cannot function to establish prices because it is usually impracticable to subdivide these services into units for purchase and sale and permit each landowner to decide whether he does or does not want flood protection. Thus, for a substantial part of the benefits derived from estuarine resources, we are

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16 Hardin, Garrett, *Science*, 162, December, 1968, pp. 1243-1248.

unable or unwilling to rely upon market forces to establish their value.

Fourth, closely related to the third point above, the development and use of estuarine resources may have social and economic repercussions that are not reflected in the immediate value of the resource product. A fishery resource, for example, may constitute the principal support of an entire community with the result that if this resource is adversely affected, the social and economic fabric of the entire community may be impaired. The market simply does not reflect such values in the prices it establishes for fishery products.

As this cursory review of the limitations of market forces in allocating estuarine resources implies, we look to government to supplement market institutions in several respects. For common property resources, we expect government to regulate users to assure efficient use of resources. For many of the goods, services and effects of estuarine resources, we expect government to determine the benefits, costs or damages involved. In the case of natural monopolies we expect government to see that prices reflect actual values and that the entities involved meet reasonable standards of performance. In the past it has often been assumed that governmental institutions could automatically perform these tasks without difficulty. However, a political-administrative system also has handicaps and these must be overcome if fully effective institutions are to be developed.

The handicaps of a political system

While a political system is intended first to determine and then to implement the social will, it is far from a simple task to employ the powers and procedures of government so that it does in fact achieve this result. The irreversible nature of many allocation decisions makes the development of natural resources vulnerable to politically expedient decisions which may well strengthen the pressures of a market system motivated by short term profit. If the political system is involved in resource allocation, a political expediency contrary to the long term public interest must be guarded against. It must also be kept in mind that the political system must make decisions in the face of as much uncertainty as the market system.

A representative democracy is based on two important premises. One is that government decisions should be made either directly or indirectly by popularly elected individuals who are expected to reflect the social will even at the expense of known but less obvious public benefits. The other is that decisions will be made on the basis of good and sufficient information about the choices and their consequences. Implicit in this formulation is the often unstated premise that governmental employees - the public service - are neutral and faithfully reflect the values of elected representatives.

In dealing with estuarine resources, as with many other areas of governmental decisions, there are serious difficulties in functioning in accord with these premises. An initial problem is encountered in identifying and assessing the choices with regard to possible uses of estuarine resources. Here two difficulties tend to arise. First, governmental activities tend to be sub-divided so that no one agency has responsibility for identifying the full range of choices. The fisheries agency is concerned with fishery uses, and the transportation agency has responsibility for transportation uses but generally government tends not to be organized so that the full range of uses of potential interest to society are examined. This is one way in which information about choices tends to be deficient.

A second problem is that the information generated about the consequences of identified choices is inclined not be be balanced and complete. This stems in part from the fact that governmental organizations are not neutral and in part because some private organizations establish close working relationships with government agencies and often have superior capabilities to assemble information in support of the choices they prefer.

A third problem is that elected representatives face serious difficulties in determining what constitutes the public interest and in ensuring that preferred policies are faithfully observed by governmental agencies. An elected representative may have trouble assessing complex sets of information in a wide range of fields, much of it of a highly technical nature. He may be unable to maintain communication with all sectors of his constituency so as to secure a balanced view of preferences. Furthermore, because of limited time and resources, and a wide range of responsibilities, it is difficult for the elected representative to exercise effective control over what public agencies in fact do. Because of these handicaps, public decisions tend to reflect the results of interactions among organized private groups and government agencies with control by elected representatives only at the very broad policy level. This system may reflect public preferences, or guide public acceptance of less obvious benefits, reasonably well if resources to generate information are well balanced and if each of the various interests in society are represented by either a government agency or an organized private group. All too often, resources to produce information are not well balanced and some interests in society are represented only by the elected representative.

Finally, the political system may gradually drift into a costly and time consuming process. Differences in preferences will cause delays and create a demand for more information in the hope that a technical solution can be found that satisfies all interests.

If the political system is to allocate estuarine resources in the public interest, it must circumvent these problems. It should discourage politically expedient, irreversible decisions. It should identify the range of choices and make available adequate authoritative information about the consequences of each, including an examination of the implications of any uncertainties. It should assure representation of both organized groups and unorganized interests in the decision-making process.

V

MANAGING ESTUARINE RESOURCES IN THE CANADIAN INSTITUTIONAL CONTEXT

Since Canadian governments are already seriously involved in managing the use of estuarine resources, how can government best function to assure the optimum use of these resources? To lay the foundation for some specific suggestions, it is necessary to identify the precise nature of the task faced in Canada.

