Volume 3
Resource Values

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1.0 INTRODUCTION

Volume 3 of the Courtenay River Estuary Management Plan presents information on environmental resource values and land and water uses associated with the Courtenay River Estuary (see Appendix A, Figure 1). This information includes the consolidation of scientific research to date, where available, on environmental resources; descriptions of historic and current land and water uses; and summaries of issues identified during the research process. The data and issues presented in this volume comprise the baseline information referenced during development of the Integrated Management Plan (Volume 1: Working Draft, March 2000).

2.0 ENVIRONMENTAL RESOURCE VALUES

2.1 Plants

2.1.1 Non-Vascular Plants[1]

Comprehensive species inventories and descriptions of species assemblages of non-vascular plants for the Courtenay River estuary have not been conducted. An inventory of terrestrial and fresh water aquatic non-vascular plants, such as mosses, liverworts and lichens, has not been conducted within, or in close proximity to the planning area. Accordingly, as it is the intent of this document to provide information specific to the planning area regarding environmental resources, terrestrial and fresh water non-vascular plants are not addressed. Inventories specific to the planning area, although localized, have been conducted for marine aquatic non-vascular plants; an indication as to the nature of the marine aquatic community of the estuary may be derived from Austin and Adams (1972; cited in Morris *et al.,* 1979) and Brooks *et al.* (1994). A species list is provided by Appendix B-1.

Austin and Adams (1972) compiled a species list of marine algae and identified eleven species associations for an area of the east coast of Vancouver in proximity to the Courtenay River estuary, specifically the east coast of Denman Island, Willemar Bluff to Little River, Little River to William Beach and Elma Bay to Shelter Point.

The distribution of algae was observed to depend primarily upon substrate type and elevation. Within the high intertidal zone, the *Rhodemala larix* association was observed upon sedimentary rock while the *Fucus distichus-Gigartina stellata* association was found attached primarily boulders. The mid to low intertidal zone was characterized by 3 associations: *Entermorpha intestinalis*; *Sargassum muticum*; *Crytosiphonia woodii-*

[1] Non-vascular plants are those plants for which a specialized structure (vascular system) for conveying food and water is generally lacking.

Iridaea heterocarpa. The *E. intestinalis* association was found attached to pebbles, while the *S. muticum* association was observed attached to pebbles, cobbles and boulders. The *C. woodii-I. heterocarpa* association was observed on cobble and boulder substrates.

Six (6) associations were observed below the local low water elevation. The association characterized by *Priontis lyalli-Iridaea cordata-Plocamium coccinaeum* was observed attached to substrates from pebbles to boulders. A sub-association, defined by *Callophyllis violacaea-Polyneura latissima*, was observed on similar substrates at lower depths. A *Laminaria groenlandica* association was observed along the margins of these assemblages anchored to similar substrates. An *Alaria tenuifolia-Costaria costata* association was observed seaward (i.e. at greater depths) of *L. groendlandica* on similar substrates. Two (2) associations were observed on sand substrates: *Desmarestia aculeata-Neaoagardhiella baireli* and eelgrass (*Zostera marina*; predominantly with regard to epiphyte communities).

Brooks *et al.* (1994) complied at list of species observed on the Trent River delta. Prevalent species within the high intertidal zone were *F. distichus, Punctaria expansa, Vaucheria* sp., *Bangia fuscopurpurea* and *Urospora mirabilis*. *P. expansa* was observed along the margins of the Gartley Channel log basin. *B. fuscopurpurea* and *U. mirabilis* were observed matted upon salt marsh vegetation; *U. mirabilis* was also observed on cobble below the lower elevational zone of salt marsh. *F. distichus* was observed growing on cobble within the lower salt marsh.

E. intestinalis was observed in and about fresh seeps and upstream within the Trent River to the Highway 19 bridge. Beds of *Entermorpha linza* were observed at the mouth of the river; this species was also found within the river channel.

Pebbles and cobbles within the mid intertidal zone sustained clumps of *F. distichus* and *Gigartina papillata*. Within the low intertidal zone, *Ulva lactuca* was common on fine sediments while *Laminaria saccharina, S. muticum* and *Lithothamnion pacificum* were observed on large hard substrates of the south beach. Prevalent species within tidal pools included *U. lactuca, F. distichus, Polysiphonia* sp. and *Hildenbrandia* sp.

2.1.2 Vascular Plants[2]

In the context of providing a general description of plant assemblages that occur throughout the planning area, assemblages may be categorized according to the prevailing water level regime. Those species assemblages that occur below local low water, regardless of whether it is within the hydraulic channel of the Courtenay River or within the main body of the estuary, are categorized as submergent plant communities. Those assemblages within the normal range of intertidal elevations throughout the estuary are categorized as emergent plant communities. Species assemblages typically occurring in proximity to, and above the normal high tide elevation are categorized as riparian plant

[2] Vascular plants possess a specialized structure (a vascular system), typically consisting of two distinctive tissues, phloem and xylem, which is essential for the conduction of food and water.

communities. An inventory of plant species documented within the Courtenay River estuary is presented within Appendix B-1

The plant species inventory is incomplete; plant assemblages of the Courtenay River estuary have been poorly studied. A comprehensive inventory of plant assemblages, documenting the distribution of species and assemblages throughout the estuary and utilizing a standard survey methodology throughout the study area, is required.

2.1.2.1 Submergent Plant Assemblages

As part of field investigations conducted during development of the Management Plan, pondweed (*Potamogeton* spp.) was observed within the tidal channels of Hollyhock Flats (low salinity brackish marsh; in proximity to the mouth of Duck Slough) and within Duck Slough (fresh pond and marsh). Widgeon grass (*Ruppia maritima*) was observed within the tidal channels of brackish marshes in immediate proximity to the mouth of the Courtenay River.

The distribution of eelgrass (*Zostera marina*) was interpreted from aerial photographs by Fisheries and Oceans Canada (1997). Eelgrass typically occurs from approximately local low water to -6 metres below local low water. Eelgrass beds occur throughout the seaward portion of the estuary, and are particularly prevalent within the embayment of Goose Spit, from the embayment along the northern shoreline of the estuary to the subtidal flats located immediately west of the municipal marina at Comox, along the Courtenay River delta, and along the periphery of the Trent River delta (Fisheries and Oceans Canada, 1997; Brooks *et. al*. 1994). Japanese eelgrass (*Z. japonica*) occurs within the shallower portions of eelgrass meadows and onto low elevation intertidal flats (Fisheries and Oceans, 1997) . Eelgrass occurs sporadically along the seaward margin of the Trent River delta (Fisheries and Oceans Canada, 1997; Brooks *et al.*, 1994).

2.1.2.2 Emergent Plant Assemblages

The plant species that comprise the tidal marshes of the Courtenay River estuary are typically found in recurring and obvious patterns, zoned on a conspicuous gradient of tidal inundation. Several physical factors are influenced by tidal inundation, which in turn influence the distribution of species. Such factors include soil oxygen concentrations, flooding and drainage, nutrient availability and the accumulation by soil of sulfide and salt. Water salinity is considered to affect both the horizontal and vertical distribution of plant species within a tidal marsh. The horizontal distribution of plant species is often a function of proximity to a fresh water discharge. The vertical distribution is typically a result of the extent of inundation by tidal and seasonal water levels. Species zonation is likely a result of a combination of parameters that impose a complex effect on plant species vigour, which ultimately determines the species membership of an assemblage.

Kennedy (1982) qualitatively described the distribution and associations of emergent plant species for the Courtenay River estuary. Twelve (12) intertidal marsh communities were described and categorized according to dominant species:

1. three-square bulrush (*Scirpus americanus*);

2. tufted hairgrass (*Deschampsia cespitosa*), Pacific cinquefoil (*Potentilla pacifica*) and Lyngby's sedge (*Carex lyngbyei*);

3. small-fruited bulrush (*Scirpus microcarpus*) and Lyngby's sedge;

4. Lyngby's sedge;

5. Pacific cinquefoil and springbank clover (*Trifolium wormskjodii*);

6. reed canary grass (*Phalaris arundinacea*), willow dock (*Rumex salicifolius*) and wild rye (*Elymus mollis*);

7. tufted hairgrass, spike rush (*Eleocharis palustris*) and Pacific cinquefoil;

8. Baltic rush (*Juncus balticus*), Pacific cinquefoil and Lyngby's sedge;

9. tufted hairgrass, Pacific cinquefoil, Lyngby's sedge and marsh hollyhock (*Sidalcea hendersonii*);

10. cattail (*Typha latifolia*);

11. water parsley (*Oenanthe sarmentosa*); and

12. western manna grass (*Glyceria occidentalis*).

Small-fruited bulrush of the third association may have been salt marsh bulrush (*Scirpus maritimus*); the location delineated by Kennedy (1982) is characterized by brackish conditions. Small-fruited bulrush is generally intolerant of all but the lowest salt concentrations. As well, Baltic rush may have been Arctic rush (*J. arcticus*). Baltic rush is part of the species complex of Arctic rush, and is a local variant of this latter species within tidal marshes south of the Courtenay River estuary.

Kennedy restricted the study area to the delta of the Courtenay River, and did not survey intertidal portions of the estuary seaward of Comox Marina and the ship breakwater, along the northern and southern margins of the estuary, respectively. Generally, the species assemblages described by Kennedy are characteristic of tidal fresh and brackish marshes.

Brooks *et al*. (1994) conducted a survey of intertidal species assemblages of the Trent River delta. They documented 9 major assemblages, of which several were characterized by sub-assemblages. These assemblages and sub-assemblages are listed according to dominant species:

1. salt grass (*Distichlis spicata*) - pickleweed (*Salicornia virginnica*)
   - 1a. salt grass - saltbush (*Atriplex patula*)
   - 1b. salt grass - sea milkwort (*Glaux maritima*)
   - 1c. salt grass - arrowgrass (*Triglochin maritimum*);

2. pickleweed
   - 2a. pickleweed - gumweed (*Grindelia integrifolia*)
   - 2b. pickleweed - salt grass
   - 2c. pickleweed - seaside plantain (*Plantago maritima*)
   - 2d. pickleweed - saltbush;

3. saltbush
   - 3a. saltbush - gumweed;

4. sea milkwort - pickleweed;

5. gumweed - arrowgrass
   - 5a. gumweed - pickleweed;

6. seaside plantain - pickleweed
   - 6a. seaside plantain - salt grass;

7. sandspurry (*Spergularia canadensis*) - pickleweed;

8. quack grass (*Agropyron repens*) - salt grass; and

9. Arctic rush - gumweed.

In general, the species assemblages of the Trent River delta are characteristic of salt marsh. For the most part, the high elevation assemblages are distinguished by salt grass, while pickleweed typifies mid elevation assemblages. Sea milkwort and sandspurry are indicative of low elevation assemblages.

The Sensitive Ecosystems Inventory Project, a joint project of the Canadian Wildlife Service and the British Columbia Conservation Data Centre, surveyed specific marshes within the estuary. The data provided by this field exercise (British Columbia Conservation Data Centre, 1998), in conjunction with data collected during a reconnaissance survey of vegetation conducted during the summer of 1998 as part of the Management Plan planning exercise, provides an indication of the distribution of fresh, brackish and salt marshes throughout the estuary.

Fresh marshes within the western portion of the planning area, encompassing lower reaches of the Tsolum and Puntledge rivers, and the Courtenay River, are characterized by species tolerant of water level fluctuations attributable to both tidal and riverine processes. Prevalent species along the main hydraulic channels include water sedge (*Carex aquatilis*), mannagrass (*Glyceria* spp.), small-fruited bulrush, reed canary grass (*Phalaris arundinacea*) and reed fescue (*Festuca arundinacea*). Exposed backwater channels, where organic fines dominate soils within the rooting horizon for plants, are characterized by small-fruited bulrush and reed canary grass along the higher margins of the channels, while mannagrass, spike rush (*Eleocharis palustris*), burreed (*Sparganium* sp.), water plantain (*Alisma plantago-aquatica*), beggar's tick (*Bidens tripartita*) and purple loosestrife (*Lythrum salicaria*) characterize the lower margins.

Moving downstream from the Tsolum and Puntledge rivers and into the Courtenay River, Lyngby's sedge becomes a conspicuous component of fresh marshes downstream of the 5th Street bridge. The distribution of Lyngby's sedge extends into the brackish marshes located in immediate proximity of the mouth of the Courtenay River. In order of increasing salinity, species assemblages, as defined by species exhibiting dominance in areal cover, include:

1. Lyngby's sedge;

2. Arctic rush-Pacific cinquefoil-Lyngby's sedge;

3. tufted hairgrass-Pacific cinquefoil-Lyngby's sedge; and

4. salt marsh bulrush-Lyngby's sedge (restored sewage lagoon at Lagoon Park).

Lyngby's sedge is a conspicuous component of a tidal fresh marsh, known as Hollyhock flats (Plan 19915 and District Lot 190), in immediate proximity to the mouth of Dyke slough. Fresh water influence is strong, and is provided by the discharge of the Courtenay River (through a permeable back levee) and Duck Slough. The species assemblage of this marsh is highly diverse, with dominant species including marsh hollyhock, Pacific cinquefoil, mannagrass, tufted hairgrass, Arctic rush and water parsley. Conspicuous, but less common species include softstem bulrush (*Scirpus validus*), marsh willow-herb (*Epilobium watsonii*), mint (*Mentha arvensis*), northern rice root (*Fritallaria camschatcensis*), Columbia lily (*Lilium columbianum*), beggar's tick, water plantain, purple loosestrife and Pacific aster (*Aster subspicatus*).

Hollyhock Flats is notable for sustaining the greatest concentration of purple loosestrife within the Courtenay River estuary. It is a non-native emergent that is extremely invasive, and if left unchecked, can displace native species and establish expansive mononspecific stands. Due in large part to the efforts of the Comox-Strathcona Natural History Society, whose members endeavour to remove

loosestrife from fresh and brackish marshes of the Courtenay River estuary, loosestrife is only an incidental species within fresh and brackish assemblages.

The delta lagoon of Millard Creek is characterized by a species assemblage dominated by Lyngby's sedge-bentgrass (*Agrostis alba*). Conspicuous but less common species include reed canary grass, tufted hair grass, marsh hollyhock, cattail (*Typha latifolia*), soft stem bulrush (*Scirpus validus*), Pacific aster, and lilaeopsis (*Lilaeopsis occidentalis*).

Brackish marsh is the dominant marsh type along the southern shoreline of the estuary, from approximately Lagoon Park to the ship breakwater. The high elevation zone of the marsh is dominated by tufted hairgrass, with occasional reed canary grass, reed fescue and wild rye along the landward margin of the zone, and Lyngby's sedge and three-square bulrush along the waterward margin of the zone. The low elevation zone of brackish marsh is dominated by three-square bulrush.

Brackish marsh is prevalent along the northern shoreline of the estuary from approximately the cement silo to the delta of Brooklyn Creek. Due to the numerous fresh seeps that occur along the northern shoreline, the species assemblage of the high elevation marsh is disjunct. Broad-leaved cattail and small-fruited bulrush are typical fresh species that occur at seepage locations. The high marsh is dominated by grass species, with tufted hairgrass, reed canary grass, reed fescue and several bentgrass species occurring as mixed species or monospecific stands. The waterward margin of the high elevation zone is occupied by Lyngby's sedge, three-square bulrush and salt marsh bulrush. The lower elevation zone is dominated by three-square bulrush.

Salt marsh along the southern shoreline of the estuary, moving in an easterly direction from the ship breakwater towards Baynes Sound, is first apparent at the Shell Pier at Royston. Due to seeps along the high water mark, the highest elevations of this marsh sustain a mixed assemblage of emergent species characteristic of both brackish and salt marshes. Wild rye defines the landward margin of this assemblage, with conspicuous species consisting of tufted hairgrass, Pacific cinquefoil, three-square bulrush, arrowgrass, and Arctic rush. Beyond the immediate influence of the seeps, species typical of salt marshes dominate. The higher elevation component of this assemblage is characterized by salt grass and sea milkwort, with other conspicuous species being arrowgrass, gumweed, pickleweed, sandspurry, alkali grass (*Puccinellia pumila*) and seaside plantain. The lower elevation component of the salt marsh is characterized by salt grass and pickleweed, with other conspicuous components being gumweed, sea milkwort, sandspurry, alkali grass and seaside plantain.

Salt marsh species assemblages to the seaward margin of the planning area of the southern shoreline are organized in general accordance with associations described by Brooks *et al.* (1994).

Field surveys of northern shoreline salt marshes conducted as part of the Management Plan planning exercise provided the most compelling information regarding emergent plant assemblages of the Courtenay River estuary. Expansive stands of saltmeadow cordgrass (*Spartina patens*) were observed at the delta of Brooklyn Creek to the embayed area of Goose Spit. Saltmeadow cordgrass is not native to coastal British Columbia. It has its origins on the Atlantic coast of North America, where it is a dominant species of high elevation salt marshes. It was not documented within the estuary by either Kennedy (1982), Brooks *et al*. (1994) or by the Sensitive Ecosystems Inventory Project (British Columbia Conservation Data Centre, 1998).

Saltmeadow cordgrass is an extremely invasive species. It readily establishes monospecific stands. Near monospecific stands dominate the Brooklyn Creek delta. It is apparent that the plant prefers the higher portions of the elevational zone typically dominated by salt grass. Incidental species existing within near monospecific stands of cordgrass include meadow barley (*Hordeum brachyantherum*), arrow grass, Arctic rush, sea milkwort, pickleweed, gumweed, salt grass, sandspurry and seaside plantain. Within the lower portion of the salt grass elevational zone, cordgrass was an incidental species within an assemblage dominated by salt grass and arrow grass. Other incidental species included pickleweed and sandspurry.

Within the embayed area of Goose Spit, saltmeadow cordgrass is a member of a highly diverse assemblage of emergents, of which Arctic rush and salt grass are the dominant species. Other member species include pickleweed, wild rye, saltbush, seaside plantain and meadow barley. It was absent from the lower portion of the salt grass zone, where salt grass formed a near monospecific stand, and incidental species included pickleweed, gumweed, saltbush, and seaside plantain.

2.1.2.3 Riparian Plant Communities

By rigid definition, riparian plant assemblages are those assemblages that are affected by flowing water. This definition fits many of the tidal marshes within the estuary. The conventional resource management definition interprets riparian plant communities as those communities that occur above the normal high water elevation. For the purposes of the following descriptions, riparian plant assemblages are those assemblages comprised in some part by woody plant species, located in close proximity (marginally below and well above) the normal high water elevation.

The general descriptions of riparian plant assemblages presented below are based on data presented by the Sensitive Ecosystems Inventory Project (British Columbia Conservation Data Centre, 1998) and on data collected during field surveys conducted as part of this planning exercise.

Portions of the riparian plant communities of the Courtenay River and the lower Tsolum and Puntledge rivers are seasonally flooded. A typical flooding event occurs when high flows occur in conjunction with an extreme high tide. The most frequently flooded woody plant assemblages are categorically swamps.

The best example of swamp within the Courtenay River estuary occurs on the island located immediately upstream of the confluence of the Tsolum and Puntledge rivers, where the Tsolum and Puntledge rivers define the northeastern and southwestern margins of the island, respectively. Swamp occurs along the margins of the island, and in association with numerous flood channels that traverse the island. The canopy is dominated by black cottonwood (*Populus trichocarpa*) and red alder (*Alnus rubra*), with occasional western red cedar (*Thuja plicata*) and Sitka spruce (*Picea sitchensis*). Due to the extensive edge associated with the river margin, and a relatively open canopy, the shrub layer is dominated by salmonberry (*Rubus spectabilis*), with occasional ninebark (*Physocarpus capitatus*), black twinberry (*Lonicera involucrata*), willow (*Salix* spp.) and hardhack (*Spiraea douglasii*). Cascara (*Rhamnus purshiana*), a small tree, occurs throughout the shrub layer and as well forms a superficial subcanopy with small red alder and black cottonwood. The herb layer is characterized by lady fern (*Athyrium filix-femina)*, skunk cabbage (*Lysichiton americanum*) and slough sedge (*Carex obnupta*) within shaded areas, while open areas were characterized by mannagrass and small-fruited bulrush. Considerably smaller swamps, displaying similar species membership, may be found in association with the main hydraulic and flood channels of Millard Creek, Brooklyn Creek and Trent River.