It is obviously impracticable, either in the near future or even over a long time, to make wise decisions about how *all* Canadian estuarine resources should be utilized for the indefinite future. This impracticability stems in part from the fact that the great number and diversity of estuaries would make a comprehensive assessment a gigantic task. It stems in part from the complexity of the economic and social system involved, systems which could not be dissected in detail even if a mammoth investigation were launched. Finally, it stems from the dynamic nature of the systems to be dealt with, because ecological systems evolve, human values change, and the demands for resources increase and diminish over time depending on a variety of factors. Thus, it must be recognized that the task is not one of deciding now or in the near future how all of these resources should be allocated, but rather to devise a system that will function to make allocation decisions as needed and in the light of continuously changing conditions.

The second element of the task faced in Canada arises out of the nature of the Canadian institutional framework. Under our federal system, authority over estuarine resources is shared by the federal and provincial governments. Since each province delegates authority to local and sometimes regional jurisdictions, three and sometimes four levels of government are involved to some degree in the allocation of estuarine resources. Of equal significance, several agencies at each level have an interest in and some responsibility for these resources. Such a pluralistic system has, as centuries of experience have demonstrated, many benefits.

In this connection, the irreversible nature of many of the resource allocation decisions attaches importance to the development of decision-making procedures which assures deliberate consideration of the long term consequences of a change in resource use. Following is a brief examination of the problems that must be overcome, based in large part upon experience on the West Coast.

A. Unless specific provision is made, leadership is not provided to deal in a comprehensive and forthright manner with all aspects of the resource management problem.

The West Coast, and particularly the Fraser estuary and delta, is used to illustrate this point. The West Coast is urgently in need of a set of policy guidelines covering coastal resource use. Federal and provincial agencies have organized a committee to work on this problem. While this committee provides a useful forum for an exchange of ideas and information, it suffers from three important handicaps. *First*, it is composed of second echelon personnel who are not in a position to resolve some of the troublesome interagency and intergovernmental issues. *Second*, and of major importance, this committee does not include representatives from some of the major users of coastal resources such as the federal and provincial ministries of transportation. How can such a committee expect to evolve suitable guidelines when some of the most powerful users are not taking part? *Third*, there is no focal point of federal or provincial leadership. No one is responsible for ensuring that all interests are represented, and no one is motivated to take the lead in working out a resolution of the differences that are certain to arise.

In the case of the Fraser River estuary and delta, the federal Department of Fisheries and Environment and the British Columbia Department of the Environment have agreed to work out a common set of policies governing the use of the resources of this area. Yet it is evident that some of the principal users of the Fraser estuary and delta are not participating, including the federal Ministry of Transport. In view of the independent manner in which MOT has operated in the past, will agreements negotiated by the two environment departments be of much value?

Federal representatives appear reluctant to involve all affected interests, especially the federal Ministry of Transport. It is suspected that this stems from a feeling that MOT is too powerful to function in harness with the other federal agencies and that therefore the only solution lies in a joining of forces by federal and provincial environmental agencies to control developmental interests including MOT.

It also appears that federal representatives are overwhelmed by the number of jurisdictions as well as agencies that are involved in the management of the resources of the Fraser estuary and delta. This is understandable because in addition to a range of federal and provincial agencies, there exists the Greater Vancouver Regional District and numerous local jurisdictions. Instead of the federal government seeking to develop some all-compassing coordinating mechanism, it should first address the question of providing effective leadership in the coordination of federal policy development. If it can find a means of reconciling its own internal differences it will have come a long way toward (a) implementing a consistent set of federal policies and (b) working effectively with provincial authorities.

B. Some government agencies and private interests have more resources and influence at their disposal than others, with the result that the range of preferences in society do not receive balanced representation in the decisions. This problem is aggravated by the confidentiality of the results of investigations and analyses.

Generally speaking, developmental agencies, since they are usually engaged in expensive construction projects, also have large funds for "planning" purposes. Many other interests affected by such projects do not have the staff and financial resources to examine such plans. Of particular importance, planning may be well advanced and a commitment to a particular decision made before other affected interests become involved.

The newspaper clipping in Annex I is a good reflection of the nature of this problem. The National Harbours Board has been planning an expansion of the superport at Roberts Bank for several years. With large sums having been spent on planning the facility and a commitment to a decision virtually made, consideration is now being given to a very rapid environmental impact assessment. It is well recognized that adequate consideration of environmental effects cannot take place unless they are considered as an integral part of the planning process. Large developmental organizations, both public and private, often are powerful enough to ignore this important maxim.

Provincial and private organizations as well as large federal agencies may be guilty of this behaviour. The recent proposal by a private developer to fill in part of Ladner Marsh near the mouth of the Fraser River is a case in point. Full attention to the environmental effects of the proposal did not take place until after the developer had invested a large amount in acquiring the land and planning the development.

Environmental interests tend to be under-represented when the process follows this course, because seldom are sufficient time and resources made available to assess the consequences of the proposal.

There is probably no ideal solution to this problem, but it does not seem impossible to devise planning and decision-making procedures which will assure both the assessment of environmental effects and the involvement of environmental interests at an early stage of the planning process.

C. Politically responsible officials tend to lose control of critical decisions because large agencies develop goals and political support outside of the framework of legislative accountability.

The Ministry of Transport appears to be an example of a public agency in which the bureaucracy has assumed responsibilities which are constitutionally vested only in the Minister and the Cabinet. Its handling of the proposed expansion of Vancouver International Airport gave the distinct impression that a responsible elected representative was not guiding the course of MOT on this issue. It was extremely reluctant to consider alternatives to the third runway which it proposed and it gave those concerned about the potential environmental effects of the proposal the distinct feeling that it was unwilling to give fair and objective consideration to opposing views. While a decision with regard to the third runway was still pending, the Ministry arranged to excavate sand and gravel from the North Arm of the Fraser and the Minister and his staff gave conflicting reports on the use to be made of this material. The Vancouver office announced that it was to be used for airport maintenance purposes whereas the Minister, in response to a question in Parliament, stated it was to be used for construction of the new runway. When this kind of behaviour occurs, can one really believe that politically accountable representatives are in charge of the situation?

One must recognize that when governmental processes operate under these conditions, government is deficient in several respects. It can mean, for example, that the tradeoffs between development and environmental effects are not responsibly weighed. But in the larger sense, it means that government is not functioning in a responsible fashion which in turn leads to a disenchantment with the capability of government to serve the public interest. And to the government in power, this means as well an erosion of public support. There can be little doubt that the government lost a great deal of credibility because of the cumbersome way it handled the proposal to expand Vancouver International Airport, but it should be emphasized that this loss of support stemmed from the impressions conveyed by MOT, not because of any specific decision that was made about airport expansion.

While the actions of the Ministry of Transport pose a particular problem in managing estuaries and associated lands, it seems unlikely that this problem is limited to a single agency. If estuarine resources are to be allocated in a socially responsible fashion, politically accountable representatives must be in control of their allocation.

D. Small changes in resource allocation are made without a careful balancing of the advantages and disadvantages, because no single decision is deemed to be sufficiently important to merit the time required to give it attention. Yet the accumulation of these decisions over time produces major changes in the pattern of resource use.

Actions such as to infill a wetland are often authorized for all practical purposes by a local jurisdiction or by a single agency after little, if any, consultation with other interests. The press clipping attached as Annex II reports on a case, seemingly of little importance, which some environmental interest groups tried to stop without success. Generally, these cases slip by because neither interested agency personnel nor interest groups can afford the time to fight each case individually.

These types of situations suggest the need for policies that apply to classes of areas. Once such policies have been worked out, all developmental actions can be guided by them.

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This characterization of the management problem points up the issues that need to be addressed. *First,* it is evident that a general strategy of some type must be developed for allocating estuarine and associated land resources which establishes priorities and procedures that make the task a manageable one in view of the enormity of the area to be covered, the intrinsic complexity of the issues to be addressed, and the dynamic nature of both the resources and the demands for their use.

Second, some provision is needed for leadership in the management of estuarine resources if important opportunities are not to be lost and major interests excluded from consideration. While the task of providing such leadership is a difficult one because of the number of jurisdictions involved, the federal government needs to demonstrate that it can provide unified leadership within the federal establishment.

Third, while it is utopian to expect that all interests will have equal resources to participate in and influence allocation decisions, it is evident that procedures are required which assure involvement of all interests, including environmental interests, in the initial stages of

the planning process, and for environmental and social interests to have sufficient staff and funding to assess the impacts of alternative plans.

Fourth, some agencies of the federal government are particularly guilty of functioning outside of the framework of legislative accountability. This situation must be remedied if there is to be any hope for responsible public decision-making.

Fifth, institutional arrangements are needed which will stop the erosion in value of estuarine resources through a series of small and individually insignificant decisions.

Sixth, the processes sought must be particularly deliberate in nature to assure that the consequences of irreversible decisions (of which there are legion) will be carefully weighed.

VI

STRENGTHENING THE MANAGEMENT OF ESTUARINE RESOURCES

The problem of managing estuarine resources to serve the long term public interest has two broad aspects. One need is for the development of a management strategy so that the large size, complex and dynamic nature of these resources can be dealt with in a practical way. The second need is to develop decision-making and implementing processes which will assure that decisions are made in accord with the precepts which underlie the Canadian constitutional framework. The following examines possibilities for developing such a strategy and institutional arrangement.