Those portions of the island and adjacent mainland not regularly inundated by high water are characterized by a mixed deciduous-coniferous woodland, with Douglas fir (*Pseudotsuga menziesii*), western hemlock (*Tsuga heterophylla*), western redcedar, Sitka spruce, broadleaf maple (*Acer macrophyllum*), black cottonwood and red alder being the most prevalent canopy species. The shrub layer is well developed, with salmonberry and snowberry (*Symphoricarpos albus*) being the most prevalent species, with other common shrubs being dull Oregon grape (*Mahonia nervosa*), salal (*Gaultheria shallon*), red huckleberry (*Vaccinium parvifolium*) and ninebark. Bitter cherry (*Prunus emarginata*), ash (*Sorbus* sp.) and cascara, together with small individuals of the species that comprise the canopy layer, occur sporadically throughout the shrub layer and often form a poorly developed subcanopy. The herb layer is relatively sparse, with conspicuous constituents being sword fern (*Polystichum munitum*), lady fern, false lily-of-the-valley (*Maianthemum dilatatum*), and vanilla leaf (*Achlys triphylla*). The upper riparian zones of the lower reaches of many of the water courses that discharge flows into the estuary display similar species membership and structure.

Drier riparian sites within the Courtenay River estuary, such as Goose Spit, display an assemblage characterized by a canopy layer that is often incomplete,

and that is predominantly Douglas fir. Douglas fir is occasionally accompanied by broadleaf maple and white pine (*Pinus monticola*). These species often comprise a poorly developed subcanopy layer, with smaller individuals also comprising a portion of the shrub layer. Prevalent shrub layer species include black hawthorn (*Crataegus douglasii*), Saskatoon (*Amelanchier alnifolia*), Nootka rose (*Rosa nutkana*), snowberry, dull Oregon grape and ninebark. Scotch broom (*Cystisus scoparius*), a non-native species, is often a dominant species of exposed shrub assemblages.

Scotch broom occurs throughout the planning area within disturbed riparian areas. Other common non-native invasive species of disturbed riparian areas include Himalayan blackberry (*Rubus discolor*) and evergreen blackberry (*R. laciniatus*).

2.2 Benthic Invertebrates[3]

The planning area sustains a rich community of invertebrates, due in large part to the diversity of physical environments that occur within the estuary. Substrate type, elevation and salinity strongly influence the species membership and abundance of invertebrates at a particular locale. The values of these parameters define specific physical environments, and are dependent upon the nature of the prevailing physical feature. Notable features within the estuary include the exposed sand beaches of Goose Spit, the protected mud/sandflats of Goose Spit, the tidal backwater of Courtenay Lagoon, the rocky alluvial flats of the Trent River delta and the breakwaters of marina facilities. The hardness and extent of consolidation of substrates determines whether or not an invertebrate assemblage is characterized by encrusting or burrowing species. Elevation determines the duration of exposure during low tide events; the higher the elevation, the greater the duration of exposure. Special adaptations allow particular invertebrates to tolerate exposure during low tide events. Invertebrates typically inhabit a restricted range of salt concentrations within water. Species typical of high salt (marine) environments are intolerant of low salinities, while species typical of low salt (riverine) environments are intolerant of high salinities. Salinity increases with increasing distance from the mouth of the Courtenay River and the outlets of other watercourses located within the planning area. Specific assemblages of invertebrates inhabit specific physical environments.

Recent studies of the occurrence and distribution of estuarine and marine invertebrates for the Courtenay River estuary are unavailable; however, an overview can be developed based on Morris *et al.* (1979), Holmes *et al.* (1985), Envirowest (1991;1993) and Brooks *et al.* (1994). A survey of intertidal invertebrates along the outer shores of Comox Harbour in 1974 yielded 30 species of marine marcroinvertebrates (Pollution Control Branch, 1974, cited in Morris *et al.*, 1979). The most abundant epifauna collected were beach crabs (*Hemigraspus mudus*), barnacles (*Balanus balanus*), mussels (*Mytilus*

[3] Benthic invertebrates are organisms that live on or in the bed of the ocean, from the high water mark to the greatest depths. Epifauna are benthic invertebrates that live on the surface of the ocean floor; infauna burrow into the ocean floor.

edulis), limpets (*Acmaea pelta* and *A.digitalis*), rock whelks (*Thais lamellosa*) and Pacific oysters (*Crassostrea gigas*). The most abundant infauna were polychaetes, ghost shrimp (*Callianassa californicus*) and pelecypods). Associations of these marine species were found as far upstream in the estuary as the mouth of Millard Creek.

As part of a study of the impacts on fish and fish habitat of seven British Columbia coastal marinas, Holmes *et al.* (1985) identified 19 macroinvertebrate encrusting and epifaunal species inhabiting the basin substrate, pilings, wharf and breakwater associated with Comox Marina, shown in Table 2.1.

Holmes *et al.* (1985) estimated the abundance of benthic organisms in the marina area relative to a control site, through analysis of six benthic samples taken from the marina area, and six taken from the control site. Twenty-six groups of benthic organisms were identified, of which nematodes were most abundant, followed by harpacticoid copepods, polychaetes, bivalves, and oligochaetes.

Table 2.1 Macroinvertebrates in the Vicinity of Comox Marina[4]

Scientific Name	Common Name	Scientific Name	Common Name
Cancer magister	edible crab	*Pisaster ochraceus*	purple star
Pugettia producta	kelp crab	*Obelia longissima*	sea plume
Cancer producta	red rock crab	*Henricia sanguinolenta*	blood star
Pisaster brevispious	giant pink star	*Dermasterias imbricata*	leather star
Parastichicopus californicus	California sea cucumber	*Pycnopodia helianthoides*	sunflower star
Balanus sp	barnacles	*Tonicella lineata*	lined chiton
Metridium senile	plumrose sea anemone	*Mopalia muscosa*	mossy chiton
Rostanga pulchra	red nudibranch	*Diaulula sandiegensis*	spotted sea slug
Mytilus edulis	edible blue mussel	*Notoacmea persona*	conical limpet

As part of an assessment of environmental impacts associated with proposed expansion of Comox Marina, Envirowest (1991) sampled infaunal invertebrate communities within the proposed expansion area and a comparable control site located immediately west of the marina. Divers noted species encounters along survey transects for encrusting and other epifaunal invertebrates.

The expansion area encompassed low intertidal and shallow subtidal mud/sandflats. The seaward portion of the expansion area encompassed a portion of an eelgrass (*Zostera marina*) bed. Within the expansion area, infaunal polychaetes and oligochaetes

[4] Source: Holmes *et al.* (1985)

represented the dominant (i.e. numerically) group of organisms for both intertidal and subtidal eelgrass flats. The most prevalent mollusk was *Macoma* spp. Dominant crustaceans were the amphipod *Corophium* spp. and the tanaid *Leptochelia savignyi*; both crustaceans were most prevalent within the muddy sands of the eelgrass bed. Epifaunal invertebrates occurred sporadically along the diver transects. Barnacles (*Balanus balanus*), blue mussel (*Mytilus edulis*), and oyster (*Crassostrea gigas*) occurred on cobble that occurred sporadically within the intertidal zone. Bubble shells (*Haminoea vesicula*) and cockles (*Clinocardium nuttalii*) were conspicuous inhabitants of the eelgrass bed. The interface of the eelgrass bed and landward mud/sandflats was noted by the presence of rock crab (*Cancer productus*) and tall-spired snail (*Batillaria zonalis*). A leather star (*Dermasterias imbricata*) and a moon snail (*Polinices lewisii*) were also observed within the eelgrass bed.

As for the marina expansion area, the control site encompassed low intertidal and shallow mud/sandflats and an eelgrass bed. Numerically, the dominant group of infaunal organisms within the intertidal zone were the soft shell clam (Macoma sp.) and Japanese littleneck (*Tapes phillippinariium*). The dominant group of infaunal organisms within the eelgrass bed crustaceans, of which the amphipod *Corophium* spp. and the tanaid *L. savignyi* were dominant. The most prevalent epifaunal invertebrates of the intertidal were tall-spired snail (*Batillaria zonalis*) and periwinkle (*Littorina* sp.). The most prevalent invertebrate of unvegetated subtidal sandflats and the eelgrass bed was the sand dollar (*Dendraster excentricus*). Blue mud shrimp (*Upogebia pugettensis*) were observed sporadically within the subtidal portion of the control site.

The most comprehensive study of the diversity and abundance of marine invertebrate species within the planning area was conducted by Brooks *et al.* (1994). Their study, conducted over the course of 1987, focused on describing the vegetation, marine fauna and birds of the Trent River estuary and delta. During this period, they identified 106 species of marine invertebrates (see Appendix B-2). They also produced a quantitative assessment of invertebrate abundance, based on samples taken from 30 stations in the study area. Brooks *et al.* (1994) found that the most abundant epifauna included the little acorn barnacle (*Chthamalus dalli*), acorn barnacle (*Balanus glandula*), and checkered periwinkle (*Littorina scutulata*). The most abundant infauna were the Japanese littleneck clam (*Tapes japonica*) and the threadworm (*Notomastus tenuis*). Invertebrates characteristic of high, mid and low elevation tidal zones are presented in Appendix B-2.

2.3 Fish

The Courtenay River estuary provides critical habitat functions for a variety of marine and anadromous fish. Morris *et al.* (1979), citing Goodman (1974) and Beamish *et al.* (1976), lists 58 species found in or near the Courtenay and Oyster river estuaries (see Appendix B-3). More recent underwater surveys by Holmes (1985) and Adams (1992), and beach seining by Brooks *et al.* (1994) resulted in identification of a total of 29 species, most of which are listed by Morris *et al.* (1979). Information on the distribution

and abundance of fish species utilizing the estuary is unavailable. The major commercial species found in the estuary include anadromous trout, Pacific salmon, and Pacific herring.

2.3.1 Anadromous Trout

The Puntledge, Tsolum and Trent rivers have all sustained stocks of steelhead (*Oncorhynchus mykiss*) in the past, although these stocks have declined significantly in recent years (see Appendix B-4). According to Morris *et al.* (1979), the Puntledge River race historically migrated to the upper reaches of the river throughout November, December and January, where they spawned in Comox Lake and associated creeks and rivers. Juveniles also reared in these areas of the upper Puntledge system. The decline of this race is generally attributed to changes to the Puntledge River power generating facility in the 1950's (see Section 2.3.2.2). The subsequent stock management strategy has centred on the Puntledge River Hatchery, and a catch and release fishery. The Tsolum River also supported a large stock of steelhead, but this stock has declined dramatically since the 1960's. The Ministry of Environment, Lands and Parks attributes this trend to deteriorating water quality (Axford, 1998). Water quality problems stem from acid leachate and high levels of dissolved copper leaching from an abandoned mine on Mount Washington. Information on use of the Courtenay River estuary by juvenile steelhead is not available.

Cutthroat trout (*O. clarki*) have been documented in Puntledge, Tsolum, and Trent rivers, and in Millard-Piercy, Roy and Brooklyn creeks (Morris *et al.*, 1979). Adults of this species typically start moving into freshwater in the spring or fall, although they may move back and forth between the estuary and spawning streams for some time while they feed on terrestrial and aquatic prey (Morris *et al.*, 1979). Spawning occurs from November to March and fry emerge from March to July. Juvenile cutthroat trout spend their first 2 year in freshwater before migration (Morris *et al.*, 1979). While the estuary appears to be important to this species, studies are not available that document habitat functions sustained for cutthroat trout.

2.3.2 Pacific Salmon

The creeks and rivers connected with the Courtenay River estuary presently sustain all five species of Pacific salmon, with over 110,000 spawners on average returning each year. The vast majority of these fish are chum salmon (*O. keta*) and pink salmon (*O. gorbuscha*) returning to the Courtenay River system, as indicated in Table 2.2. Generally, adult salmon migrate upstream through the estuary from May through December. Juveniles migrate downstream from March to June. The estuary is known to provide critical rearing habitat for 3 species, including chinook salmon (*O. tshawytscha*), coho salmon (*O. kisutch*), and chum salmon (Healy, 1978).

Table 2.2 Average Annual Salmon Escapements for Ten Years Within the Period 1983-1994 [5,6]

Species	Courtenay	Trent	Roy	Millard	Total
Chinook	621				621
Chum	65,450	467	39	121	66,077
Coho	5,504	1,028	113	63	6,708
Even Year Pink	13,930	92			14,022
Odd Year Pink	23,460	134		25	23,619
Sockeye	14				14
Total	108,979	1,721	152	209	111,061

2.3.2.1 Juvenile use of the estuary

Healy (1978) documented the use of the Courtenay River estuary by juvenile salmonids. He found that chinook, chum and coho salmon all made use of the Courtenay River estuary for rearing. The greatest concentrations of juvenile chinook salmon in the estuary were found during May. This species occupied areas were the salinity ranged from 10 to 27 parts per thousand. Their preferred habitats included the river channel and marshes north and west the Lafarge Cement Silo, although they were found throughout the river channel and associated marshes as far east as the Comox Marina. At high tide, they moved to the margins of the estuary. These fish were found to feed on adult and larval insects, harpacticoid codepods, amphipods, crab and other decapod larvae, mysids, fish larvae and fish eggs. Chum salmon fry were found to migrate downstream to the estuary from May to early June, where they were located in Goose Spit Lagoon and in the vicinity of Comox. Coho salmon were found to migrate downstream to the estuary as smolts. They were caught in Dyke Slough and in Comox Harbour (Healy, 1978).

2.3.2.2 Decline of Puntledge River Stocks

The Puntledge River historically sustained large stocks of a local race of chinook salmon, known to spawn in the upper reaches of the river. The summer and autumn runs were of such abundance and large size that they supported an international sport fishery, based in Comox Harbour, from the turn of the century to the 1960s (Isenor *et al.*, 1987). The decline of the Puntledge River chinook salmon runs, as well as runs of other salmon species and steelhead trout, is largely associated with improvements to the Puntledge River hydro-electric power generating station in the 1950's (Department of Fisheries and Oceans, 1958;

[5] Source: Fisheries and Oceans Canada (1998). The actual 'ten year' period for each species returning to each waterbody varies (i.e., 1983-92, 1984-93) and in some cases the actual number of years for which data is available may be less than ten years.

[6] Escapement data were unavailable for this period for Brooklyn and Oland creeks.

Lister, 1968; Morris *et al.*, 1979). Table 2.3 provides chinook salmon stock status data for a twenty year period from 1949 to 1969.

Generally, the construction of an impoundment dam in 1913 obstructed passage for all varieties of fish to Comox Lake and the upper Puntledge watershed. A fishway constructed in 1927 provided unreliable access; upgrades to the fishway were undertaken in 1946 to improve access. Hydro facility upgrades during the 1950=s posed a number of additional fisheries problems, which were initially assessed by Fisheris and Oceans Canada during the upgrading process (Department of Fisheries and Oceans, 1958). Reduced flows downstream of the impoundment dam exposed salmon migrating upstream to the hazards of delay and injury. Reduced flows also impeded access to certain spawning areas, prevented spawning activity, and exposed fertilized eggs to the hazards of desiccation and freezing. The increased diversion of flow at the modified intake structure resulted in increased entrainment of downstream migrant juveniles and mortality in the turbine estimated to be as high as 60 percent (Department of Fisheries and Oceans, 1958). Increased outflow at the powerhouse tailrace attracted upstream migrants, resulting in further injuries to fish.

Table 2.3 Change in Chinook Stock Status Over Five-Year Periods for the Puntledge River[7]

Five Year Period	Summer Run Chinook	Fall Run Chinook
1949 - 1953	2,636	2,760
1954 - 1958	1,530	3,960
1959 - 1963	820	1,430
1964 - 1968	423	495
1969 - 1973	380	252

A variety of strategies have been pursued over the years to address the impacts of the power generating facility on salmon stocks, with largely unsatisfactory results. Access to the upper reaches of the river was blocked in 1965 to prevent mortality of downstream migrants in the turbines. A spawning channel installed below the dam as substitute habitat failed to restore stocks. In 1980, the Puntledge River Hatchery was constructed to rehabilitate fish stocks in the system. The hatchery continues to supply the system with chinook, coho, chum and pink salmon, and steelhead and cuttroat trout. Fry and smolt releases for 1997, the most recent year for which complete data are available, are shown in Table 2.4. Data for the period 1989 to 1999 for adult returns and smolt/fry releases are presented in Appendix B-5.

[7] Source: Smith (1993).

Table 2.4 Puntledge Hatchery Fry and Smolt Releases, 1997

Chinook		Coho	Chum	Pink	Steelhead		Cuttroat
Summer	Fall				Summer	Fall	
406,013	855,821	1,009,375	5,769,448	2,175,938	85,564	48,772	1,064

2.3.3 Pacific Herring

Pacific herring (*Clupea pallasi*) typically return annually to spawn in the intertidal and nearshore subtidal environments of Baynes Sound and the Courtenay River estuary. Spawning in the estuary typically occurs in eelgrass beds around Goose Spit, off Gartley Point, and in the delta between Comox Marina and the Royston booming ground. This species is an important element in the marine food chain; larvae are prey to many fish and invertebrates; juveniles and adults are consumed by marine piscivores such as chinook and coho salmon, as well as by seabirds and marine mammals. Because they spawn in nearshore coastal areas, herring eggs are particularly susceptible to adverse human actions such as shoreline development.

3.4 Birds

Dawe *et al.* (1998) studied bird use of Baynes Sound-Comox Harbour estuarine ecosystem between October, 1981 and October, 1982. They found that this area provided critical life history functions for 176 migratory and resident bird species and that approximately 59,053 individual birds were dependent on the area for some aspect of their life history. Based on the data from this study, Dawe *et al.* (1998) rank the Baynes Sound-Comox Harbour estuarine ecosystem as second only to the Fraser River estuary in terms of its importance as migratory bird habitat within the Strait of Georgia. They further conclude that the Baynes Sound-Comox harbour area qualifies as a Awetland of international significance" as defined by the Convention on Wetlands of International Importance (the Ramsar Convention). The area, as of 1981, was found to regularly support a minimum of almost 59,053 birds at some stage of their life cycle and it supported at least 1 percent of the world populations of 9 species (Pacific loon, western grebe, great blue heron, trumpeter swan, Brandt, black turnstone, mew gull, Thayer=s gull, glaucus-winged gull).

As part of this larger, internationally significant bird habitat, the Courtenay River estuary provides critical life history functions for approximately 150 species[8] of resident and migratory birds (see Appendix B-6). Estimates of total numbers of birds dependent on habitats in the Comox Harbour are not available. However, Brooks *et al.* (1994) in their

[8] This figure is the total number of species identified by Dawe *et al.* 1998 in shorezone units 1 - 25, during the course of their study (1980-81). 'One Day Christmas Bird Counts' conducted each year from 1990 through 1998 show a combined total of 147 species observed for the area defined as "Comox Valley" (Sauer *et al.* 1996).

study of the vegetation, marine fauna and birds of the Trent River estuary, identified 124 species and estimated that a minimum of 7,153 birds were dependent on the Trent River estuary alone for some aspect of their life history.

Detailed studies of bird use of habitats for the entire Courtenay River estuary are not available. However, Dawe *et al.* (1998) provide insight into species= preferences for specific areas of the estuary. Dawe *et al.* (1998) note that, generally, the area near Roy Creek and the Trent River received more use by birds than all but one of the 48 shorezones in the Baynes Sound-Comox Harbour study area during the study period October,1980 to October, 1981. Over the course of the year, approximately 24,000 thousand ducks (primarily diving ducks), 11,000 western grebes, and 11,000 gulls were observed.