A Management Strategy

Defining the coverage

In developing a practical and effective strategy, it is necessary to define more precisely the specific resources with which the federal government should concern itself. There are two reasons for giving careful consideration to the scope of federal coverage. One is that the resources are so extensive and the management task so large that it would be unwise to include resources in its coverage unless there are important reasons for doing so. The second reason is that there is little to be gained by pursuing a course of action that fosters controversy with provincial jurisdictions. Defining the federal role somewhat narrowly at the outset need not preclude an eventual expansion of the federal role if a good case can be made for doing so but it would avoid a stalemate situation that prevents anything from being done.

There seems to be a clear case for the federal government to adopt a major role in making the following types of decisions:

1. *Those affecting the use of water, fisheries and beds of estuaries because of federal responsibility in areas of fisheries, navigation and migratory birds.*

2. *Those relating to the use of land resources where a potential land use may affect water quality and other aspects of fisheries habitat, migratory birds or navigation.*

The federal government should limit itself at the outset to a scope that the provinces will recognize as fully acceptable. At the same time, it may wish to place the provinces on notice that it may eventually seek through negotiation some modification in its scope.

Implicit in the foregoing definition is exclusion of uses of land, forests and wildlife which do not affect navigation, fisheries and migratory birds. This means, for example, that the conversion of land from agricultural to urban uses would not fall within the scope of federal activity unless such conversion affected these aspects of federal responsibility. Possibly the federal government should be seeking to conserve agricultural land, but if so, that matter should be treated separately and negotiations on that issue should not impede progress on vital aspects of managing estuarine land resources which the two levels of government can readily agree should be dealt with jointly.

Once the federal government has defined the resources for which it claims responsibility, its next step should be to try to work out a procedure with each province for joint decision-making. Since provinces have responsibility for land, water and mineral resources and since these responsibilities overlap federal authority over fisheries, navigation and migratory birds, these are areas for which responsibility is clearly shared. The federal government should take the initiative to achieve agreement by the provincial governments on joint decision-making procedures for these areas.

In some instances it may not be practicable for the two levels of government to agree on joint action. If negotiations become protracted, the federal government should proceed on its own initiative to establish procedures to be followed for gaining federal approval for a change in use of resources. In other words, the federal government should evolve a process for reconciling differences among federal agencies and which will determine, for example, whether the filling of a slough that will

damage fishery habitat is to be permitted by the federal government. Though joint action is preferable, inability to achieve agreement is no excuse for the federal government to avoid putting its own house in order and deciding what resource uses it will consider to be acceptable.

Classifying the resources

The second step in the development of a suitable strategy is to classify estuarine resources so as to help establish priorities and specific procedures for decision-making. Consideration of this need leads to a suggestion that the federal and provincial jurisdictions cooperate in classifying these resources into four broad categories on the basis of readily available information.

Category I — Current use appears to approximate most appropriate use for the indefinite future.

These would include biologically sensitive areas that are not being degraded and which the provincial and federal governments agree should continue as they are for the indefinite future. It might also include beaches and other recreation areas which it is considered should remain in their current status. By assigning such areas to Category I, developers would be on notice that approval of a change in status is unlikely. This category would include, in addition, those areas which have been subject to irreversible decisions (such as urban-industrial shoreline areas), the use of which cannot be improved during the foreseeable future. Areas in Category I need be subject to further investigation and study for allocation purposes only if a change in use is seriously proposed.

Category II — Continuation of present use does not degrade the resource or preclude conversion to another use in the future; no evident opportunities or demands to change use exist.

It is assumed that substantial areas in and along the less developed estuaries will fall in this category. These areas would be subject to investigation and study for reallocation only if a change in use is seriously proposed.

Category III — Continuation of present use degrades the resources and appears to threaten the possibility of realizing best use of the resource over time.

A number of resource uses fall in this category, such as pollution of estuarine waters, erosion of land causing infilling of a slough, or intensive recreation use affecting wildlife habitat. Category III areas might be assigned a priority classification, e.g., high, intermediate and low, to indicate their relative importance and the priority they are to be given for future investigation.

Category IV — Continuation of present use does not degrade the resource, but there are pressures for and the possibility exists for use that will create greater social benefits.

These are areas where there are legitimate pressures for a change in use, or where available information indicates that possibilities exist for changing use to increase social benefits. For these areas, priorities for investigation and study might be established as proposed for Category III.

It is believed that this type of classification scheme and designation of priorities will indicate how funds available for investigation and analysis can best be used to assure the most appropriate use of estuarine and associated land resources.