Comparative use of the Courtenay River estuary by species during each season is shown on Table 2.5. According to data from Dawe *et al.* (1998), the numbers of waterbirds present in the Comox Harbour for autumn, winter and spring of 1980-81 were higher than for any other bird group. In autumn, diving ducks were present in largest numbers, followed, in terms of comparative abundance, by dabbling ducks, gulls, passerines and grebes. The seasonal total number of observations of all species in Comox Harbour for autumn was 116,114. In winter, diving ducks were again present in largest numbers, followed by gulls, dabbling ducks, grebes and passerines. The seasonal total number of observations for all species in Comox Harbour was 74,696. In spring, diving ducks again ranked first in terms of comparative use of the estuary, followed by gulls, dabbling ducks, geese, and passerines. The seasonal total number of observations for all species in Comox Harbour was 70,724. In summer, gulls were present in largest numbers, followed by diving ducks, passerines shorebirds and dabbling ducks. The seasonal total number of observations for all species in Comox Harbour for spring was 32,177.

Table 2.5 Proportional Bird Species Group Use of Comox Harbour Per Season, 1981-82[9]

Species Group	**Season**							
	Autumn		**Winter**		**Spring**		**Summer**	
	total[10]	%[11]	total	%	total	%	total	%
Loons	460	0.40	351	0.47	531	0.75	50	0.16
Grebes	12,614	10.90	5,746	7.70	4,573	6.50	32	0.10
Cormorants	297	0.26	194	0.26	85	0.12	7	0.02
Herons	326	0.28	144	0.19	319	0.45	572	1.78
Swans	189	0.16	351	0.47	10	0.01	8	0.02

Table 2.5 continued

[9] This table is based on data from Dawe *et al.* (1998). Proportional species use is calculated using the total number of birds counted.

[10] This number is the total number of birds counted during weekly surveys in the study area for the period 1980-81. It does not represent the actual number of birds dependent on the estuary (see Dawe *et al.* 1998).

[11] Represents proportion of species group using estuary per season.

Species Group	Season							
	Autumn		Winter		Spring		Summer	
	total	%	total	%	total	%	total	%
Geese	495	0.42	9	0.01	7,720	10.91	202	0.63
Dabbling Ducks	24,637	21.23	15,919	21.31	10,669	15.08	2,115	6.57
Diving Ducks	42,765	36.83	26,342	35.27	27,161	3841	7,701	23.93
Raptors	128	0.11	282	0.38	136	0.19	109	0.34
Land Fowl	1	0.00	1	0.00	6	0.01	2	0.01
Coots/Cranes	456	0.39	140	0.19	108	0.15	8	0.02
Shorebirds	2,927	2.52	402	0.54	1,683	2.39	3,231	10.04
Gulls	15,989	13.77	20,612	27.59	12,692	17.95	11,116	35.55
Terns/Alcids	46	0.04	222	0.30	19	0.03	19	0.06
Doves/Pigeons	212	0.18	50	0.07	102	0.14	81	0.25
Hummingbirds					15	0.02	10	0.03
Kingfishers	111	0.10	67	0.09	37	0.05	87	0.27
Woodpeckers	56	0.05	18	0.02	28	0.04	14	0.04
Passerines	14,405	12.41	3,846	5.15	4,830	6.80	6,813	21.17
Total Observations	116,114		74,696		70,724		32,177	

2.4.1 Bird Species of Management Concern

Bird species of management concern are typically those identified on the Provincial Red and Blue lists. The Red and Blue lists provide a list of species to be considered for more formal designation as Endangered or Threatened, either provincially under the *British Columbia Wildlife Act*, or nationally by the *Committee on the Status of Endangered Wildlife in Canada* (COSEWIC). These lists also serve as a method of assigning conservation priorities for species considered at risk in British Columbia (Ministry of Environment, Lands and Parks, 1998a). Red listed species "include any indigenous species or subspecies (taxa) considered to be Extirpated, Endangered or Threatened in British Columbia. Extirpated taxa no longer exist in the wild in British Columbia, but do exist elsewhere. Endangered taxa are facing imminent extirpation or extinction. Threatened taxa are likely to become endangered if limiting factors are not reversed" (Ministry of Environment, Lands and Parks, 1998a). Blue-listed species "include any indigenous species or subspecies considered to be vulnerable in British Columbia. Vulnerable taxa are of special concern because of characteristics that make them particularly sensitive to human activities or natural events. Blue listed taxa are at risk, but not Extirpated, Endangered or Threatened" (Ministry of Environment, Lands and Parks, 1998a).

Among approximately 150 documented species associated with the Courtenay River estuary, there are presently 4 species on the 1999 Provincial Red List and 8 species on the 1999 Provincial Blue List. Table 2.6 lists these species.

Table 2.6 Red and Blue Listed Bird Species Associated with the Courtenay River Estuary [12,13]

Red List		**Blue List**	
Scientific Name	**Common Name**	**Scientific Name**	**Common Name**
Aechmorus occidentalis	western grebe	*Phalocrocorax auritus*	double crested cormorant
Buteo swainsoni	Swainson's hawk	*Ardea herodias*	great blue heron
Uria aalge	common murre	*Cygnus buccinator*	trumpeter swan
Brachyramphus marmoratus	marbled murrelet	*Clangula hyemalis*	oldsquaw
		Melanitta perspicillata	surf scoter
		Grus canadensis	sandhill crane
		Limnodromus griseus	short billed dowitcher
		Larus californicus	California gull

2.5 Mammals

2.5.1 Terrestrial Mammals

Morris *et al*. (1979) noted a lack of information about terrestrial mammals in their study area, which extended from Deep Bay to Oyster Bay and included the Courtenay River estuary and watershed. This situation appears to be unchanged; recent studies of mammal presence and use of habitats associated with the Courtenay River estuary were not available for this document.

A list of mammals potentially found near the Courtenay River estuary is presented in Appendix B-7. Based on Stevens (1995), this list identifies 25 species, native or introduced to Vancouver Island, that are known to utilize habitats in the Maritime subzone of the Coastal Western Hemlock biogeoclimatic zone. Three (3) of these species, the water shrew (*Sorex palustris brooksii*), the Keen's myotis (*Myotis keenii*) and the wolverine (*Gulo luscus vancouverensis*) are considered endangered (red listed); 3 species, the Townsend's big-eared bat (*Plecotus townsendii*), the Vancouver Island ermine (*Mustella erminea anguinae*) and the Roosevelt elk (*Cervus elaphus roosevelti*), are considered vulnerable (blue listed).

[12] The identification of Red and Blue listed species associated with the Courtenay River estuary is based combining species identified by Dawe at al. (1998) during 1980 - 81, and species identified during One Day Christmas Bird Counts for "Comox Valley" from 1983 to 1998 (Sauer *et al*. 1996)

[13] Source: Ministry of Environment, Lands and Parks (1999)

2.5.2 Marine Mammals

Morris et al. (1979) reported 8 species of marine mammals utilizing Baynes Sound and the nearby Strait of Georgia. Of these, the harbour seal (*Phoca vitulina*) was identified as being an extensive user of the Courtenay River estuary, with one colony of seals known to haul out nightly on log booms at Royson. More recently, the harbour seal has been identified as a species of management concern in the estuary due to predation on salmonids. Jurk *et al.* (1996) found that this species was forming feeding lines under the 5th Street and 17th Street bridges (City of Courtenay) at night in spring, intercepting thousands of smolts that were migrating downstream. Management strategies that have been implemented or considered include annual culls, translocation, and feeding pattern disruption.

2.6 Water Quality

2.6.1 Fish/Temperature

Morris *et al.*(1979) reviewed the literature regarding general water quality conditions for salmonids and found that temperature, dissolved oxygen, pH, turbidity and relative concentration of diatoms in the Courtenay River estuary were acceptable for salmon. Studies pertaining to water quality parameters for aquatic life in the estuary have not been conducted since the 1970=s. This gap in the research was noted by Bravender (1999). Bravender conducted salmonid sampling at 17 sites in the Courtenay River estuary between May 06 and July 29, 1998. Temperature, salinity and dissolved oxygen levels were also measured for each site. Bravender found that temperatures ranged from a low of 12.0°C to a high of 24.8°C. Generally, temperatures were above 15°C, and increased continuously during the summer sampling. The optimal temperature range for most salmonid species is approximately 12 to 14°C. Lethal levels for adults are generally in the range of 20 to 25°C (Nagpal *et al*., 1995).

2.6.2 Fecal Wastes

Fecal wastes are known to transmit organisms, including worms, protozoans, viruses and bacteria, which are pathogenic to humans and other warm blooded animals. The major means of transmission of such organisms is through direct consumption of water contaminated by fecal matter or through consumption of bivalve molluscan shellfish that have accumulated bacteriological pollutants as a result of exposure to fecal matter in the water column.

The presence of fecal matter is typically determined through the measurement of fecal coliforms, bacteria normally found in human and animal waste. The acceptable level of

fecal coliforms in untreated drinking water is 0 MPN[14]/100mL; the acceptable level for water used for recreational purposes were immersion is probable is 200 MPN/100mL; the acceptable level for shellfish harvesting is 14 MPN/100mL (Nagpal *et al.*,1995). Fecal coliform levels in the Courtenay River estuary are monitored annually by Environment Canada in accordance with its responsibilities, under the Canadian Shellfish Sanitation Program, for water quality and classification of shellfish growing areas.

The Courtenay River estuary has a history of fecal contamination, largely as a result of domestic sewage disposal into the harbour. Morris *et al.* 1979 describe the development and status of domestic sewage management in relation to the estuary. Prior to 1962, the domestic sewage infrastructure of Comox, Courtenay and Cumberland was comprised of storm drains which conveyed raw sewage from houses and septic tanks to outfalls located on the Trent and Courtenay rivers, and around the estuary (Morris *et al.*, 1979). Subsequent treatment initiatives, including the construction of sewage lagoons at Courtenay and Cumberland and the conveyance of Comox sewage to a deepwater outfall in Baynes Sound, helped to mitigate the problem, although studies showed that treated effluent discharged into the estuary from the lagoons still contained high levels of total coliforms (Morris *et al.*, 1979; Waldichuk 1974). Other sources of fecal pollution identified in the 1970=s included effluent from leaking septic tanks near the shoreline of the estuary and agricultural runoff. In 1983, the City of Courtenay constructed a new sewage system that discharged treated effluents into Baynes Sound via a deepwater outfall. The Courtenay Sewage lagoon was abandoned at that time. Despite this significant infrastructural improvement, fecal waste contamination remains a problem in the estuary, particularly for shellfish harvesting.

A recent monitoring program undertaken by the Baynes Sound Stewardship Action Groups and the Comox Valley Project Watershed Society, as part of the Baynes Sound Hot Spots Remediation Project, has focused on the fecal contamination problems posed by malfunctioning sanitary sewer/storm drain cross-sections (Pinho, 1998). A stormwater study in 1996 collected 381 fecal samples from 60 storm drain outfalls in Royston, the City of Courtenay, the Town of Comox and the Regional District of Comox Strathcona. The study found that effluent from 14 of these outfalls posed high or medium human or shellfish contamination risk (Pinho, 1998). As a result of this study, the City of Courtenay repaired 35 connections and the Town of Comox repaired 7 connections. A monitoring study conducted in 1998 indicated that these repairs had resulted in a significant improvement in the water quality of effluent discharged from storm drains in Courtenay and Comox (Pinho, 1998).

The issue of leaking septic systems is also being addressed as part of the Hot Spots Remediation Project, an initiative of the Baynes Sound Round Table. The Septic Care and Maintenance component of the Hot Spots project was undertaken by the Comox Valley Citizens Acting for Recycling and the Environment (CARE) in 1996. It has included the development of a Septic System Manual, voluntary system inspections and

[14] Most Probable Number (MPN)

education on septic system care (Heath, 1998a). A third component of the Hot Spots Remediation Project is focused on mitigating water quality impacts of agricultural runoff.

The discharge of sewage from boats is also a concern. At present, there are no regulations prohibiting the discharge of sewage from pleasure or commercial craft into Baynes Sound, including the Courtenay River estuary. However, the Ministry of Environment, Lands and Parks has recommended that the Federal *Canada Shipping Act* >Pleasure Craft Sewage Pollution Prevention Regulations= be amended to designate Baynes Sound as a prohibited area for sewage discharge. This designation would affect both pleasure and commercial craft using the estuary. Boaters would be required to dump their sewage in the Strait of Georgia, or other undesignated waters, or seek marina pump-out facilities. Presently, there are no sewage pump-out facilities available at marinas in the estuary, although Comox Bay Marina is considering developing a sewage pump-out service (Krejge, 1998).

The Ministry of Environment, Lands and Parks Pollution Prevention Branch is responsible for authorizing the discharge of domestic sewage into aquatic systems. There is only one sewage discharge permit in the planning area. Permit PE-0551, held by Kingfishers Inns Limited, authorizes the holder to discharge 38 m^3/day of treated sewage effluent, with a fecal coliform count of 2.2 MPN/100mL, into the estuary (Brown, 1998) (see Appendix B-8 for details).

2.6.3 Hydrogen Sulphide

Hydrogen sulphide (H_2S), formed from the anaerobic decomposition of organic matter containing sulphur (i.e. wood waste), is toxic to fish. The water quality criterion for the protection of aquatic life in British Columbia for H_2S is 2 *u*g/L. Toxic accumulations of H_2S in the water column are known to occur in areas of reduced water circulation. Substrate disturbance of accumulated wood debris is known to result in the release of H_2S (Fraser River Estuary Management Program, 1991). The potential for H_2S release as a result of dredging or other substrate disturbances at log handling and storage areas in the estuary is an ongoing water quality concern.

2.6.4 Industrial and Commercial Effluents

2.6.4.1 Antisapstain Chemicals/Sawmills

Antisapstains are chemicals used to protect export lumber from decay and discoloration caused by the growth of fungus and moulds on freshly cut softwoods. They are applied to non-kiln dried lumber in a water soluble formulation and are readily dispersed into the aquatic environment. These chemicals can be acutely toxic to fish and other organisms (Environment Canada, 1997). The most widely used antisapstain formulations contain 3-iodo-2-propynyl butyl carbamate (IPBC) and didecldimethyl ammonium chloride (DDAC) (Environment Canada, 1997). Pursuant to Section 36(3) of the Federal *Fisheries*

Act, Environment Canada has pursued monitoring, compliance and best management practices initiatives regarding antisapstains since the 1980=s. The Ministry of Environment, Lands and Parks introduced the >Antisapstain Chemical Waste Control Regulation=, under the Provincial *Waste Management Act*, in 1989 to further pursue these initiatives.

Field Sawmill (Primex Forest Products Limited) effluent is monitored quarterly to test for compliance with the >Antisapstain Chemical Waste Control Regulation=. Recent results indicate that the operation has maintained 90 percent compliance with respect to the concentration of DDAC in its effluent. The toxicity of the effluent for fish remains a problem for Field Sawmill as it does for the antisapstain industry as a whole (Finnabogason, 1999). In addition to structural and procedural improvements pursued over the past decade, Primex Forest Products Ltd. is developing a log yard runoff containment system for Field Sawmill to enhance its regulatory compliance.

2.6.4.2 Tidal Grid/Boatways

Currently, debris and powerwash effluent from repairs at all grids in the planning area are drained into the estuary (Poole, 1998). There are no provincial or federal environmental guidelines or regulations pertaining to tidal grid design and effluent.

2.6.4.3 Permits

The Ministry of Environment, Lands and Parks Pollution Prevention Branch is responsible for authorizing the discharge of commercial and industrial effluents into aquatic systems. There is only one commercial discharge permit in the planning area. Permit PE-01931, held by Jose Veloso, authorizes the holder to discharge 5.0 m^3/day of seafood processing waste from a septic tank into the estuary (Brown, 1998) (see Appendix B-8 for details).

2.7 Conservation Initiatives

2.7.1 Land Management

2.7.1.1 Millard Creek Wildlife Area

The Millard Creek Wildlife Area, situated east of the Island Highway at Millard Road on Lot A, Plan 15464, Comox District, is owned by the Nature Trust of British Columbia and leased to the Ministry of Environment, Lands and Parks. This site, purchased in 1988, features the Millard Creek estuary, an excellent example of a small estuarine ecosystem that has not been alienated by dyking or other development-related structures and facilities.

2.7.1.2 Duck Slough/Courtenay Estuary Simpson Farm

The Nature Trust of British Columbia owns 0.4 ha of upland and 3.23 ha of wetland associated with Duck Slough, also known as Dyke Slough, Lloyd Slough and Rosenlof Slough. The Nature Trust purchased this property, which is traversed by Comox Road within the Courtenay Flats area, in 1975 to preserve its wildlife values. It is known locally as Rosenlof Waterfowl Sanctuary and is leased to the Comox Valley Naturalists Society. The legal description defines the property as AThat part of Section 7, Comox District, included in the boundaries of Plan 2525, except those parts thereof lying within Lots 2,3,4,5 and 6 of said Plan≅. In addition, the Nature Trust owns the Courtenay Estuary Simpson Farm, which includes Lot 3 Plan 2525 and Lot A Plan 3248. These properties, purchased in 1996, are contiguous with Duck Slough.

2.7.1.3 Greenbelt Properties/Conservation Designations

Within the planning area, the Province of British Columbia owns 5 properties that were acquired under the Provincial *Greenbelt Act*. These properties are located on the east side of the Courtenay River estuary (see Appendix A, Figure 2) and include:

- Lot 1, Plan 3290, Section 7, Comox District;
- Lot A, Plan 2243, Section 7, Comox District;
- Lot B, Plan 2243, Section 7, Comox District;
- Lot A, Plan 3261, Section 7, Comox District; and
- Lot A, Plan 19915, Section 7 & 9, Comox District.

Plans 3290, 3343 and 3261 are upland lots leased to the Regional District of Comox Strathcona for use as a roadside rest and wildlife viewing area.

Plan 19915 comprises an extensive, undeveloped high marsh and tidal slough area. Both Plan 19915 and the adjacent aquatic lot described as District Lot 190, Comox Land District, have been afforded special use designations under Section 17 of the Provincial *Land Act*. They are designated for conservation uses and are administered by the Fish, Wildlife and Habitat Protection Unit.

2.7.1.4 Osprey Nest Reserve

An osprey nest reserve was created in 1998 under a Provincial *Land Act* Section 16 Map Reserve designation. The reserve, which is under the management of the Fish, Wildlife and Habitat Protection Unit of the Ministry of Environment, Lands and Parks, encompasses 22.3 ha and extends approximately 1000 metres from Lagoon Park into the estuary (see Appendix A, Figure 2).

2.7.1.5 Trent River Estuary

Brooks et al. (1994) documented the diverse and abundant ecological resources of the Trent River estuary. A key feature of the estuary is a large alluvial tract or island at the mouth of the river. Thomas Feely, the owner of a farm adjacent to the Trent River estuary, proposes that this island should be protected (Feely, 1998). Mr. Feely believes that the island is part of the original Crown grant for his property (Section 5, Nelson Land District). He is willing to entrust the island to the appropriate environmental agency or group if the interested party facilitates the steps involved in acquiring it. The preliminary opinion of the Office of the Surveyor General regarding the legal status of the island is that determination of ownership will require an extensive review, using mathematical controls, of historic field notes, records and air photos; fieldwork may also be necessary (Beddoes, 1999).