When a classification and set of priorities within a given province have been tentatively decided, the results should be reported to the public and an opportunity afforded for public reaction before final decisions are made. It is essential that modifications in the classification be made regularly on the basis of new information and when such modifications are being considered, there should be an opportunity for public input.

Procedures for changing use of resources

A critical element of an appropriate strategy for managing estuarine resources properly entails the development of procedures for (a) upgrading resource use where resources are now being degraded and (b) authorizing a public or private entity to alter the use of a given resource. This is far from a simple task and makes special demands upon the public agencies concerned with these procedures. But it is important, because existing and potential users of these resources must be quite clear about the procedures they are expected to follow.

Of foremost importance is the recognition that it will often be difficult to estimate the ecological, economic and social consequences of a change in use. While each proposed change must include an assessment of these effects, it will frequently be necessary to map out a strategy for proceeding in a manner that takes into account the

uncertainties that exist, that includes measures for reducing uncertainty over time, and provides for succeeding steps to be taken as uncertainty is reduced. Thus it is urged that any proposal to change a use or any plan to upgrade existing uses must include not only an estimate of ecological, social and economic effects but also a program and strategy for proceeding in a manner that will deal in a realistic fashion over time with the uncertainties that remain. Interested public groups should, of course, have an opportunity to react to such proposals.

It is worthwhile pausing to note that this proposed approach alters the role that government agencies have traditionally taken with regard to resource management. Instead of simply approving or disapproving a change in resource use, the resource agencies must involve themselves in a dynamic learning process. Their primary concern would be with the generation and processing of information that will assist governments to make continuing adjustments in resource use over time.

Institutional Arrangements

The arrangements for deciding on and implementing policies present a difficult problem because both the federal and provincial jurisdictions must be involved and a large number of different interests taken into account. No doubt these difficulties are responsible for the deficiencies in existing practices described in section IV. With these inadequacies in mind, the institutional arrangements should ideally have the following characteristics:

1. *Where federal and provincial responsibilities overlap, decisions should be made jointly by the two levels of government regarding resources.*

2. *The processes of decision-making should be deliberate so as to avoid ill-considered decisions of expediency.*

3. *Responsibility for leadership in policy development and implementation should be clearly delineated.*

4. *All agencies concerned with estuarine resources should be involved in policy development and implementation, and have staff and funds adequate to investigate impacts from the perspective of their respective agency responsibilities.*

5. *All public and private organizations involved in using estuarine resources should be required to follow the same process of decision-making relative to any change in resource use.*

6. *Control of decision processes by politically accountable representatives should be assured.*

In considering how to modify existing arrangements to produce a system with these characteristics, it is suggested that the federal government recognize and indicate at the outset that it expects the provincial government to deal with and represent local jurisdictions. The next step would be for the federal and provincial governments to establish a *joint federal-provincial committee* composed of two, four or six individuals to make decisions or make recommendations to their respective cabinets on policies and implementation on all matters relating to the use of estuarine resources. This joint body would be responsible for classifying the resources and establishing priorities as proposed above, as well as acting on proposals for change in use. It would also be responsible for ensuring that a coordinated investigatory program is planned and carried out in accord with the priorities established. (This kind of joint arrangement operates in planning and constructing flood control works on the Lower Fraser and appears to function effectively). If adopted, this committee will meet three essential criteria. It will provide for joint federal-provincial decision-making, it will foster deliberation in deciding what should be done, and it will fix responsibility for leadership in the development and implementation of policies.

For the joint committee to function effectively, it is essential that differences within each jurisdiction can be resolved. For the federal representatives on the joint committee to speak with authority, they must be able to reconcile the inevitable differences that arise between the developmental agencies, such as the Ministry of Transport, and those concerned with environmental affects, such as the Fisheries Service. Each province will face a similar problem, but on the assumption that if the federal house is put in order the provinces will be motivated to do likewise, suggestions are limited to federal organization.

It is proposed that in each province that has estuarine resources, a *federal interagency committee* be established to coordinate federal agency policies and activities regarding the management of these resources. This committee would be responsible for developing and maintaining a coordinated three-year plan of investigation for estuarine resources, including the budget estimates, so that headquarter offices will be kept fully aware of the coordinated views of field personnel, of actions being contemplated and investigatory work required. It is essential that developmental as well as environmental agencies have membership on this committee and that the developmental agencies adhere faithfully to committee procedures and decisions. The federal representatives on the joint federal-provincial committee would be guided by the decisions of the interagency committee.

This step would meet two criteria with regard to the federal government. It would assure involvement in and require adherence to the same set of procedures by all federal agencies. It also would provide a process for joint planning and budgeting of investigatory activities which would foster a better balance in the staff and funds available to the various interests concerned with these resources.

The most difficult task is that of controlling the large and powerful agencies because unless arrangements are made explicit, they will tend to ignore the committee and proceed independently. Closely related to this problem is the need for a greater degree of political accountability. It is patently evident that ministers experience great difficulty in maintaining control over the far flung operations of their departments; of equal significance, few effective processes exist for integrated federal regional operations in a politically sensitive fashion. The current emphasis on decentralization may aggravate this problem.

To deal with these inter-related problems, it is suggested that a *ministry of state* be established for each major region of the country. This ministry would have no authority to make decisions. Its responsibilities would be twofold. *First,* it would employ its good offices in coordinating federal programmes with one another and with provincial jurisdictions within the region. *Second,* it would be the eyes and ears of the Cabinet within the region and report to Cabinet on regional issues that arise and which merit Cabinet consideration.

If this step were taken, it would be only logical that the Secretary of the regional ministry of state chair the federal interagency committee responsible for estuarine resources. In all probability, this official should also be a member of the proposed joint-federal provincial committee. As such, he could speak with authority on the federal position on all matters that come before the committee.

This step would help assure adherence of all federal agencies to the same processes. In addition, it would make politically responsible the field operations of the federal government forces operating in each region, not only as they relate to estuarine resources, but to other federal activities as well.

VII

CONCLUSIONS AND RECOMMENDATIONS

In this final section, the conclusions and recommendations regarding management of estuarine resources are summarized. Since the various

aspects of the problem could not be studied in detail, these proposals cover only the broad outlines of an approach. Six basic recommendations are as follows:

1. The federal government should begin by defining the resource area for which jurisdiction is shared by the federal and provincial governments.

This step is necessary so that all parties are clear about the coverage of a joint effort. It is urged further that controversial areas be omitted from the initial definition so that progress can be made on matters for which mutual responsibilities are recognized. Joint action may be called for (a) where through water use, water quality, beds of estuaries, fisheries, navigation and migration of birds are directly affected; and (b) when a potential land use may directly or indirectly affect water quality, fisheries habitat, navigation and migratory birds.

2. In each province that has estuarine resources, the federal government should seek the collaboration of the provincial government in establishing a joint inter-governmental committee to provide leadership and a focus of responsibility in the management of estuarine resources.

Leadership and a fixing of responsibility for management of these resources are major needs. This committee would be responsible for arriving at a classification and a set of investigation priorities *(see 3 below)* for establishing detailed procedures governing the application for and consideration of changes in resource use, for initiating programs for upgrading resources now being degraded, and for maintaining surveillance over the use of these resources.

3. Each joint committee, with the cooperation and assistance of federal and provincial agencies, should proceed immediately (a) to classify resource areas of the estuaries of the province to facilitate management decisions; and (b) to establish priorities for future investigation.

Specifically, it is suggested that estuarine resources be classified into four categories as follows:

(a) Continued use appears to approximate most appropriate use for the indefinite future;

(b) Continuation of present use does not degrade the resource or preclude conversion to another use in the future; no evident opportunities or demands exist to change use;

(c) Continuation of present use degrades the resource and appears to threaten the possibility of realizing the best use of the resource;

(d) Continuation of present use does not degrade the resource but pressures and possibilities may exist for uses that will create greater social benefits.

Priorities for investigation and planning should be established with regard to the last two categories.

4. Each joint committee should establish procedures for resource users and public agencies to follow in applying for or initiating changes in resource use and for maintaining surveillance over estuarine resources.

Those interested in initiating a change in use must understand the procedures to which they must adhere. These procedures should make provision for an assessment of ecological, economic and social effects of the changes, and should require a strategic approach to possible changes involving major uncertainties. The fact that many uncertainties will always exist necessitates the establishment of surveillance programs so that remedial action can be initiated wherever problems are encountered.

5. A federal interagency committee should be established composed of representatives of all agencies concerned with the management of estuarine resources, to coordinate federal activities with regard to these resources, to reconcile differences over how these resources should be utilized and to guide federal representatives in the joint federal-provincial committee with regard to federal policy. In the case of estuaries with a strong economic base, management could take the form of a crown corporation.

There is no doubt that federal agencies are currently pursuing conflicting objectives. While such conflicts are to be expected, there exists no forum for the reconciliation of differences. One of the most urgent needs relating to the management of estuarine resources is a process whereby developmental proposals are weighed carefully and deliberately in light of their social and environmental effects. This proposed committee, if organized with an appropriate charter, could go a long way toward achieving this result.

6. Consideration should be given to establishing a ministry of state for each major region of the country, with responsibility for coordinating federal policies and programs within the region, and to keep the Cabinet apprised of regional politically sensitive issues.