2.7.1.6 Trumpeter Swan Habitat

McKelvey (1981) studied the winter feeding ecology of trumpeter swans in the Courtenay River estuary and Port Alberni. He concluded that the most attractive feature of the Courtenay River estuary for swans was the agricultural fields adjacent to the estuary and that grazing on agricultural pastures was a newly acquired habit with management implications. Typically, overwintering swans in coastal BC prefer the roots and rhizomes of emergent aquatic plants that are readily available in coastal estuaries. The acquisition of the habit of grazing on agricultural pastures is associated with higher nutrient values of agricultural grasses (McKelvey, 1981). From the perspective of trumpeter swan population management, several initiatives have been undertaken in the Comox Valley to secure agricultural pasture or access to it for trumpeter swans. These initiatives have included the acquisition of agricultural land by Ducks Unlimited Canada and the Nature Trust of BC, and planting winter crops suitable for swan consumption. More detailed discussions of these initiatives occur in Section 3.5. A sustained effort to raise awareness of trumpeter swan use of the estuary has been pursued by the Trumpeter Swan Sentinel Society.

2.7.2 Habitat Enhancement

2.7.2.1 Puntledge River Power Generating Facilities

While there are no hydro-electric power generating facilities within the planning area, development of power generating facilities on the Puntledge River have had a documented impact on salmon stocks indigenous to the Puntledge/Courtenay River watershed (Department of Fisheries and Oceans, 1958). A number of remedial measures have been undertaken over the years to mitigate the problems posed by the construction and upgrading of the Puntledge River hydroelectric facility. These activities are summarized in Table 2.7.

Table 2.7 Habitat Enhancement – Puntledge River[15]

Year	Activity
1927	Construction of fishways at impoundment dam and diversion dam provided access to upper watershed; timber construction made upper fishway unreliable.
1946	Reconstruction of upper fishway to provide reliable access.
1954 - 1971	Minimum flow requirements (300 - 500 cfs) imposed through Stotan and Nibs falls area to provide safe passage for upstream migrants.
1956	Installation of protective gratings at powerhouse tailrace tube to prevent access by upstream migrants.
1955 - 1965	Ongoing fish salvages at intake structure to reduce downstream migrant mortality in turbine.
1965	Construction of spawning channel (Aupper site≅) adjacent to diversion dam to substitute for chinook salmon and steelhead trout spawning grounds in the upper watershed.
1965	Closure of upper fishway to terminate upstream migration and subsequent downstream entrainment of juvenile chinook salmon and steelhead trout in intake structure.
1969	Establishment of minimum flow requirements for powerhouse tailrace.
1972	Upper spawning channel converted to rearing channel due to poor survival rates.
1980	Full scale hatchery (Alower site≅) opened.
1981	Coho salmon colonization program initiated in upper watershed using fry and presmolt surplus to the needs of lower river.
1984	Construction of fish ladders at Stotan Falls.
1988 - 1993	Success of upper watershed colonization stimulates investigation of ways to reduce juvenile mortality in turbine. Eicher Penstock Screen found to result 99.8 percent bypass of the intake by downstream migrants.

[15] based on Morris *et al.* (1979); Isenor *et al.* (1987); and Smith (1993)

2.7.2.2 Courtenay Sewage Lagoon/Park

The Courtenay Sewage Lagoon, abandoned in 1983, was redeveloped in the 1990's as a park comprised of a tidal wetland and upland passive recreation area. The Small Craft Harbours Branch of Fisheries and Oceans Canada constructed the wetland as partial compensation for impact to fish and wildlife habitat associated with the expansion of the federal marina at Comox. The tidal wetland consists of mudflats, brackish marsh and subtidal pools. Tidal flows are conveyed by a channel constructed through a breach in the lagoon dyke along its eastern margin.

2.7.2.3 Simms Millenium Park

Simms Millennium Park is located near the upper limits of tidal influence on the Courtenay (Puntledge) River, at the confluence with the Courtenay Slough Federal Harbour. The park is being developed as the 'cultural heart' of the Courtenay Parks system, with a small amphitheatre and a paleotology interpretive route. All uses in the park will be passive, with active sports facilities provided in the existing Lewis Park across 5th Street (Reid, 2000).

Fish and wildlife habitat enhancement is a major component of the park. About 25 percent of the park area is maintained as existing cottonwood forest and wetlands area typical of the historic 'floodplain' setting of the park. Three areas have been excavated to create new intertidal fish habitat, including (Reid, 2000):

- The Back Channel, which is excavated from an old building site on the river side, to provide off-channel refuge and rearing habitat for fish. The channel includes whole tree and root wad large woody debris (LWD), boulder clusters and sedge marsh areas. A new riparian zone of native plant material has been installed around the channel. A new pedestrian bridge at the channel mouth will include interpretive signage on fisheries and other habitat improvements. Remnant piles at the river mouth have been used as supports for new bird boxes.

- The Central Pond, which is excavated from a previous fill site near the centre of the park and is connected to the Back Channel and the Slough by fish accessible culverts. To keep water temperatures cool, the pond is located in the shade of existing woods, has deep micropools, and is subject to tidal flushing every tidal cycle. Large woody debris structures have been placed in the pond, as well as a pile supported deck overlook and interpretive signage. A large terrace in the intertidal zone has been planted as sedge marsh, and native riparian plantings will complete the project.

- The Bay on the Slough, which is excavated at the head of the Slough marina to form a 'bay' shoreline area. Sedge marsh has been planted at the bay centre. A pier and kayak launch may be added in the near future. The bay provides better views from the park to the fish boats and activity in the marina. Smaller pocket

excavations and LWD installations with sedge marsh have also been made along the edges of the park at the Slough.

Salmon use of the LWD in the back channel was observed within two weeks of opening the channel, in September 1999 (Reid, 2000).

The park construction has also been an excellent example of responsible erosion and sediment control, including use of construction staging and scheduling, silt fence, diversion swales, sediment trap, sediment pond, revegetation, grading design, catch basin inlet traps and check dams to create clean water prior to it leaving the site (Reid, 2000).

Most habitat improvements at the Park are now complete. Work will accelerate in the spring of 2000 on the 'people' parts of the park, with Phase One of Simms Millennium Park to open in July 2000 (Reid, 2000).

3.0 Land and Water Uses and Issues

3.1 Introduction

This section describes historic and present land and water uses associated with the Courtenay River estuary. Figure 2 (Appendix A) shows current Crown land tenures and land use priorities in the planning area. Appendix C-1 provides detailed information on Crown land tenures in the planning area.

3.2 Historic First Nations Land and Water Uses

The Comox Valley has a long and continuous history of human habitation, as indicated in the numerous shell middens, burial sites and earthenwork structures identified by archaeological investigations in the area. At least twenty known archaeological sites, including extensive shell middens and an earthenwork refuge structure, are located in the planning area (Ministry of Small Business, Tourism and Culture, 1998). Carbon 14 dating of cultural materials has indicated that human activity occurred in the area as long ago as 7,000 years before the present (BP). Evidence of 1,600 years of habitation, from 3,500 BP to 1,900 years BP, has been found at a site located at Millard Creek near the Island Highway. Another site, in the vicinity of Headquarters Road and the Old Island Highway (Sandwick), shows human activity 300 to 400 years ago (Isenor *et al.*, 1987).

Archaeological evidence and historic accounts suggest that the original inhabitants of the area were a Coast Salish tribe known as the Puntlache, whose territory extended from Kye Bay to Mud Bay (Isenor *et al.*, 1987). In the 1850=s, the residents of Comox Harbour comprised an alliance of four tribes, including the Puntlache, the Comoncs from Cape Mudge, the Qualicoms and the Ey-exen. These tribes had all experienced major population losses as a result of prolonged intertribal warfare and disease, and had banded together to protect themselves from raids by tribes from the west and north coasts of the island (Bailey, 1993; Isenor *et al.*, 1987).

At the time of European arrival in the 1850=s, the Comox Indian Band had permanent village sites around the estuary. The main Comox Indian Band village was located where the Puntledge and Tsolum rivers meet, at the site of Puntledge Indian Reserve 2. Another village was sited at Comox, seven potlatch houses were situated on the Comox Road waterfront, and continuous habitations lined the western side of the bay (Bailey, 1993). An earthenwork fortification, used for refuge during invasions, was located at Robb Bluff (Bailey, 1993).

The estuary and its environs provided First Nations inhabitants with a wealth of natural resources. Chief Hardy (1998) reports that his ancestors caught and salted salmon, herring and other fish and harvested shellfish, kelp and saltgrass in the estuary. Muskrat and otter were trapped and waterfowl and deer hunted in the vicinity of the estuary. Archaeological evidence reveals that shellfish, salmon, herring, deer, elk and seal were predominant in

the diet of local inhabitants (Isenor *et al.*, 1987). Historic accounts indicate that a variety of plant foods, including estuarine species such as arrow grass, tiger and chocolate lily bulbs, were harvested. Seafoods, including clams, mussels, rockfish and salmon were central to the local diet. Clams were a staple as the estuary sustained an abundant and readily harvestable supply. Salmon were harpooned and trapped in the estuary as well as in the Puntledge River and the Strait of Georgia. Herring and herring spawn were harvested on the east side of the estuary between Millard Creek and Roy Creek (Isenor *et al*., 1987). Tidal fish weirs were constructed at the mouth of the river and along the edges of the estuary. The weirs were the most efficient means of harvesting fish for a large number of people (Hardy, 1998). The remains of weirs, constructed in the 1800=s, are visible at low tide.

The Comox Indian Band is presently conducting a traditional use study that will document the Band's historic land and water use patterns in their traditional territory (Knox, 1998).

3.3 Current Population and Residential Land Use

Population data specific to the Estuary Management Plan planning area are unavailable. The population of the Comox Valley, including RDCS Areas A, B, and C, and the Town of Comox, City of Courtenay and Village of Cumberland is estimated at 52,681, based on Statistics Canada 1996 census data (CitySpaces Consulting Ltd, 1997). The majority of this population is concentrated in the City of Courtenay and Town of Comox. Population growth rates are estimated to be between 2.7 and 3.5 percent between 1996 and 2006 for rural Comox Valley (Electoral Areas A, B, and C) and between 3.5 and 5.0 percent for the municipalities of Comox, Courtenay and Cumberland (CitySpaces Consulting Ltd, 1997).

Generally, the majority of land in the Estuary Management Plan planning area is designated for residential land use, either exclusively or in combination with other types of uses. The Regional District has adopted a policy of urban containment to manage population growth pressures in rural Comox Valley and has assigned development permit areas to environmentally sensitive lands (Regional District Comox Strathcona, 1998). Royston has been identified as an urban containment area (Arural settlement area"). The City of Courtenay has designated some waterfront land south of the Airpark for high density (37 - 100 units per hectare) multi-family dwellings, while designating the west bank of the Courtenay River for mixed residential/commercial development (City of Courtenay, 1998). The Town of Comox has designated most of its waterfront for single family and multi-family residential development (Town of Comox, 1997).

The total registered population of the Comox Indian Band is 261 people (Department of Indian and Northern Affairs, 1998). The Comox Indian Band reserve lands, allocated by the British Columbia Joint Reserve Commission in 1877, total 284.9 hectares on four sites. Three of these sites are waterfront properties in the Estuary Management Plan planning area. Comox Reserve 1, situated on Comox Road, is the main site of the present community. This site houses the majority of the on-reserve population of 118 people.

Puntlache Reserve 2 is presently uninhabited. Comox Reserve 3, situated on Goose Spit, is the site of a traditional burial ground for chiefs.

3.4 Commercial and Industrial Land and Water Uses

The major commercial and industrial activities directly associated with the estuary include water-based transportation and services, fishing and forestry. These activities are described in the following sections.

3.4.1 Water-Based Transportation and Services

3.4.1.2 History

The Courtenay River Estuary was the focal point of transportation to and from the Comox Valley until land-based transportation became available after the Second World War (Isenor *et al.*,1987). Marine shipping and passenger services operated primarily from the Comox wharf, built in 1874 at the present site of the Comox marina complex. The Courtenay River channel became a major transportation route in the 1880=s with the settlement of the Courtenay town site.

Historically, the navigable section of the Courtenay River extended from the mouth of the river to the 5th Street bridge (Mackie, 1995). This channel, too shallow for tugboat activity during low tide, was dredged and cleared of debris on a regular basis (Isenor *et al.* 1987). Tugboats pulling barges shipped goods from the Comox wharf to docks on the river. Some of the currently vacant lots on the river (e.g. District Lots 173, 85, 276) were historically tenured by marine-based commercial enterprises such as Standard Oil Incorporated and the Vancouver Barge and Transportation Company. The river was also used for transporting logs harvested on holdings in the Tsolum River watershed to booming grounds in the estuary (Isenor *et al.*, 1987). Some of the historic wharf and grid footings are still visible

A road and bridge network, first developed in the 1870=s, was an important extension of the water-based transportation system, connecting Courtenay to the Comox wharf. Precursors of the present-day 5th Street Bridge, Courtenay Slough crossing, and Comox Road were constructed during the 1870=s. The right-of-way across the Courtenay Slough was filled in the early part of the 20th century (Summary of City Council Minutes in Isenor *et al.*,1987). The road to the Comox wharf included an elevated shoreline bridge, called the Long Bridge, from the present site of Field Sawmill, across the high marsh of Plan 19915 and across Duck Slough (District Lot 190). The footings of this bridge are visible in the area of Plan 19915, across the river from the Courtenay Airpark.

3.4.1.2 Courtenay River Channel

Presently, the Courtenay River navigation channel is recognized as a Amain navigation channel≅ by the Canadian Coast Guard and provides marine access to a number of recreational, commercial and industrial sites along the lower reaches of the river. The subtidal and intertidal land associated with the navigable channel is identified under the Provincial *Land Act* as a Section 17 Map Reserve in the name of Transport Canada. This reserve extends approximately 4.5 kilometres from the 17th Street Bridge to 20m below local low water (-20m LLW) in the centre of the estuary. While medium and large size vessels typically utilize the incoming tide to travel up the channel due to depth constraints (Dane, 1998; Finnabogason 1998), periodic maintenance dredging has ensured safe access (Dutchak, 1998).

3.4.1.3 Marinas and Wharves

Six marinas are situated in the Courtenay River estuary, providing operators of commercial vessels and pleasure craft with full harbour amenities and a combined permanent moorage capacity of approximately 625 berths.

Small Craft Harbours/Comox Valley Harbour Authority

The Comox Valley Harbour Authority, under the auspices of the Small Craft Harbours Branch of Fisheries and Oceans Canada, operates two public harbour facilities in the estuary.

The major facility is located at the Comox Harbour marina complex at the foot of Port Augusta Road, in District Lots 203 A, B, and C, 468 and 2004. District Lots 203 A, B, C and 468 are tenured to Public Works Canada, on behalf of Small Craft Harbours, under a Provincial *Land Act* Section 15 Order-in-Council. District Lot 2004 is tenured under a Provincial *Land Act* Section 17 Map Reserve.

This facility provides permanent and transient moorage primarily to commercial vessels. It is a homeport for commercial fishing vessels, largely owned by local residents. Harbour berthage capacity is approximately 164 vessels distributed between two basins located east and west of a main causeway. The facility provides a full range of services, including off-loading for commercial fish. During the peak use periods, recreational vessels are not normally accepted at the facility. This period typically extends from September to June. During the summer, approximately 13 percent of vessels moored at the facility are pleasure craft (Webb, 1998).

The Harbour Authority=s Courtenay Slough facility provides winter storage for wooden hulled commercial vessels. It is considered by users to provide ideal fresh water moorage. Located on the Courtenay River in District Lot 252, the facility accommodates 30 to 45 vessels (Dane, 1998). District Lot 252 is tenured to Public Works Canada under a Provincial *Land Act* Section 15 Order-in-Council.

Comox Municipal Harbour

Comox Municipal Harbour, located in the Comox Harbour marina complex in District Lot 380, has 144 berths and full amenities. All berths are permanent, and are occupied by pleasure craft up to 40 feet in length (Hansen, 1998.).

Courtenay City Marina

The Courtenay City Marina, located at the foot of 21st Street and adjacent to the Courtenay Airpark, has 29 permanent berths, one transient moorage berth and a double launch ramp. The marina, operated by the Courtenay Marina Society, provides moorage to members who rent by the year. All vessels are pleasure craft (Burbridge, 1998).

Comox Bay Marina

The Comox Bay Marina, located in the Comox marina complex in District Lot 203D, is a privately owned facility with 230 permanent berths and accommodations for overnight tie-up. Three tugboats and one commercial fishing boat occupy permanent berths at the marina. The remainder is pleasure craft. Transient vessels are primarily summer pleasure craft, ranging in size from 20 to 165 feet (Krejci, 1998).

Black Fin Marina

Black Fin Marina, also located at the Comox Harbour marina complex, has 25 permanent berths dedicated to pleasure craft, 21 of which are leased to Sail Pacific Yacht Charters Limited. Two transient berths are also available. This marina operates the fuel dock that supplies the entire marina complex (Bentley, 1998).

Department of National Defence

The Department of National Defence maintains a marina at HMCS Quadra (see Section 4.7.1) located at Goose Spit. This marina, comprised of two vessel docks and one fuel dock, is used by a number of federal departments for various programs, including Sea Cadet training, the Sea Survival School, the Marine Rescue Section, and the Canadian Forces Sailing Association (Gauthier, 1998). DND also maintains a fuel pier extended from the main causeway of the federal Comox Harbour

Wharves

Other significant marine structures in the planning area include the Shell Canada wharf (District Lot 184), and the public wharf at the Courtenay Airpark. The Shell Canada wharf, located at the foot of Royston Road, was used for oil and gasoline off-loading from the early part of the 20th century until the late 1980=s (Blair, 1998). Shell is in the process of transferring ownership of the derelict

structure and tenure of the waterlot to the Regional District of Comox Strathcona and the Royston Community Association for redevelopment as a recreational amenity. The public wharf, under tenure to the Provincial Department of Transportation and Highways, is located adjacent to the Courtenay Airpark. A ramp is located adjacent to the wharf. This site is used for floatplane and recreational boat access and tie-up.

3.4.1.4 Lafarge Cement Inc. Barge Off-Loading Site

Lafarge Cement Inc. owns waterfront property on Comox Road near Duck Slough (Plan 41234), and maintains tenure on two waterlots adjacent to this property (Lots 250 A and B). Until June 1998, LaFarge was a major competitor in the ready mix cement business, but has since withdrawn from the market. The main feature at their Comox facility is a cement silo that was used for storage of ready mix cement barged up the Georgia Strait from the company=s Richmond plant. Barge transport to the Comox silo was the most economical means of relaying bulk loads of product to the north island (product was distributed from the silo to north island outlets by truck.) The silo will be removed in the near future. LaFarge has no other plans for the site at present (Adams, 1998).

3.4.1.5 Other Marine Services

Dredging

Up to 1997, the Waterways Development Section of the Canadian Coast Guard provided maintenance of the Courtenay River navigation channel. Recent dredging work (early 1990's) was concentrated at the seaward end of the channel (Dutchak, 1998). Federal funding for dredging of major navigation channels was terminated in 1997. Current responsibilities of the Waterways Development Section include provision of channel depth surveys and project management services for user funded dredging projects. Existing users of the Courtenay River navigation channel have yet to coordinate a user fee structured dredging plan (Dane, 1998; Finnabogason, 1998). Periodic dredging is also undertaken to maintain depths in marina basins. Maintenance dredging of the Field Sawmill log pocket in Lot 258 is undertaken annually to mitigate debris accumulation.

Tidal Grids/Boatways

Tidal grids are timber or concrete frameworks that allow a vessel to be floated in at high tide so that repairs, mainly hull cleaning and painting, can be undertaken during low tide. Four tidal grids occur within the planning boundary. Two are located at the Town of Comox Municipal Marina, one at the federal Comox Harbour and another at Kwantum Boatway at District Lot 82 (Hanson, 1998). User fees are charged for use of the tidal grids at the Municipal Marina and Federal Harbour.

3.4.2 Commercial and Aboriginal Fisheries

In recent years, commercial fisheries in the vicinity of the Courtenay River estuary have been restricted largely due to declining fish stocks and poor water quality conditions. The status of these fisheries is discussed briefly below in the context of >Statistical Area 14=, an area of the Strait of Georgia extending from Parksville to Shelter Point on Vancouver Island, including Baynes Sound. Statistical Areas are geographically defined administrative units used by Fisheries and Oceans Canada for catch data records and licensing arrangements. Catch data information specific to Subarea 14-14 (Comox Harbour) is not available (Davidson, 1998).

3.4.2.1 Salmon Fishery

Commercial catch data (1982-1995) reveal that the salmon fishery in Statistical Area 14 has been focused on chum, coho and chinook salmon. Pink and sockeye salmon are fished to a lesser extent. Gillnet, seine, troll and freezer geared vessels have all participated in the Statistical Area 14 fishery. In 1995, the catch for all species was significantly reduced and the fishery was only open to gillnetters and trollers (Table 3.1). The last opening for a commercial salmon fishery in the vicinity of Comox Harbour was in 1986, as surpluses since then have been inadequate to sustain a commercial fishery (McEachen, 1998).

Table 3.1 Statistical Area 14: 1994/5 Salmon Pieces by Gear and Species[16]

1994	Chinook	Sockeye	Coho	Pink	Chum	TOTAL
Gillnet	1,170	10	1,943	921	2,491,515	2,495,559
Seine	0	0	0	0	1,115,206	1,115,206
Troll	65,895	3,930	14,6705	1,952	2,738	221,220
Freezer	704	0	3,634	6	0	4,344
1995	Chinook	Sockeye	Coho	Pink	Chum	TOTAL
Gillnet	204	0	19	0	18,297	18,520
Troll	0	0	0	0	2,489	2,489

The commercial fishing statistics for Statistical Area 14, presented in Appendix C-2, show that in 1994, 3,836,329 Pacific salmon were harvested, with an estimated value of $1,895,782. In 1995, the total catch was 21,009 with a value of $90,066 (Davidson, 1998).

3.4.2.2 Roe Herring Fishery

Roe herring is an important commercial fishery. The season lasts one to three days during late February and/or early March, and has typically occurred in Baynes Sound, the Hornby-Denman area, Lambert Channel, Cape Lazo, and French Creek

[16] Source: Davidson (1998).

(Fisheries and Oceans Canada, 1998a). Comox Harbour has been closed to the roe herring fishery for over a decade (Coke, 1998). 1995 catch data show that seiners and gillnetters caught 12,549 tonnes of roe herring in Statistical Area 14 (Davidson, 1998).

The value of the 1995 roe herring catch for Statistical Area 14 was $20,600,000. The value of the fishery to fishers and processors declined substantially in 1997 due to a dramatic reduction in the international price paid for roe herring. The price fall is attributed to poor economic conditions in Japan (Fisheries and Oceans Canada, 1998b).

3.4.2.3 Groundfish Fishery

The Strait of Georgia groundfish fishery is primarily comprised of a groundfish trawl and a hook and line fishery targeting rockfish, lingcod, dogfish, hake, pollock, Pacific cod and sole.

In Statistical Area 14, the groundfish trawl, open year round, landed 9 tonnes of fish in 1995, including brill, lemon and rock sole, Pacific cod, dogfish, hake, and flounder (Davidson, 1998). Low stock assessments of lingcod and rockfish resulted in closures of these fisheries to trawling in 1998. Comox Harbour was closed to trawling due to navigational concerns (Fisheries and Oceans Canada, 1998b).

Rockfish, Pacific cod, lingcod, red snapper, skate and dogfish are all caught with hook and line gear in Statistical Area 14, totalling 69 tonnes in 1995. Comox Harbour was closed to the hook and line fisheries in 1998 primarily as they conflict with normal harbour operations (Fisheries and Oceans Canada, 1998c).

3.4.2.4 Invertebrate Fisheries

Invertebrate fisheries in Statistical Area 14 target a wide range of species, including: Pacific oysters, clams, dungeness crab, shrimp, prawns, red sea urchins, scallops, geoducks, and octopus. The Baynes Sound area is particularly well suited for Pacific oyster farming; a significant local industry has developed in response to this opportunity. The Courtenay River estuary, a component of Baynes Sound, has an extensive intertidal area conducive to the culture of Pacific oysters. Historically, companies such as BC Packers, who held extensive Crown land leases on the estuary mudflats, exploited this opportunity. In 1963, the estuary was closed to shellfish harvesting as a result of declining water quality conditions, particularly high fecal coliform counts (Heath, 1998b). The majority of the estuary has since remained closed to direct harvesting due to continued poor water quality conditions.

In some parts of the estuary, oysters can be produced or harvested by permit under specified conditions for depuration, relaying, experimental purposes or other approved processing (Environment Canada, 1998). A prohibition against any

form of processing or harvesting has been placed on the mudflats in the vicinity of Royston (Heath, 1998). Presently, three oyster culture leases, encompassing approximately 20 ha, are maintained in Comox Harbour. Two of these leases are active nurseries; oysters are cultured and then relayed to areas where the water quality is conducive to maturation and harvesting. A third lease is inactive (Carswell, 1998).

3.4.2.5 Aboriginal Fishery

The aboriginal fishery in British Columbia is managed through the Aboriginal Fisheries Strategy, an initiative of Fisheries and Oceans Canada. In accordance with this strategy, Fisheries and Oceans Canada and the Kwakiutl Territorial Fisheries Commission (KTFC), representing fourteen bands including the Comox Indian Band, have signed annual agreements for a number of years regarding the co-management of aboriginal fisheries in KTFC territory. The KTFC territory includes Baynes Sound and the Courtenay River estuary. The 1998 agreement provides communal subsistence licensing for the harvest of salmon, herring and groundfish and shellfish, and communal commercial licensing for salmon and herring roe (Fisheries and Oceans Canada, 1998f). Maximum quantities for salmon, herring and groundfish are defined. Access to the finfish fishery is limited to specific individuals designated by KTFC. All band members can harvest shellfish. Licences are subject to in-season conservation closures applied to specific locations defined by Fisheries and Oceans Canada.

As with non-native fishers affected by declining stocks, Comox Indian Band members no longer depends on salmon fishing as an economic mainstay (Hardy, 1998). Band members voluntarily stopped fishing for salmon in the estuary in the mid-1980=s in order to help restore historic runs. They have also refrained from direct shellfish harvesting in the estuary due to concerns related to water quality (Knox, 1998). Given these resource trends and their negative impacts on the community economy, the Band has an abiding interest in habitat restoration and the recovery of finfish and shellfish stocks.

3.4.3 Forestry

The Courtenay River estuary has provided a critical link in the production of raw and value added forest products in the Comox Valley since the arrival of European settlers in the 1860=s. In the early phase of European settlement, forestry was focused on production of goods for the local economy. The main channel of the Courtenay River provided a means of transportation and log handling in an era when the local land transportation infrastructure was minimal. A key event during this period was the opening of the first sawmill in 1872 at 6th Street and Anderton Road on the Courtenay River (Isenor *et al*., 1987). Many other small lumber and shingle mills, serving local and regional markets, have operated at various times on the estuary over the past century.

In the early part of the 20th century, the Courtenay River estuary became a key factor in the development of the local export based forest industry. The major force behind this development strategy was the Comox Logging and Railroad Company (CLRC), which transported raw logs from its extensive timber holdings in the Puntledge River watershed to its mill on the Fraser River (Isenor *et al*., 1987). As the Puntledge River watershed was unsuitable for log transport, the CLRC built a railway line from its timber holdings to a log dumping pier and booming ground developed on the Courtenay River estuary in the vicinity of Royston. A breakwater, comprised of derelict ship hulls, was added in the 1930=s to protect the booming ground from winds off the Strait of Georgia. The railway operated from 1910 until 1953, its demise predicated by a company shift to trucking. The site was used for log dumping and handling for an additional twenty-five years. Presently, it is an important component of the Field Sawmill operation.

3.4.3.1 Field Sawmill

While raw log production and export, for decades a key component of the local economy, has declined in recent years (Barometer, Vol. 1, No. 1), the Courtenay River estuary remains integral to the local forest products industry. This is due to the presence of Field Sawmill, a specialty products business located at the mouth of the Courtenay River on Lots 1,2,3, and 4 of Plan 52477.

Field Sawmill, started in 1947, is presently the only forestry industry operating on the estuary. The operation, 70 percent owned by Primex Forest Products and 30 percent owned by MacMillan Bloedel Limited, consists of a sawmill, in-line planer and planermill (Primex Forest Products Ltd, 1998). The operation, which specializes in manufacturing sizes and grades of lumber used in the Japanese traditional housing market, produced 94 million feet in 1998. Raw logs, primarily western hemlock and Douglas fir, are purchased on open markets; Primex does not have timber harvesting rights (Malpass, 1999). Primex has invested $25 - 30 million in capital improvements in recent years, and has plans for further upgrades in order to achieve capacity of 125 million feet (Sullivan, 1999). Primex has also invested in a comprehensive Environmental Management System to assist in achieving compliance with environmental regulations. Field Sawmill currently employs 220 waged and salaried employees, and reports a $15 million dollar payroll, making it the largest private employer in the area (Malpass, 1999).

Log Management

Historically, Field Sawmill was located on the estuary in order to achieve efficiencies in raw log transportation and storage. Primex continues to utilize the estuary as this remains the most efficient means of managing raw logs, given constraints imposed by the location of the mill with respect to raw log markets, and the upland storage limitations of the operation. Logs, purchased at open markets, are towed in booms from Howe Sound to temporary storage at the Royston booming ground. Small bundles of logs are towed from Royston on a daily basis to a staging site in the vicinity of Goose Spit lagoon and then up river

with the rising tide to the mill. They are received at a dewatering bay at the mill site.

Primex=s log management system in the estuary is dependent on land use designations and Crown land leases afforded by government agencies. The Regional District of Comox-Strathcona has zoned the booming ground and staging site in the estuary for industrial land use. Primex holds leases, granted by the Land Administration Branch of the Ministry of Environment, Lands and Parks, for Waterlots 169, 2016, and 2017 (Royston booming ground), the Goose Spit Lagoon staging site (file 1406504), and Waterlots 346 and 258 (log pocket at mill). These leases were granted subject to an interagency review that included agreement to pursue log management practices appropriate for the estuary (Sullivan, 1999).

Maintenance dredging of the Field Sawmill log pocket in Lot 258 is undertaken annually to mitigate debris accumulation. Dredging can result in environmental impacts, such as release of sediments and hydrogen sulphide (H_2S) in the water column. Accordingly, environmental agency approvals must be obtained prior to commencing work.

3.5 Agriculture

3.5.1 History and Present Status

Over one third of the land in the planning area falls within the Provincial Agricultural Land Reserve. Most of this land, 156 ha, is located in the area known as the Courtenay Flats. Another 40 ha encompasses parts of the Puntlache Indian Reserve and adjacent farmland at the confluence of the Tsolum and Puntledge rivers, while 24 ha are located at the mouth of the Trent River, the site of the Feely Farm.

The agricultural potential of the Comox Valley, recognized by British explorers in the 1850=s, drew the first wave of European settlers to the area in 1862-63. The Courtenay Flats, part of the Courtenay River floodplain, was the first area to be settled because little land clearing was required to commence farming. Homesteaders practiced mixed farming and generated cash through sale of produce to communities south of Courtenay, including Victoria and Nanaimo. Shipping of produce from the Comox wharf, constructed in 1874, was central to farmers until land transport became available. The Courtenay Flats, from Comox Hill to Sandwick Corner, were dyked in the 1880=s to protect the farmland from flooding (Isenor *et al.*, 1987).

Local agriculture provided most of the food and much of the employment in the Comox Valley until the post-World War II period. After the war, the local agricultural economy changed significantly, influenced by such factors as population growth, a booming provincial economy, and increasing land values. Changes included increasing sale of farmland for development, the consolidation of ownership of smaller farm operations,

and a growing dependency on importation of food (Isenor *et al.*, 1987). During the period 1950 to 1986 one hundred hectares of agricultural land adjacent to the Courtenay River estuary was redeveloped as residential and commercial property (Campbell-Prentice and Boyd, 1988). Despite these changes, farming remains an important activity in the area, with some of the highest agricultural capability (Class 1) soils on Vancouver Island situated within the Estuary Management Plan boundaries (Hatfield, 1998).

Currently, three large farms and a number of smaller farms operate in the Courtenay Flats. Farquharson Farm, a 192 acre operation regarded as an institution in the valley, was sold by the Farquharson family to Ducks Unlimited Canada in 1998 and is presently leased to the Evans family. The new management team is endeavouring to accommodate the winter foraging requirements of trumpeter swans, while developing a profitable, community-based agricultural enterprise that produces organic fruits and vegetables. Haven Farm, on 160 acres adjacent to Farquharson Farm, is operated as a dairy farm. Roy Creek Farm, also a dairy operation, produces forage on its property in the Courtenay Flats (Hatfield, 1998). In addition to these large farms, the British Columbia Nature Trust owns a small farm known as the Courtenay Estuary Simpson Farm, situated on the east side of Duck Slough. The Simpson Farm is leased by Joe Simpson, who raises beef cattle and grows perennial grasses and corn on this farm as well as on Glacierview Farm (Fowler, 1998). Other operations in the Courtenay Flats include the Berry Farm and Russell Ranch.

Other large farms within the planning area include: Grassy Point Farm, located on the south side of the Trent River estuary, owned by the Feely family since the 1890=s (Feely, 1998); and, Samsom Farms Ltd, owned by N.C.P. Samsom, located on the west side of the Tsolum River.

Crop irrigation is integral to the functioning of many farms in the Comox Valley. Table 3.2 lists water licences for irrigation in which the source and appurtenant land is located within the planning area.

Table 3.2 Water Licences for Irrigation[17]

Licence No.s	Licensee	Source	Date
F016673	Roy Creek Farms	Lloyd Slough (Duck Slough)	1953/03/09
C059213	Farquharson Farms Ltd	Courtenay River	1982/08/23
F015868	Simpson, J & R.	Oland Creek	1951/02/21
FO44519	Samsom Farms Ltd.	Tsolum River	1951/08/14
Z101989	Tim and Marcia Haley	Tsolum River	1991/06/06

[17] Source: Ministry of Environment, Lands and Parks (1999a). Note that Table 3.2 only identifies water licences for irrigation purposes for which both the source and the appurtenant land are within the planning area. Many additional water licences (for irrigation, domestic consumption and public works) exist that are associated with the sources listed in Table 3.2 as well as with Roy Creek and Millard Creek.

3.5.2 Conflicts with Waterfowl

The agricultural lands in the Comox Valley, particularly in the Courtenay Flats area, provide important winter foraging habitat for waterfowl, including trumpeter swans, a species of Aspecial management concern≅ to environmental agencies. Foraging activities by waterfowl result in crop loss and soil compaction, issues that have created conflicts between the farming community and conservation agencies and groups. The Comox Valley Waterfowl Management Project, supported by the Canadian Wildlife Service and Ducks Unlimited Canada through the Pacific Coast Joint Venture program, was initiated in 1991 to address and minimize conflicts arising from these competing uses of agricultural land.

The Project employs three basic strategies. Firstly, in order to lure waterfowl from the perennial grass fields, 500 acres of fallow land are sown with winter cover crops. Farmers are paid $25.00 per acre to plant these crops. Secondly, a Project officer facilitates protection of perennial grass fields through a waterfowl scare program. Thirdly, community education is pursued regarding waterfowl/agricultural conflicts and their solutions. Within the Estuary Management Plan planning area, six farms presently participate in the Waterfowl Management Program. These include Farquharson Farm, Haven Farm, Roycreek Farm, Berry Farm, Glacierview Farm and Russell Ranch (Fowler, 1998). Despite these efforts, local farmers do not consider the Project wholly effective and they bare significant financial costs as a result of waterfowl foraging activity on their land (Hurford, 1999).

3.5.3 Drainage and Flooding

The Courtenay Flats area, situated in the 200 year floodplain of the Courtenay River, is part of a 851 ha drainage catchment area that includes residential areas north of Ryan Road and east of Back Road in the City of Courtenay (Klohn Leonoff, 1987). The major outlet for this drainage area is the concrete floodbox beneath Comox Road at the west end of Duck Slough. The slough is fed by two main ditch/creek systems that convey surface water from the majority of the catchment area.

In the mid-1980=s the Ministry of Agriculture conducted a prefeasibility study (Klohn Leonoff, 1987) to address concerns regarding increasingly severe drainage and flooding problems in the Courtenay Flats. This study concluded that the flooding and drainage problems were the result of a number of factors: the Comox Road floodbox was inadequate and malfunctioning; siltation of the slough and ditches; and increased silt load and runoff from the upland areas due to urban expansion. Recommendations for solving the drainage problem included upgrading the existing floodbox, installing a new floodbox adjacent to the existing one, and lowering the approach channel to the floodbox. The Regional District of Comox Strathcona subsequently borrowed funds on behalf of the farm owners in the area to implement recommended drainage improvements.

Despite these improvements, drainage and flooding of agricultural fields remains a problem for farmers in the Courtenay Flats (Hatfield, 1998). Interagency cooperation is

required to address the primary causes and to secure funding for any further improvements to the drainage system (Hatfield, 1998). One farmer, concerned about the viability of his operation, has suggested that the conflict between maintaining the conveyance capacity of the ditch system through dredging and maintaining fish habitat values could be achieved through a cooperative approach with agency personnel (Hurford, 1999).

3.6 Recreation

3.6.1 Land-Based Recreation

Land-based recreational pursuits around the estuary include nature study, beach activities, and pedestrian/cycling fitness. The estuary provides a wide range of opportunities to learn about plants, wildlife and natural processes. The presence of high profile wildlife species, such as the trumpeter swan, contributes to the estuary=s attractiveness both for casual observers and naturalists. Organized nature study activities around the estuary, such as birding, are pursued by the Comox Valley Naturalist Society (Comox Valley Naturalists Society, undated). Beach activities, such as wading, picnicking and sunbathing, are pursued at various locations, particularly Goose Spit Coastal Recreation Park. Walking, running and cycling activities are undertaken at parks at Goose Spit, McDonald Wood, Mack Laing and Courtenay Lagoon.

Hunting in the Comox Harbour is prohibited under the Provincial *Wildlife Act*. However, hunting, particularly for ducks, geese, pheasant, and occasionally for deer, is pursued on the upland rural areas surrounding the estuary (Browne-Clayton, 1998). Members of the Comox Valley Fish and Game Protective Association hunt on the Courtenay Estuary Simpson Farm, which is owned by the British Columbia Nature Trust. Waterfowl hunting is also pursued on privately owned agricultural land in the Courtenay Flats (Browne-Clayton, 1998).

3.6.1.1 Infrastructure

Key infrastructure considerations related to land-based recreational activities include provision of access points to the estuary, pathways, viewing structures, parking and toilets. These infrastructure considerations continue to be, for the most part, accommodated through the planning functions of local government. Access point and amenity needs have been typically addressed by the development of waterfront parks. As most of the estuary waterfront is privately owned and designated for residential or commercial development, the Regional District, City of Courtenay and Town of Comox have initiated waterfront greenway policies in recognition of present and future pressures to increase recreational opportunities adjacent to the estuary.

Parks and Recreation Areas

Sixteen public parks provide open space, waterfront access and amenities for land-based recreational activity in the estuarine/fluvial setting of the planning area. All of these sites, except for Goose Spit Coastal Recreation Park and Comox Roadside Rest Area, are located within the municipal boundaries of the Town of Comox and the City of Courtenay. Appendix C-3 provides detailed information regarding these parks. In addition to these managed sites, a small roadside rest area is located on accreted Crown land seaward of Marine Drive in Royston. This site, adjacent to Waterlot 184 (the derelict Shell Pier and active Shell Corporation lease) includes access to the waterfront for both pedestrians and boats. Royston community members are actively seeking Recreation Area status for this site, as well as tenure of Waterlot 184 and ownership of the derelict pier (Mewett, 1998; Blair, 1998).