While such a ministry would be concerned with other matters than estuaries and associated lands, it is suggested that the Secretary of the ministry chair the federal interagency committee, and be a member of the joint federal-provincial committee. Such a designation, giving a relatively neutral individual a key role in the process, should be conducive to a reconciliation of differences. Of major importance, it would associate a key political figure - the Minister of State - with the decision-making process so that the demands of various interests will tend to be carefully weighed.

One of the authors (Dr. Nowlan) believes that in lieu of the arrangements suggested above, in some cases a management corporation owned by the several levels of government concerned and charged with long range planning for the estuary might be considered as an efficient method of reconciling diverse interests with the minimum of political interference. Certain estuaries have a well developed economic base, with multiple competing interests. Prudent management of the overall resource is hampered by the differing priorities of agencies from different levels of government agencies which frequently have minimal contact with each other and only minimal understanding of the inter-locking effects of individual actions. It is in these cases that a management corporation should be considered. Such an organization could function only when fees from usage would be adequate to support such data gathering and research as is necessary to permit optimal long range planning.

One final point deserves emphasis. Difficulties and the need for prolonged negotiation with a province is no excuse whatsoever for federal inaction. The federal house is not in order. The federal government urgently needs procedures for coordinating its own policies and programs. If it reconciles its intragovernmental differences and establishes its own clear policies, provincial authorities will find it difficult to procrastinate. While every effort should be made to initiate a joint approach, the federal government should proceed forthwith to function in a coordinated and effective fashion in discharging its own responsibilities in this field. There is little time and no excuse for delay.

ANNEX I

VANCOUVER PROVINCE, December 15, 1976

EXPANSION PLAN EYED FOR ROBERTS BANK

By Alan Merridew

Federal and provincial authorities are reportedly close to an agreement which will allow an environmental study of the impact of an expansion program at Roberts Bank to go ahead.

The study, to cost an estimated $400,000, would be the first step toward expansion of the deepwater port. A doubling of the port's current bulk coal handling capacity would cost an estimated $50 million.

Westshore Terminals Ltd., a subsidiary of Kaiser Resources Ltd., has operated the present 50-acre terminal under a lease from the National Harbours Board since the man-made island port, three miles offshore and 18 miles south of Vancouver, opened more than six years ago.

Westshore handles metallurgical coal, mostly bound for Japan, from Kaiser and other mines in southeastern B.C.

Of late, Kaiser has been saying that time in which to decide whether to expand Roberts Bank is running out. Continued delay could mean a crunch between capacity and demand, said John E. Heffernan, vice-president of terminal operations and traffic for Kaiser, in a recent interview.

But according to Neptune Terminals Ltd., which operates bulkloading facilities in North Vancouver, there will not be enough tonnage in the foreseeable future to justify expansion at Roberts Bank.

Kaiser has an option on the first 50 acres of expansion at Roberts Bank and wants to exercise it, said Heffernan. Under existing plans, the island would be enlarged by 200 acres in one operation.

Until recently, the NHB has taken the position that expansion cannot be undertaken until the Supreme Court of Canada decides who owns the seabed between the mainland and Vancouver Island.

It would 'be foolish', an NHB official said as recently as late November, for the NHB to go ahead with the environmental study unless the province agreed to reimburse the federal government should the province win the seabed ownership fight.

The island was created in the Strait of Georgia by dredging and filling and is linked to the shore by a three-mile-long causeway. Expansion would involve more dredging and filling.

Last summer the B.C. Court of Appeal ruled that B.C. owns the seabed between the mainland and Vancouver Island. The federal government filed an appeal against this decision with the Supreme Court of Canada on Oct. 26. A spokesman for Ros Basford, federal minister of justice, said he has 'absolutely no idea' when the Supreme Court might rule on the appeal.

Not only may the costs of any possible Roberts Bank expansion be involved, but also potentially millions, if not billions, of dollars worth of undersea mineral development.

Roberts Bank cost the NHB about $5.5 million to build and Kaiser spent about $15 million on the bulkloading facilities.

The NHB selected a firm more than a year ago to study environmental effects of expansion. Assuming the NHB retains jurisdiction and is able to proceed in 1977, Roberts Bank could be expanded in time to increase capacity in 1980, S.B. Ellam, NHB corporate secretary told The Province.

But Heffernan said Kaiser "can't wait for a Supreme Court decision".

"Some accommodation should be made between the federal and provincial governments" over who would eventually pay for the environmental study, he said. "I believe the real issue is not the cost of the environmental study", said Heffernan. He saw the issue as 'political'.

He estimated that it would take 12 months between a decision to start the study and start dredging, assuming the study's results did not bar expansion.