Waterfront Greenways

The Official Community Plans (OCP) for Comox, Courtenay and Rural Comox Valley provide for the development of linear recreational corridors along the perimeter of the estuary. Ultimately, these planning objectives, if pursued, would result in a continuous pedestrian corridor, adjacent to the waterfront where possible, around the Courtenay River estuary.

The Town of Comox Official Community Plan includes provisions for a greenway along the entire waterfront area within its jurisdiction. Municipal right-of-way acquisitions will be pursued to develop this amenity. Appendix B of the OCP, a greenways study conducted by Chislett, Lattey, Manson (1993), recommends that the waterfront walkway should consist of pathways (no construction) in areas with stable substrates, and boardwalks in high use areas (around the marina) and across mudflats.

The City of Courtenay Official Community Plan includes provisions for a greenway along the river and estuary from Millard Road to the Puntledge River on the east side, and from the Island Highway Bridge to the Tsolum River on the west side of the Courtenay River. Part of this recreational/pedestrian corridor has been constructed, providing a paved surface around Lagoon Park and through to 31st Street.

The Regional District of Comox-Strathcona Rural Comox Valley Official Community Plan includes provisions for the development of a greenway system that includes a waterfront component. An appendix of the OCP, referred to as the Comox Valley Greenways Concept Plan (BioAyer Consultants, 1997), identified the need for a recreational AEast Coast Trail≅ extending from Mud Bay to Oyster Bay. This walk/cycle corridor would consist of existing highway and road right-of-ways, as well as foreshore in non-environmentally sensitive areas. The OCP

stipulates that greenway development will be pursued in cooperation with affected landowners, in consultation with affected agencies, and with respect to Aappropriate trail design, development and management standards≅ that ensure protection of environmental values and minimization of land use conflicts.

3.6.2 Water-Based Recreation

3.6.2.1 Kayaking, Paddling and Rowing

The Courtenay River estuary is used year round by kayakers and paddlers, although most of the activity occurs in the summer months. The local kayak and paddling club, with 48 members, has a number of popular routes in the estuary. The most popular links the ship wreck breakwater near Royston to the public wharf at the Courtenay Airpark. Frequent trips are also taken up the river and around Goose Spit (Neiderer, 1998). The popularity of these activities with both residents and tourists sustains a local market in tours, lessons and gear sales. Private sector operators, such as Comox Valley Kayaks and Tree Island Kayaks, offer lessons and commercial tours. Both the City of Courtenay and the Town of Comox recreation departments provide spring and summer kayaking and paddling courses in the estuary (Robinson, 1998).

The Courtenay River channel, from the Courtenay Airpark to Lewis Park, is suitable for recreational rowing (Thomas, 1998). The Comox Valley Rowing Club, formed in 1996, uses this part of the channel for skill development and training. The Club presently owns one boat (four person plus coxswain) and occasionally conducts workshops at the public wharf by the Airpark. The commercial potential of recreational rowing in the channel has inspired the development of a small company, Even Keel Rowing Co., which plans to rent out single shell rowing boats.

3.6.2.2 Sailing, Sailboarding and Boating

The Courtenay River estuary provides suitable conditions for dinghy sailing in the spring and summer as it is protected from severe offshore weather conditions (Robinson, 1998). In 1998, the Town of Comox Recreation Department registered 150 children in its annual nine-week summer sailing program, and also offered sailing lessons to adults during the spring (Robinson, 1998). Sail boarding is also popular, particularly in the Gooses Spit lagoon and at the mouth of the harbour.

3.6.2.3 Recreational Boating and Yachting

Two thirds of permanent moorage berths in the estuary (approximately 420) are dedicated to pleasure craft, indicating the importance of the estuary as an amenity for yachting and sailing activities in coastal waters. Comox Bay Marina, the largest facility in the area, provides over 200 berths to pleasure craft, split evenly

between sail and powerboats (Krejci, 1998). Both Comox Bay Marina and Black Fin Marina lease berths to charter companies that operate primarily during the summer months. Temporary berths at all marinas in the estuary are in high demand during summer months due to the influx of transient yachts ranging in size from 20 to 165 feet (Krejci, 1998).

3.6.2.4 Recreational Fishing

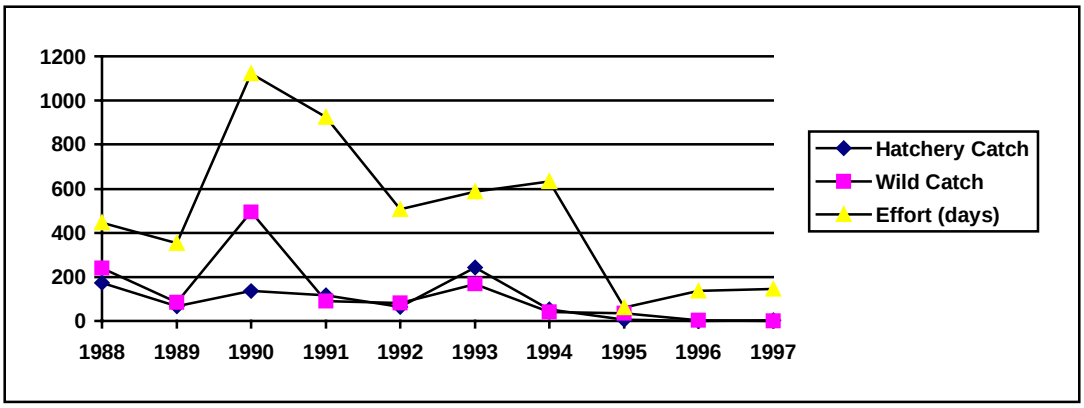
Freshwater Sport Fishery

The Puntledge and Trent rivers are popular recreational fishing sites. The Puntledge River yields chinook, coho, chum, pink, and sockeye salmon in addition to steelhead, rainbow and cutthroat trout. It is ranked among the top 20 Vancouver Island rivers in terms of angler effort and catch for steelhead trout (Fisheries and Oceans Canada, 1998f). The Steelhead Harvest Analysis shows the annual Puntledge River catch of both wild and hatchery steelhead trout fluctuating between a 30 year maximum of 1,471 fish (1967) and a 30 year minimum of 3 fish (1980, 1996, 1997) (Ministry of Environment, Lands and Parks, 1998b). Angler effort reached a 30 year maximum of 4,559 days in 1969 and a 30 year minimum of 62 days in 1995 (see Appendix C-4 for Steelhead Harvest Analysis data). Table 3.3 shows angler effort and catch for the period 1988 to 1997. 210 steelhead trout were caught on average each year during this period; the average annual angler effort was 492 days.

The Steelhead Harvest Analysis for the Tsolum River reveals that no steelhead trout have been caught in the Tsolum River since 1987, despite ongoing angler effort. The Ministry of Environment, Lands and Parks attributes these catch results to declining steelhead trout populations in the Tsolum River due to water pollution (Axford, 1998). Recreational fishing data for the Trent River reveal modest yields of steelhead trout. In 1994 anglers spent 25 days on the river and landed 15 pieces; in 1995, the effort was again 25 days, but no fish were caught.

Effort and catch data for other freshwater recreational sport fisheries are not available (Axford, 1998).

Table 3.3 Puntledge River Catch and Effort - Steelhead Harvest Analysis[18]



Sport Fishery

From the 1880=s to the 1960=s, the Courtenay River estuary was a focal point for sport fishers. It's popularity was due primarily to the abundance and large size class of spring and fall run chinook (a.k.a. tyee) salmon found in >tyee pools= in the subtidal areas of the estuary (Isenor *et al.*, 1987). These runs decreased rapidly after the Puntledge River dam was upgraded in 1958, leading to the demise of the sport fishery in the estuary.

In 1998, Comox Harbour was closed to recreational finfish harvesting from May 01 to July 31, except along the shallow shoreline, where fishing of all finfish except chinook salmon was permitted. From August 01 to October 15, Comox Harbour was open to finfish harvesting, including a non-retention fishery for chinook salmon. A non-retention policy for coho salmon and a barbless hook policy for all salmon species applied throughout 1998 (Fisheries and Oceans Canada, 1998e).

1997 creel survey data document 48,926 boat trips between April and October in Statistical Area 14, with a yield of 20,023 retained salmon and 45,095 released salmon (Fisheries and Oceans Canada, 1998g). A range of other species, including rockfish, lingcod and dogfish, were also caught (see Appendix C-4).

Infrastructure - Docks, Ramps and Marinas

Key infrastructure considerations related to water-based recreational activities include provision of docks, ramps and marina services. Generally[19], three public agencies and two private operators accommodate these infrastructure needs. Public marinas include the federal harbour at Comox, the Courtenay Municipal Marina, and the Comox Municipal Marina. Private facilities include the Comox Bay Marina

[18] Source: Axford (1998)
[19] See section on Transportation for more details

and Black Fin Marina. Some important public access points for small craft include the beach area adjacent to the derelict Shell Pier in Royston, the floatplane ramp at the Courtenay Airpark, and the ramp at the Comox Municipal Marina.

3.6.3 Tourism

The most popular activities pursued by visitors to the Comox Valley are touring and sight seeing, primarily by automobile (Tourism Comox Valley, 1998). Summer outdoor pursuits, such as hiking, biking and kayaking are second in popularity, followed, in order of priority, by golfing, cultural activities, skiing and fishing. Data on visitor use of the estuary in particular (e.g. birding, kayaking, boating, beaching, and walking) are unavailable (Greasley, 1998). However, the presence of tourism operations associated with the estuary, particularly kayaking and marina services, suggests that the natural environment of the estuary, and the amenities currently associated with it, attract visitors and provide local economic benefits.

One trend with significant implications for the estuary is the growing interest in eco-tourism. A report in the Barometer (Vol.1, No.4, 1998) suggests that Comox Valley tourism companies are successfully marketing eco-tourism packages to local and non-local visitors. Eco-tourism is described as minimum environmental impact activity focused on learning and appreciation of natural or historical features or events. Local companies are selling educational tours related to astronomy, ethno-botany, bird watching and local history. In this regard, the Courtenay River Estuary is becoming an eco-tourism destination, with attributes such as the Royston shipwrecks featured by progressive tour operators. One company, keen to develop low impact recreational use of the estuary, is compiling a waterproof handout for clients that will provide both natural history information and guidelines for minimizing impacts to the estuarine ecosystem (Thomsen, 1999).

3.7 Institutional Land and Water Uses

3.7.1 HMCS Quadra

Goose Spit has been under military occupation since the later part of the 19th century, when the site was used as a camp for small arms drill and land-based recreation by the British Royal Navy. In 1909, the Royal Canadian Navy was granted user possession of the Spit by the Province of British Columbia, and buildings were erected between 1912 and 1916 to facilitate use of the site for naval training. The site was used for full-scale naval training during both the first and the second world wars (Isenor *et al.*, 1987).

A Provincial *Land Act* Section 15 Order-in-Council (OIC 959/44), issued in 1944, gives the Department of National Defence (DND) tenure of Lots 113G, 203G, and 204G on Goose Spit. In addition, DND has a Provincial *Land Act* Section 16 Licence-of-

Occupation (File 1402887) over 68 hectares of foreshore around Goose Spit for the purposes of military training.

Presently, HMCS Quadra is a defence training and operational area used by various federal organizations including HMCS Quadra Cadets, Canadian Forces School of Search and Rescue (CFSSAR), Marine Section - 19 Wing Comox, Royal Canadian Mounted Police, and Fisheries and Oceans Canada. The Canadian Forces Sailing Association uses the facility for recreational purposes. The HMCS Quadra marina is comprised of three docks - two for vessels and one for fuel (Gauthier, 1998).

HMCS Quadra is used as a sea cadet training camp, in which 1,200 cadets are taught seamanship skills over summer months (June until September). Cadets use Comox Harbour and Baynes Sound for training purposes. Marine vessels include six 32-foot workboats, two diesels, two auxiliary boats, eight 32-foot cutters, nine 27-foot whalers and thirty dinghies. These vessels are stored on land when the cadets are not in training (Gauthier, 1998).

CFSSAR, in conjunction with the Sea Survival School, runs one or two courses monthly consisting of one or two days each. On occasion, military divers conduct dive activity off the jetty to maintain or upgrade their diving qualifications. CFSSAR vessels consist of one 16-foot rigid hull zodiac and one 16-foot Boston whaler (Gauthier, 1998).

The Marine Section, which operates two 53-foot fibreglass crash boats out of HMCS Quadra, provides on-call rescue services for all training and marine emergencies through RCC Victoria, Comox Coast Guard and the Control Tower at 19 Wing Comox (Gauthier, 1998).

The Canadian Forces Sailing Association (CFSA) is a non-funded recreational group, which owns two keelboats and six Albacores. CFSA small craft sailors prefer the harbour because it offers suitable wind conditions and is considered safe. Those with larger keelboats tend to sail in Baynes Sound. Windsurfers are part of the CFSA as a special interest entity and do not have a separate club name. They launch from the Spit and on occasion use the lagoon for training. Recreational scuba divers do not normally dive in the harbour (Gauthier, 1998).

3.7.2 Courtenay Air Park

The Courtenay River estuary has been used for airplane transportation services to and from the Comox Valley since the development of commercial and recreational flying in the 1920=s. The first airplane to arrive in the Comox Valley landed in an agricultural field in the Courtenay Flats in 1919 (Isenor *et al.*, 1987). Until the construction of the airstrip at Canadian Forces Base Comox in 1943, flights into the area were either by float planes using the Courtenay River main channel or estuary, or by aircraft using improvised field landing strips (Isenor *et al.*, 1987). The Courtenay River estuary became a permanent component of the local flying infrastructure with the construction of the Courtenay Airpark, built in 1964 at the mouth of the Courtenay River on land dedicated

by the City of Courtenay. It was built in order to provide civilian pilots with an alternative to CFB Comox, as civilian access to the latter airstrip was restricted (Isenor *et al.*, 1987).

Presently, the Airpark is comprised of two Transport Canada registered aerodromes, one land-based and the other water-based, which are operated by the 170 member Courtenay Airpark Association. The facility has a 1,800 by 60 foot paved runway, accessible from the north or south, and two Transport Canada dedicated floatplane landing areas in the Courtenay River navigation channel. A Ministry of Transportation and Highways wharf and a ramp near the north end of the runway provides floatplane pilots with tie-up and water access amenities. The facility currently houses eighty aircraft and provides amenities such as hangars and access to aircraft fuel. Small commercial operators and recreational pilots use the Airpark (Comox Valley Economic Development Society, 1998).

Aviation rules imposed by Transport Canada define the flight patterns and elevations of airplane traffic associated with the Courtenay Airpark. Generally, flights are restricted to airspace east of the runway, over the estuary. Flights are not permitted over the City of Courtenay except for take-off and landing manoeuvres (Graham, 1999).

While birds are considered a safely concern for all airports, the slower aircraft typical of small airports provide birds with time to move out of the way. In this regard, no safety issues have arisen for users of the Airpark despite its close proximity to the Courtenay River estuary=s migratory and resident bird populations (Graham, 1999). However, such issues may arise in the future with the ongoing efforts of resource agencies and interest groups to enhance the estuary=s carrying capacity for waterfowl, particularly trumpeter swans.

4.0 REFERENCES

Adams, K. 1998. Personal Communication. Lafarge Canada - Cement Division. Richmond, BC.

Adams, M.A. 1992. Comox Fishing Harbour Expansion - Status of Habitat Budget. Prepared for Public Works Canada. New Westminster, BC.

Austin, A. and R. Adams. 1972. Development of a method for surveying red algal sources in Canadian pacific waters. Prepared for British Columbia Department of Recreation and Conservation, Marine Resources Branch. Victoria, BC. Cited in Morris, S., A. Leaney, L. Bell, and J. Thompson. 1979.

Axford, R. 1998. Personal Communication. Ministry of Environment, Lands and Parks, Fish, Wildlife and Habitat Protection Unit. Nanaimo, BC.

Axford, R. **1998a**. Steelhead Harvest Analysis Data. Ministry of Environment, Lands and Parks.. Victoria, BC.

Bailey, L. 1993 The Indians of Comox Bay - a segment of history. Island Life Magazine. (Spring 1993). Victoria, BC.

Barometer. 1998 (Vol. 1, Issue 1). Forestry. Barometer - Economic and Labour Market Review. Courtenay, BC. <http://barometer.ark.com>

Barometer. 1998 (Vol. 1, Issue 4). Eco-tourism - a new way to view the valley. Barometer - Economic And Labour Market Review. Courtenay, BC. <http://barometer.ark.com>

Beamish, R.J., J.R. Scarsbrook and F.P. Jordan. 1976. A bottom trawl study of Pacific hake and walleye pollock along the inshore areas adjacent to Vancouver Island in the Strait of Georgia. Data Record No. 4. Fisheries and Marine Service, Pacific Biological Station. Nanaimo, BC.

Beddoes, J. 1999. Personal Communication. Ministry of Environment, Lands and Parks, Office of the Surveyor General. Victoria, BC.

Bentley, C. 1998. Personal Communication. Black Fin Marina. Comox, BC.

BioAyers Consultants. 1997. The Comox Valley Greenways Plan Report. Prepared for the Regional District of Comox-Strathcona. Courtenay, BC.

Blair, M. 1998. Personal Communication. Shell Canada, Real Estate Division. Calgary, AB.

Bravender, B. 1999. Personal Communication. Fisheries and Oceans Canada, Coastal and Marine Habitat Science Section. Nanaimo, BC.

British Columbia Conservation Data Centre. 1998. Sensitive Ecoystems Inventory: East Coast Vancouver Island - Ground Truthing Forms. Unpublished Data. Joint Project of Environment Canada, Canadian Wildlife Service and B.C. Ministry of Environment, Lands and Parks, Conservation Data Centre. Victoria, BC.

British Columbia Salmon Marketing Council. 1996. Salmon Market Database. Internet site <http://www.bcsalmon.ca>

Brooks, B., G., Bush, and N. Morton, (Eds.) 1994. A study of the vegetation, marine fauna and birds of the Trent River delta and estuary - 1987. Technical Report Series No. 205. Canadian Wildlife Service, Pacific and Yukon Region, BC.

Brown, D.F. 1998. Personal Communication. Ministry of Environment, Lands and Parks, Regional Waste Manager, Vancouver Island Region. Nanaimo, BC.

Browne-Clayton, P. 1998. Personal Communication. Ministry of Environment, Lands and Parks, Conservation Officer Service. Campbell River, BC.

Burbridge, B. 1998. Personal Communication. Courtenay Marina Society. Courtenay, BC.

Burt, W. H. and R. P Grossenheider. 1976. A Field Guide to the Mammals of North America. Peterson Field Guide Series. Houghton Mifflin Co., New York, NY.

Campbell, R.W., N. Dawe, I. McTaggart-Cowan, J. Cooper, G. Kaiser, and M. McNail. 1990. The Birds of British Columbia. Volume 1. Royal British Columbia Museum and Environment Canada. Victoria, BC.

Campbell-Prentice, A. and W.S. Boyd. 1988. Intertidal and adjacent upland habitat in estuaries located on the east side of Vancouver Island - a pilot assessment of their historical changes. Technical Report Series No. 38. Canadian Wildlife Service, Pacific and Yukon Region, BC.

Carswell, B. 1998. Personal Communication. Ministry of Fisheries, Fisheries Planning and Information Branch. Victoria, BC.

Chislett Lattey Manson. 1993. Greenways Study, Comox, BC. Prepared for the Town of Comox. Comox, BC.

City of Courtenay. 1998. Official Community Plan. Bylaw No. 1781. City of Courtenay. Courtenay, BC.

CitySpaces Consulting Ltd. 1997. Overview Report - Rural Comox Valley Official Community Plan. Prepared for the Regional District of Comox Strathcona. Nanaimo, BC.

Clermont, T. 1998. Personal Communication. Ministry of Environment, Lands and Parks. Nanaimo, BC.

Coke, B. 1998. Personal Communication. Fisheries and Oceans Canada. Comox, BC.

Comox Valley Naturalists Society. **Undated**. Comox Valley Naturalists Society - See Nature With Us. Brochure produced by the Comox Valley Naturalists Society. Courtenay, BC.

Comox Valley Economic Development Society. 1998. Comox Valley Economic Profiles. Comox Valley Economic Development Society. Courtenay, BC.

Dane, B. 1998. Personal Communication. Fisheries and Oceans Canada, Small Craft Harbours Branch. Vancouver, BC.

Davidson, J. 1998. Personal Communication. Fisheries and Oceans Canada, Catch Statistics Unit. Vancouver, BC.

Dawe, N.K., R. Buechert and D.E.C. Trethewey. 1998. Bird use of Baynes Sound - Comox Harbour, Vancouver Island, British Columbia, 1980 - 1981. Technical Report Series No. 286. Canadian Wildlife Service, Pacific and Yukon Region, BC.

Department of Fisheries and Oceans. 1958. The Fisheries Problems Associated with the Power Development of the Puntledge River, Vancouver Island, BC. Department of Fisheries and Oceans. Vancouver, BC

Department of Fisheries and Oceans. 1986. Policy for the Management of Fish Habitat. Department of Fisheries and Oceans, Fish Habitat Management Branch. Ottawa, ON.

Department of Indian and Northern Affairs. 1998. BC Region Community Profiles. Department of Indian and Northern Affairs, Executive Services. Vancouver, BC.

Dutchak, W. 1998. Personal Communication. Fisheries and Oceans Canada, Canadian Coast Guard, Waterways Development. Vancouver, BC.

ECL Envirowest Consultants Limited and Precision Identification Limited. 1998 (August). Vegetation surveys conducted as part of the planning process for the Courtenay River Estuary Management Plan. Prepared by ECL Envirowest Consultants Limited. Prepared for Fisheries and Oceans Canada. Nanaimo, BC.

Environment Canada. 1997. 1996 Annual Compliance Report for the Antisapstain Wood Preservation Industry In British Columbia. Environment Canada. North Vancouver, BC.

Environment Canada. 1998. Canadian Shellfish Sanitation Program. Environment Canada, Environmental Protection Branch. Dartmouth, Nova Scotia. <http://www.ns.ec.gc.epb.sfish/cssp.html>

Feely, T. 1998. Personal Communication. Grassy Point Farm. Courtenay, BC.

Finnabogason, T. 1999. Personal Communication. Envirochem Services Ltd. North Vancouver, BC.

Fisheries and Oceans Canada. 1997. Intertidal eelgrass, July 1995. Unpublished eelgrass map of Comox Harbour. Marine Environment and Habitat Science Division. Nanaimo, BC.

Fisheries and Oceans Canada. 1998. Salmon Escapement Search Results. Fisheries Information Summary System (FISS). Fisheries and Oceans Canada, Habitat and Enhancement Branch. Vancouver, BC.

Fisheries and Oceans Canada. 1998a. Pacific Region 1998 Integrated Management Plan - Roe Herring. Fisheries and Oceans Canada, Fisheries Management Branch. Vancouver, BC.

Fisheries and Oceans Canada. 1998b. Pacific Region 1998 Management Plan - Groundfish Trawl. Fisheries and Oceans Canada, Fisheries Management Branch. Vancouver, BC.

Fisheries and Oceans Canada. 1998c. Pacific Region 1998 Management Plan - Groundfish Hook and Line. Fisheries and Oceans Canada, Fisheries Management Branch. Vancouver, BC.

Fisheries and Oceans Canada. 1998d. Fisheries Information Summary System (FISS). Fisheries and Oceans Canada, Habitat and Enhancement Branch. Vancouver, BC.

Fisheries and Oceans Canada. 1998e. British Columbia Tidal Waters Sport Fishing Guide 1998/1999. Fisheries and Oceans Canada, Fisheries Management Branch. Vancouver, BC.

Fisheries and Oceans Canada. 1998f. Fisheries Agreement Amendment between the Minister of Fisheries and Oceans and the Kwakiutl Territorial Fisheries Commission (AFA98-308). Fisheries and Oceans Canada, Aboriginal Fisheries Strategy. Vancouver, BC.

Fisheries and Oceans Canada. 1998g. Georgia Strait Creel Survey. Fisheries and Oceans Canada, Fisheries Management Branch. Vancouver, BC.

Fowler, G. 1998. Personal Communication. Comox Valley Waterfowl Management Program. Courtenay, BC.

Fraser River Estuary Management Program. 1991. Log Management in the Fraser River Estuary. Prepared by the Log Management Activity Workgroup, Fraser River Estuary Management Program. Vancouver, BC.

Fraser River Estuary Management Program. 1994. A Living Working River - An Estuary Management Plan for the Fraser River. Fraser River Estuary Management Program. New Westminster, BC.

Gauthier, W.H.J. (Major). 1998. Personal Communication. Department of National Defense, Canadian Forces Base Comox. Lazo, BC.

Goodman, D. 1974. An assessment of the impact of a proposed access channel and breakwater on the fisheries resources of the Oyster River. Technical Report No. PAC/T-74-4. Canada Department of the Environment, Fisheries and Marine Service. Vancouver, BC. Cited in Morris *et al*. 1979.

Graham, G. 1999. Personal Communication. Transport Canada, Aviation Department. Vancouver, BC.

Greasley, L. 1998. Personal Communication. Tourism Comox Valley. Courtenay, BC.

Gee, R.S. 1998. Personal Communication. Keystone Corporate Group. Courtenay, BC.

Hanson, D. 1998. Personal Communication. Comox Municipal Marina. Comox, BC.

Hardy, E. 1998. Personal Communication. Comox Indian Band. Comox. BC.

Hatfield, J. 1998. Personal Communication. Ministry of Agriculture and Food. Courtenay, BC.

Healy, M. 1978. Courtenay River and Estuary Sampling Program. Canada Department of the Environment, Fisheries and Marine Service, Pacific Biological Station. Nanaimo, BC. Cited in Morris *et al*. 1979.

Heath, B. 1998a. Baynes Sound Round Table - Summary of Water Quality Remediation Work in Baynes Sound. Ministry of Fisheries. Comox, BC.

Heath, B. 1998b. Personal Communication. British Columbia Ministry of Fisheries, Finfish Production. Courtenay, BC.

Hilliar, C. 1999. Puntledge Hatchery Data. Unpublished Data. Fisheries and Oceans Canada, Courtenay, BC.

Holmes, P.E, M.L. Tarves, R. Tomio and W. Jansen. 1985. Fish and fish habitat impact study of seven British Columbia coastal marinas, 1984. Canadian Manuscript of Fisheries and Aquatic Sciences No. 1809. Department of Fisheries and Oceans, Field Services Branch. Nanaimo, BC.

Hurford, D. 1999. Personal Communication. Haven Farm. Courtenay, BC.

Isenor, D.E., WN. McInnis, E.G. Stephens and D.E. Watson (Authors - Editors). 1987. Land of Plenty - A History of the Comox District. Ptarmigan Press. Campbell River, BC.

Jurk, H., A.W., Trites, C.L. Wilson, G.M. Ellis, and J.K.B. Ford. 1996. Reducing the predation on outmigrating juvenile salmonids caused by harbours seals (Phoca vitulina) in the Puntledge River, British Columbia. Draft report prepared for Fisheries and Oceans Canada. Nanaimo, B.C.

Kennedy, K.A. 1982. Plant Communities and Their Standing Crops on Estuaries of the East Coast of Vancouver Island. M.Sc. Thesis. Department of Botany, University of British Columbia. Vancouver, BC.

Klohn Leonoff Ltd. 1987. Courtenay Flats Drainage Project Feasibility Study. Prepared for Ministry of Agriculture and Fisheries. Richmond, BC.

Knox, M. 1998. Personal Communication. Comox Indian Band. Comox, BC.

Krejci, E. 1998. Personal Communication. Comox Bay Marina. Comox, BC.

Lister, B. 1968. Progress Report on Assessment of the Puntledge River Spawning Channel June 1965 to May 1968. Department of Fisheries and Oceans, Vancouver, BC.

Mackie, R. 1995. The Wilderness Profound: Victorian Life on the Gulf of Georgia. Sono Nis Press. Victoria, BC.

Malpass, G. 1999. Personal Communication. Primex Forest Products Limited, President. Delta, BC.

McEachen, G. 1998. Personal Communication. Fisheries and Oceans Canada. Comox, BC.

McKelvey, R. 1981. Some Aspects of the Winter Feeding Ecology of Trumpeter Swans at Port Alberni and Comox Harbour, British Columbia. M.Sc. Thesis. Simon Fraser University. Burnaby, BC.

Mewett, A. 1998. Personal Communication. Regional District Comox-Strathcona, Parks Coordinator. Courtenay, BC.

Ministry of Environment, Lands and Parks. 1998a. Memorandum Regarding 1998 Red and Blue Lists for Amphibians, Reptiles, Birds and Mammals. Ministry of Environment, Lands and Parks, Fish, Wildlife and Habitat Protection Unit. Victoria, BC.

Ministry of Environment, Lands and Parks. 1998b. Steelhead Harvest Analysis. Ministry of Environment, Lands and Parks, Fish, Wildlife and Habitat Protection Unit. Victoria, BC.

Ministry of Environment, Lands and Parks. 1999. 1999 Provincial Vertebrate Animal Tracking List. BC Conservation Data Centre. Victoria, BC.

Ministry of Environment, Lands and Parks. **1999a.** Water Licences Query Database. Ministry of Environment, Lands and Parks, Water Management Branch. Victoria, BC. <http://www.elp.gov.bc.ca/wat/>

Ministry of Small Business, Tourism and Culture. 1998. BC Provincial Heritage Register. Ministry of Small Business, Tourism and Culture, Archaeology Branch, Inventory and Mapping Program. Victoria, BC.

Morris, S., A. Leaney, L. Bell, and J. Thompson. 1979. The Courtenay River estuary status of environmental knowledge to 1978. Special Estuary Series No. 8. Department of Fisheries and the Environment, Regional Board Pacific Region, Estuary Working Group. Vancouver, BC.

Nagpal, NK and LW Pommen. 1995. Approved and Working Criteria for Water Quality, 1995. Ministry of Environment, Lands and Parks, Water Quality Branch. Victoria, BC.

Neiderer, N. 1998. Personal Communication. Comox Valley Kayak and Canoe Club. Courtenay, BC.

Pinho, O. 1998. Stormwater Quality in the Comox Valley - Results of Monitoring Programs in 1996 and 1998 City of Courtenay, Town of Comox and Royston. Prepared for the Baynes Sound Stewardship Action Group and Comox Valley Project Watershed Society. Courtenay, BC.

Pollution Control Branch. 1974. Intertidal (beach) biology: Appendix E. in Provincial interagency evaluation of Comox Harbour. Report prepared by BC Department of the Environment, Pollution Control Branch, Water Resources Service for BC Department of the Environment, Environment and Land Use Committee Secretariat. Victoria, BC. Cited in Morris *et al*. 1979.

Poole, D. 1998. Personal Communication. Kesho Group. Courtenay, BC.

Primex Forest Products. 1998. Primex Annual Report 1997. Primex Forest Products. Delta, BC.

Regional District of Comox-Strathcona. 1998. Rural Comox Valley Official Community Plan. Bylaw No. 2042. Regional District of Comox-Strathcona. Courtenay, BC.

Reid, D.J. 2000. Personal Communication. Lanarc Consultants Limited. Nanaimo, BC

Robinson, J. 1998. Personal Communication. Town of Comox, Recreation Department. Comox, BC.

Rodgers, R. 1978. Personal Communication. Regional Conservation Officer, Ministry of the Environment, Fish and Wildlife Branch. Courtenay, BC. Cited in Morris *et al*. 1979.

Sauer, J.R., S. Schwartz, and B. Hoover. 1996. The Christmas Bird Count Home Page. Version 95.1. Patunex Wildlife Research Centre. Laurel, MD. <http://www.mbr.nbs.gov/bbs/cbc.html>

Smith, H. 1993. Development of a Fish Passage Solution at the Puntledge Hydro Intake Facility. Paper presented to the American Fisheries Society Annual General Meeting, Portland, OR. BC Hydro. Burnaby, BC.

Stevens, V. 1995. Wildlife diversity in British Columbia: distribution and habitat use of amphibians, reptiles, birds, and mammals in biogeoclimatic zones. Res. Br., B.C. Min. For., and Wildl. Br., B.C. Min. Environ, Lands and Parks. Victoria, BC. Work Pap. 04/1995.

Sullivan, JP. 1999. Personal Communication. Primex Forest Products Limited, Vice President. Delta, BC.

Thomas, J. 1998. Personal Communication. Comox Valley Rowing Club. Courtenay, BC.

Thomsen, E. 1999. Personal Communication. Comox Valley Kayaks. Courtenay, BC.

Tourism Comox Valley. 1998. Marketing Plan 1999. Tourism Comox Valley. Courtenay, BC.

Town of Comox. 1997. Official Community Plan. Bylaw No. 1249. Town of Comox. Comox, BC.

Waldichuk, M. 1974. Application of oceanographic information to the design of sewer and industrial waste outfalls. Rapp. P - Reun. Const. Int. Explor. Mer. 167. Cited in Morris *et al*. 1979.

Webb, R.1998. Personal Communication. Comox Valley Harbour Authority. Comox BC.

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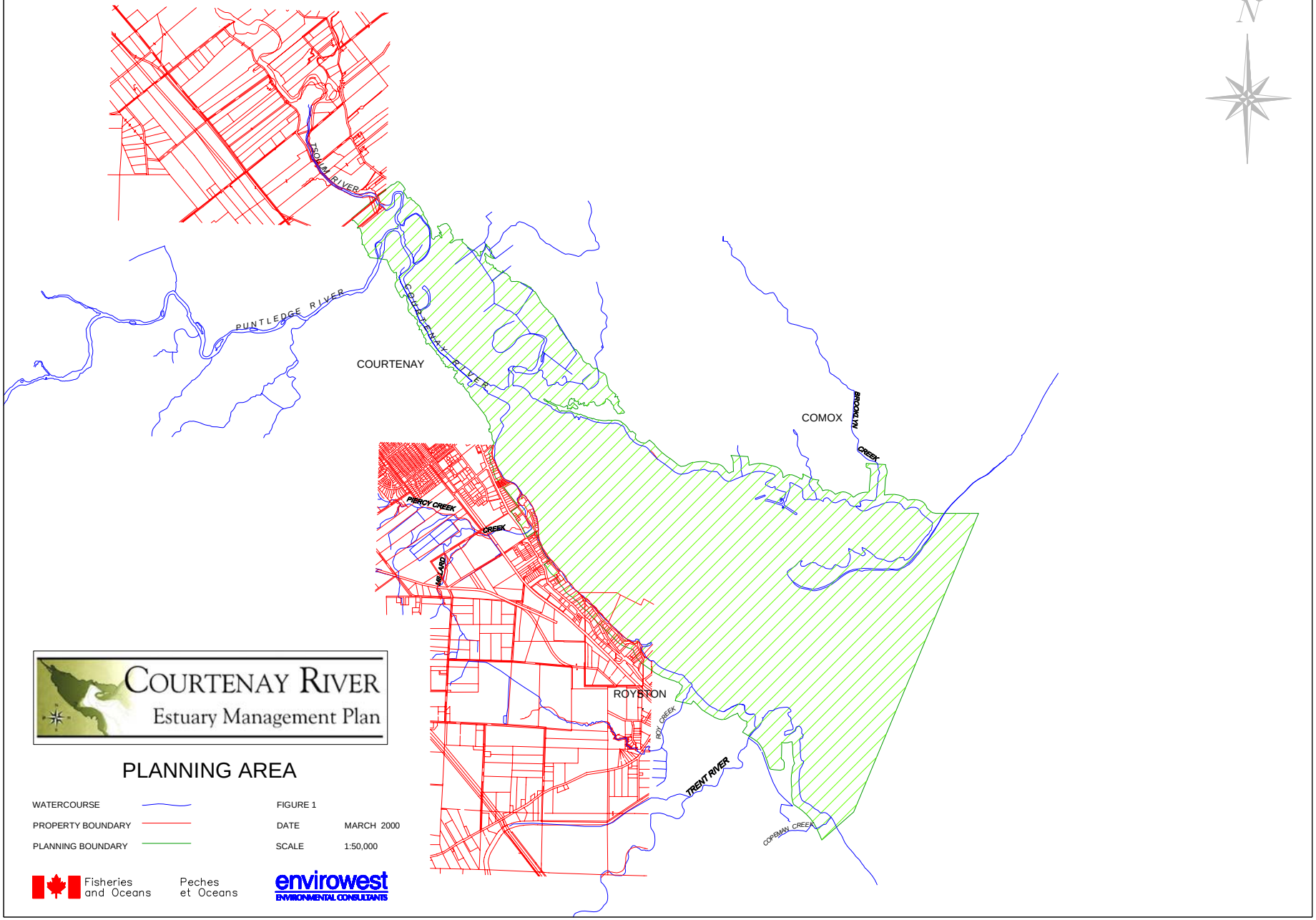
Appendix A

Figures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TROAKE RIVER
PUNTLEDGE RIVER
COURTENAY RIVER
COURTENAY
COMOX
BROOKLYN CREEK
PIERCY CREEK
CREEK
MILLARD
ROYSTON
ROY CREEK
TRENT RIVER
COPEMAN CREEK
COURTENAY RIVER
Estuary Management Plan
PLANNING AREA
WATERCOURSE
PROPERTY BOUNDARY
PLANNING BOUNDARY
FIGURE 1
DATE MARCH 2000
SCALE 1:50,000
Fisheries and Oceans
Peches et Oceans
envirowest
ENVIRONMENTAL CONSULTANTS

Appendix B-5 Puntledge Hatchery Data[1]