Roberts Bank now has a rated capacity of nine million long tons a year. In 1975 its throughput was 8.2 million tons - about 5.2 million tons from Kaiser and three million tons from Fording Coal Co. mines in southeastern B.C. This year's throughput will not be quite as much, Heffernan said.

"We're virtually at capacity now at Roberts Bank", said Heffernan.

Kaiser is now completing a financial study for two million tons a year of new coal production in southeastern B.C. If it is financially feasible, it could come on line in 1980 or 1981, he said.

It would be impossible to move substantially greater volume of coal without government support or subsidies.

Fred Spoke, Vancouver port manager, said through his secretary Tuesday that he had 'no comment' on the likelihood of an early agreement between the federal and provincial governments enabling an environmental impact study of Roberts Bank to start soon.

However, David King, B.C. Harbours Board secretary, said "we're on the verge" of an agreement, but it has not been signed. The agreement is not confined to the costs of the study, King said.

ANNEX II

VANCOUVER PROVINCE, December 10, 1976

ECOLOGISTS LOSE SLOUGHS BATTLE

Efforts by wildlife and agricultural groups to stop a developer from filling in three Richmond sloughs failed Thursday in Supreme Court.

The group had sought to quash a decision by water rights comptroller Howard DeBeck, which gave Nu-West Developments Corporation Ltd. permission to fill in McDonald, Lee and Spur sloughs in the development of an industrial park.

The DeBeck decision was attacked on the grounds that opponents were not given an opportunity to present their case.

Mr. Justice Harry McKay ruled that under the B.C. Water Act, DeBeck was not legally required to receive submissions in opposition.

He ruled that the comptroller was acting in an administrative function and not a judicial one.

Mr. Justice McKay was told the development is an 'industry versus agricultural' issue.

"Involved is the usual conflict between environmentalists and developers. Fortunately I need not, in this application, enter that debate," said the judge.

He said the applicants - the B.C. Wildlife Federation and Richmond Agricultural Land Use Association - were concerned about the ecological loss to the community.

"No one of the applicants is affected adversely by the approval under attack other than as members of the public at large," he said.

"It has not been shown in this case that private rights have been, or will be, affected by the work carried out under the comptroller's approval. It may be that different considerations would apply if the approval could affect such rights".

CANADIAN ENVIRONMENTAL ADVISORY COUNCIL

The Canadian Environmental Advisory Council was established in 1972 by decision of the federal Cabinet, to advise the Minister of the Environment on:

- such matters as may specifically be referred to it by the Minister;
- the state of the environment and threats to it;
- the priorities for action by the federal government or by the federal government jointly with the provinces;
- the effectiveness of activities of the Department of the Environment in restoring, preserving or enhancing the quality of the environment.

The Council is composed of up to sixteen members. It includes the Chairmen of the resource councils advisory to the Minister, plus members at large who serve in an individual capacity and are drawn from a wide cross-section of Canadian life and from all across Canada. Officials of the Department of the Environment are not members of the Council; however the Department provides a continuing Secretariat.

To carry out its functions the Council undertakes studies and reviews of matters of environmental concern and policy, holds regular meetings to consider progress and developments with regard to these concerns, and prepares comments, statements and reports as appropriate. The Council publishes an *Annual Review* which includes a summary of the state of the environment in Canada, and from time to time reports on other matters of general interest and importance.

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PUBLICATIONS

Annual Review 1973-1974. Part A: Activities 1973-1974. By Arthur Porter. Part B: Problems and priorities in the Canadian environment. By Pierre Dansereau.

Annual Review 1975. Part A. Activities 1975. By Ian McTaggart-Cowan. Part B: Significant Canadian environmental problems. By J.P. Nowlan.

Annual Review 1976. Part A. Activities 1976. Part B. The state of the Canadian environment 1976.

An environmental impact assessment process for Canada. Council Report No. 1. February 1974.

An environmental ethic - its formulation and implications. Council Report No. 2. January 1975. By Norman H. Morse. Preface by Pierre Dansereau. Foreword by Donald A. Chant.

Harmony and disorder in the Canadian environment. Occasional Paper No. 1. 1975. By Pierre Dansereau (Council Report No. 3).

Environmental aspects of nuclear power development in Canada. Occasional Paper No. 2. 1977. By H.E. Duckworth, H.W. Duckworth, Arthur Porter and J.S. Rogers (Council Report No. 4).

Report of the second joint meeting of environmental advisory councils. May, 1977, Fort San, Saskatchewan. Council Report No. 5, March, 1978. Produced in collaboration with the Saskatchewan Environmental Advisory Council.

Enquiries concerning the work of the Council and requests for Council publications should be addressed to:

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