Table B-5.1 Puntledge Hatchery Fry and Smolt Releases

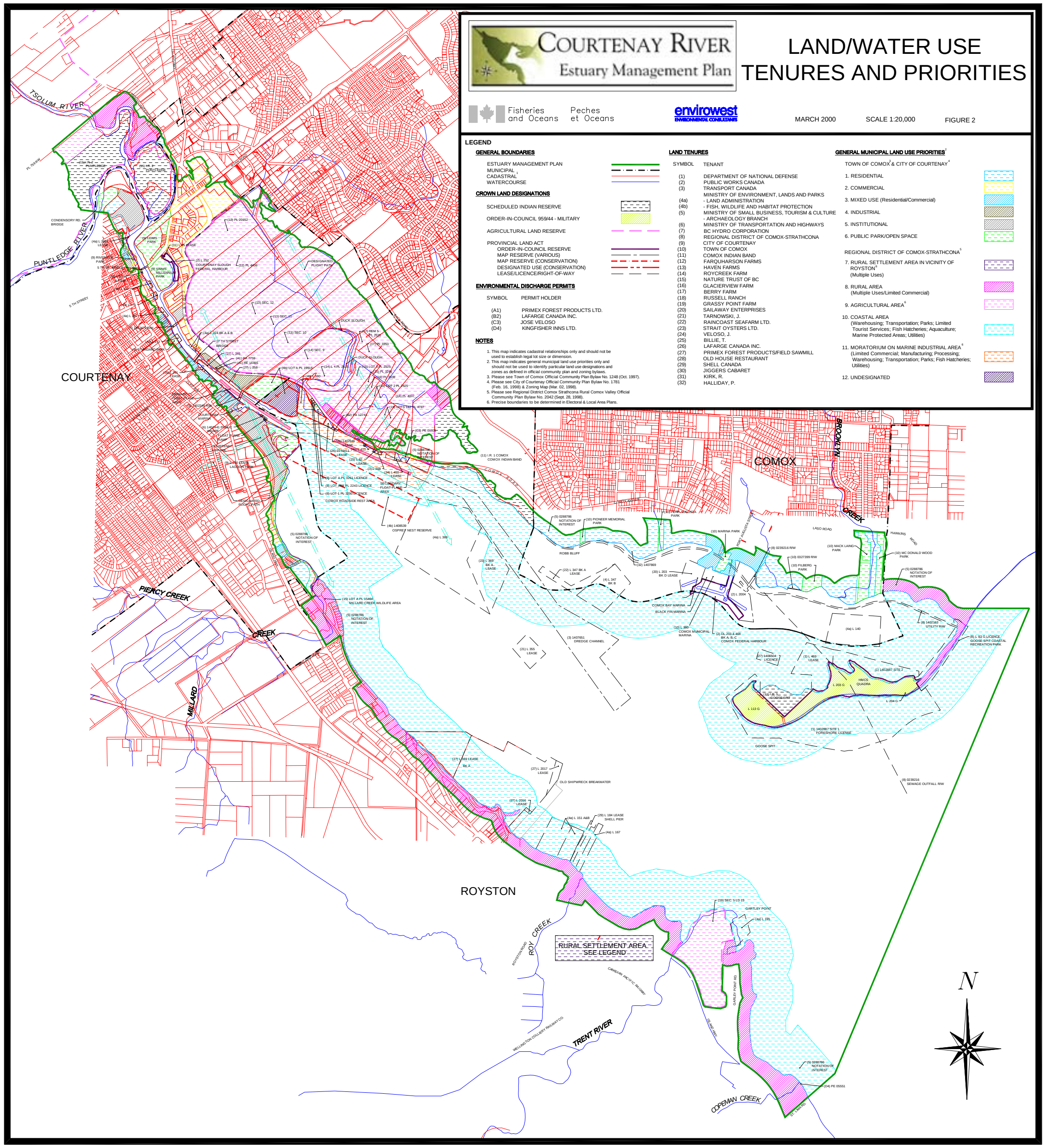
Year	Chinook		Coho	Chum	Pink	Steelhead		Cutthroat
	Summer	Fall				Summer	Winter	
1989	237,484	3,094,751	2,217,720	2,846,983	1,810,744	93,110	28,763	2,441
1990	1,638,731	3,293,420	1,955,918	5,163,162	2,824,479	22,284	59,488	9,762
1991	1,140,069	1,163,536	1,127,259	5,196,952	2,239,445	93,610	38,650	65
1992	702,884	1,400,314	1,038,603	4,915,005	2,531,984	23,038	29,015	9,516
1993	382,377	527,497	1,478,411	3,783,616	2,093,411	99,192	29,220	7,156
1994	482,355	1,881,064	1,211,882	5,032,631	2,627,774	20,571	13,484	725
1995	206,134	990,579	1,749,384	4,622,023	2,328,848	9,731	9,883	124
1996	176,985	791,325	1,179,157	3,892,554	2,352,204	17,906	1,696	1,200
1997	406,013	855,821	1,009,375	5,769,448	2,175,938	85,564	48,772	1,064
1998	227,933	1,197,149	Rearing	4,534,410	3,000,637	4,773	0	840
1999	735,000	2,200,000	2,200,000	5,000,000	4,000,000	Not Spawned yet		5,100

1999 numbers are eggs; all other release numbers except cuts are still rearing.
Fall Chinook numbers are a total of Puntledge returns plus transplants from Quinsan and Qualicum Hatcheries.
Pinks include Puntledge returns plus transplants from Quinsam Hatchery.
No transplants in 1999.

Table B-5.2 Puntledge Hatchery Adult Returns

Year	Chinook		Coho	Chum	Pink	Steelhead		Cutthroat
	Summer	Fall				Summer	Winter	
1989	345	1,312	11,380	40,000	19,000	217	17	26
1990	1,520	3,500	7,000	75,000	63,000	28	34	40
1991	1,300	1,000	10,000	12,000	42,000	78	21	8
1992	540	476	3,600	76,000	24,000	36	24	42
1993	400	265	7,000	74,000	12,000	147	21	31
1994	346	245	3,000	106,000	7,500	11	10	10
1995	142	144	8,000	55,000	3,500	14	12	14
1996	294	177	3,200	43,000	45,000	82	34	8
1997	260	272	4,700	105,000	7,000	8	0	4
1998	126	290	5,600	170,000	9,000	16	0	8
1999	308	800	8,500	91,000	100,000	12	Not Captured Yet	

[1] Source: **Hilliar, C. 1999.**



COURTENAY RIVER
Estuary Management Plan
LAND/WATER USE
TENURES AND PRIORITIES
Fisheries and Oceans
Peches et Oceans
envirowest
ENVIRONMENTAL CONSULTANTS
MARCH 2000
SCALE 1:20,000
FIGURE 2
LEGEND
GENERAL BOUNDARIES
ESTUARY MANAGEMENT PLAN
MUNICIPAL [1]
CADASTRAL
WATERCOURSE
CROWN LAND DESIGNATIONS
SCHEDULED INDIAN RESERVE
ORDER-IN-COUNCIL 959/44 - MILITARY
AGRICULTURAL LAND RESERVE
PROVINCIAL LAND ACT
ORDER-IN-COUNCIL RESERVE
MAP RESERVE (VARIOUS)
MAP RESERVE (CONSERVATION)
DESIGNATED USE (CONSERVATION)
LEASE/LICENCE/RIGHT-OF-WAY
ENVIRONMENTAL DISCHARGE PERMITS
SYMBOL PERMIT HOLDER
(A1) PRIMEX FOREST PRODUCTS LTD.
(B2) LAFARGE CANADA INC.
(C3) JOSE VELOSO
(D4) KINGFISHER INNS LTD.
NOTES
1. This map indicates cadastral relationships only and should not be used to establish legal lot size or dimension.
2. This map indicates general municipal land use priorities only and should not be used to identify particular land use designations and zones as defined in official community plan and zoning bylaws.
3. Please see Town of Comox Official Community Plan Bylaw No. 1248 (Oct. 1997).
4. Please see City of Courtenay Official Community Plan Bylaw No. 1781 (Feb. 16, 1998) & Zoning Map (Mar. 02, 1998).
5. Please see Regional District Comox Strathcona Rural Comox Valley Official Community Plan Bylaw No. 2042 (Sept. 28, 1998).
6. Precise boundaries to be determined in Electoral & Local Area Plans.
LAND TENURES
SYMBOL TENANT
(1) DEPARTMENT OF NATIONAL DEFENSE
(2) PUBLIC WORKS CANADA
(3) TRANSPORT CANADA
MINISTRY OF ENVIRONMENT, LANDS AND PARKS
(4a) - LAND ADMINISTRATION
(4b) - FISH, WILDLIFE AND HABITAT PROTECTION
(5) MINISTRY OF SMALL BUSINESS, TOURISM & CULTURE - ARCHAEOLOGY BRANCH
(6) MINISTRY OF TRANSPORTATION AND HIGHWAYS
(7) BC HYDRO CORPORATION
(8) REGIONAL DISTRICT OF COMOX-STRATHCONA
(9) CITY OF COURTENAY
(10) TOWN OF COMOX
(11) COMOX INDIAN BAND
(12) FARQUHARSON FARMS
(13) HAVEN FARMS
(14) ROYCREEK FARM
(15) NATURE TRUST OF BC
(16) GLACIERVIEW FARM
(17) BERRY FARM
(18) RUSSELL RANCH
(19) GRASSY POINT FARM
(20) SAILAWAY ENTERPRISES
(21) TARNOWSKI, J.
(22) RAINCOAST SEAFARM LTD.
(23) STRAIT OYSTERS LTD.
(24) VELOSO, J.
(25) BILLIE, T.
(26) LAFARGE CANADA INC.
(27) PRIMEX FOREST PRODUCTS/FIELD SAWMILL
(28) OLD HOUSE RESTAURANT
(29) SHELL CANADA
(30) JIGGERS CABARET
(31) KIRK, R.
(32) HALLIDAY, P.
GENERAL MUNICIPAL LAND USE PRIORITIES [2]
TOWN OF COMOX [3] & CITY OF COURTENAY [4]
1. RESIDENTIAL
2. COMMERCIAL
3. MIXED USE (Residential/Commercial)
4. INDUSTRIAL
5. INSTITUTIONAL
6. PUBLIC PARK/OPEN SPACE
REGIONAL DISTRICT OF COMOX-STRATHCONA [5]
7. RURAL SETTLEMENT AREA IN VICINITY OF ROYSTON [6] (Multiple Uses)
8. RURAL AREA (Multiple Uses/Limited Commercial)
9. AGRICULTURAL AREA [6]
10. COASTAL AREA (Warehousing; Transportation; Parks; Limited Tourist Services; Fish Hatcheries; Aquaculture; Marine Protected Areas; Utilities)
11. MORATORIUM ON MARINE INDUSTRIAL AREA [6] (Limited Commercial; Manufacturing; Processing; Warehousing; Transportation; Parks; Fish Hatcheries; Utilities)
12. UNDESIGNATED
COURTENAY
COMOX
ROYSTON
TSOLUM RIVER
PUNTLEDGE RIVER
PIERCY CREEK
CREEK
MILLARD
BROOKLYN
CREEK
ROY CREEK
TRENT RIVER
COPEMAN CREEK
RURAL SETTLEMENT AREA SEE LEGEND
N

Volume 3
Resource Values

Appendix B

Fish and Wildlife Resources

Appendix B-1 Plants of the Courtenay River Estuary

Table B-1.1 Non-Vascular Plants[1]

Family	Species	
	Scientific Name	**Common Name**
Chrysophyta		
	Vaucheria sp.	green felt
Chlorophyta		
	Cladophora trichotoma	cushion weed
	Entermorpha linza	green string lettuce
	E. intestinalis	link confetti
	E. prolifera	branched confetti
	Monostroma zostericola	grenn finge
	Ulva expansa	large sea lettuce
	U. lactuca	sea lettuce
	Urospora mirabilis	green hair
Phaeophyta		
	Colpomenia sinuosa	oyster thief
	Costeria costata	
	Desmarestia aculeata	
	Fucus distichus	popping wrack
	Laminaria groenlandica	
	L. saccharina	sugar wrack
	Nerocystis luetkeana	bull kelp
	Punctaria expansa	brown lettuce
	P. hesperia	brown fringe
	Sargass, muticum	Japanese seaweed
	Scytosiphon lomentaria	whip tube
Rhodophyta		
	Agardhiella tenara	fleshy seaweed
	Bangia fuscopupurea	bangia
	Callophyllis violaceae	
	Ceramium californicum	pottery seaweed
	Cryptosiphonia woodii	
	Endocladia muricata	nail brush
	Gigartina cristata	split Turkish towel
	G. exasperata	Turkish towel
	G. papillata	branching turkish towel
	G. stellata	
	Grateloupia sp.	lynx seaweed
	Hildenbrandia sp.	Hildenbrandia
	Iridaea heterocarpa	
	Lithothamnion pacificum	pink rock crust
	Neoagardhiella baireli	
	Plocamium coceinaeum	
	Polyneura latissima	
	Polysiphonia sp.	polly seaweed
	Porphyria lanceolata	red jabot laver
	Priantis lyalli	
	Prionitis lanceolata	iodine seaweed
	Rhodomela larix	black larch

Table B-1.1 Non-Vascular Plants continued

[1] Sources: **Brooks et al. 1994; Austin, A. and R. Adams. 1972**.

Family	Species	
	Scientific Name	**Common Name**
Rhodophyta continued	*Rhodoymenia palmata*	red kale
	Smithora naiadum	red fringe

Table B-1.2 Vascular Plants[2]

Family	Species	
	Scientific Name	**Common Name**
Aceraceae		
	Acer glabrum	Douglas maple
	A. macrophyllum	broadleaf maple
Alismataceae		
	Alisma plantago-aquatica	water plantain
Aquifoliaceae		
	Ilex sp.	holly
Araliaceae		
	Hedera helix	English ivy
Araceae		
	Lysichiton americanum	skunk cabbage
Berberidaceae		
	Achlys triphylla	vanilla leaf
	Mahonia nervosa	dull Oregon grape
Betulaceae		
	Alnus rubra	red alder
Boraginaceae		
	Myosotis laxa	small water forget-me-not
	M. scorpioides	common forget-me-not
	Symphytum asperum	rough comfry
Brassicaceae		
	Cakile edentula	searocket
Caprifoliaceae		
	Lonicera involucrata	black twinberry
	Sambucus cerulea	blue elderberry
	S. racemosa	red elderberry
	Symphoricarpos albus	snowberry
	Viburnum edule	highbush cranberry
Caryophyllaceae		
	Spergularia marina	saltmarsh sandspurry
Chenopodiaceae		
	Atriplex patula	saltbush
	Chenopodium album	lamb's quarter
	Salicornia virginica	pickleweed
Compositae		
	Achillea millefolium	yarrow
	Ambrosia chamissonis	silver burweed
	Anaphalis margaritacea	pearly-everlasting

Table B-1.2 Vascular Plants continued

[2] Primary source: ECL Envirowest Consultants Limited and Precision Identification Limited. 1998 (August). Additional source: Kennedy, 1982.

Family	Species	
	Scientific Name	**Common Name**
Compositae continued	*Aster hesperius*	Pacific aster
	A. subspicatus	marsh aster
	Bidens cernua	beggar's tick
	Cirsium arvense	Canada thistle
	C. vulgaris	thistle
	Cotula coronopifolia	brassbuttons
	Erigeron philadelphicus	Philadelphia fleabane
	Grindelia intergrifolia	gumweed
	Heliopsis helianthoides	ox-eye daisy
	Hypochaeris radicata	hairy cat's ear
	Lactuca muralis	lettuce
	L. vulgare	prickly lettuce
	Sonchus arvensis	sow thistle
Cornaceae		
	Cornus stolonifera	red-osier dogwood
Convolvulacea		
	Convolvulus sepium	morning glory
Cupressaceae		
	Thuja plicata	western red cedar
Cyperaceae		
	Carex lyngbyei	Lyngby's sedge
	C. macrocephala	bighead sedge
	C. stipata	sawbeak sedge
	Eleocharis palustris	spike rush
	Scirpus americanus	three-square bulrush
	S. cernus	pygmy bulrush
	S. maritimus	salt marsh bulrush
	S. microcarpus	smallfruited bulrush
	S. validus	softstem bulrush
Equisitaceae		
	Equisetum arvense	common horsetail
	E. hyemale	scouring rush
Ericaceae		
	Gowtheria shallon	salal
	Vaccinium parvifolium	red huckleberry
Fumariaceae		
	Dicentra formosa	Pacific bleeding heart
Graminae		
	Agropyron repens	couch grass
	Agrostis oregonensis	Oregon bentgrass
	A. scabra	rough bentgrass
	A. tenuis	colonial bentgrass
	Bromus sitchensis	Sitka brome-grass
	Calamagrostis canadensis	bluejoint reedgrass
	Dactylis glomerata	orchard grass
	Deschampsia cespitosa	tufted harigrass
	Distichlis spicata	saltgrass
	Elymus mollis	wildrye
	Festuca pratensis	meadow fescue
	Glyceria occidentalis	western mannagrass

Table B-1.2 Vascular Plants continued

Family	Species

	Scientific Name	Common Name
Gramineae continued	*Holcus lanatus*	velvet-grass
	Hordeum brachyantherum	meadow barley
	Lolium sp.	ryegrass
	Phalaris arundinacea	reed canarygrass
	Phleum pratense	Timothy
	Spartina patens	saltmeadow cordgrass
Hypericaceae		
	Hypericum formosum	*St. John's wort*
Iridaceae		
	Iris pseudacorus	yellow flag
	Sisyrinchium angustifolium	blue-eyed grass
Juncaceae		
	Juncus acuminatus	tapered rush
	J. articus	arctic rush
	J. balticus	Baltic rush
	J. bufonius	toad rush
	J. effusus	common rush
	J. gerardii	black rush
	J. tenuis	slender rush
Juncaginaceae		
	Triglochin maritimum	arrow grass
Labiatae		
	Mentha arvensis	field mint
	M. spicata	spearmint
	Prunella vulgaris	self-heal
	Scutellaria lateriflora	marsh skullcap
Leguminosae		
	Cytisus scoparius	broom
	Lathyrus japonica	pea
	L. palustris	marsh pea
	Lupinus sp.	lupine
	Melilotus alba	white sweet clover
	Trifolium dubium	least hop clover
	T. pratense	red clover
	T. repens	white clover
	T. wormskjoldii	springbank clover
	Vicia sp.	vetch
	V. gigantea	giant vetch
Lemnaceae		
	Lemna minor	duckweed
Liliaceae		
	Camassia quamash	camas
	Fritallaria camschatcensis	northern rice root
	Lilium colombianum	Columbian lily
	Maianthemum dilatatum	false-lily-of-the-valley
	Smilacina stellata	star-flowered false Solomon's seal
	Trillium ovatum	western trillium
Lythraceae		
	Lythrum salicaria	purple loosestrife

Table B-1.2 Vascular Plants continued

Family	Species	
	Scientific Name	**Common Name**

Malvaceae		
	Sidalcea hendersonii	Henderson's checker-mallow
Myricaceae		
	Myrica gale	sweet gale
Nyctaginaceae		
	Abronia latifolia	yellow sand verbena
Onagraceae		
	Epilobium angustfolium	fireweed
	E. watsonii	willow herb
Orchidaceae		
	Habenaria dilatata	bog-candle
Pinaceae		
	Picea sitchensis	Sitka spruce
	Pinus monticola	white pine
	Pseudotsuga menzesii	Douglas fir
	Tsuga heterphylla	western hemlock
Plantaginaceae		
	Plantago lanceolata	ribgrass
	P. macrocarpa	plantain
	P. major	broadleaf plantain
	P. maritima	seaside plantain
Polygonaceae		
	Polygonum lapathifolium	willow smartweed
	P. persicaria	ladysthumb
	Rumex crispus	curly dock
	R. occidentalis	western dock
	R. salicifolius	willow dock
Polypodiaceae		
	Athyrium filix femina	lady fern
	Dryoperis expansa	wood fern
	Polystichum munitum	sword fern
	Pteridium aquilinum	bracken
Portulacaceae		
	Montia parvifolia	miner's lettuce
	M. sibirica	Siberian miner's lettuce
Primulaceae		
	Dodecatheon pulchellum	shooting-star
	Glaux maritima	sea-milkwort
Ranunculaceae		
	Ranunculus repens	creeping buttercup
	Trautvetteria caroliniensis	false bugbane
	Thalictrum occidentale	western meadowrue
Rhamnaceae		
	Rhamnus purshiana	cascara
Rosaceae		
	Amelanchier alnifolia	Saskatoon
	Aruncus dioicus	goat's beard

Table B-1.2 Vascular Plants continued

Family	**Species**	
	Scientific Name	**Common Name**
Rosaceae continued	*Crataegus douglasii*	hawthorn

	Holodiscus discolor	oceanspray
	Physocarpus capitus	ninebark
	Potentilla pacifica	cinquefoil
	Prunus emgarginata	bitter cherry
	Pyrus fusca	Pacific crabapple
	Rosa gymnocarpa	little wild rose
	R. nutkana	Nootka rose
	Rubus discolor	Himalayan blackberry
	R. laciniatus	evergreen blackberry
	R. parviflorus	thimbleberry
	R. spectabilis	salmonberry
	R. ursinus	Pacific blackberry
	Sorbus scopulina	mountain ash
	Spiraea douglasii	hardhack
Rubiaceae		
	Galium aparine	bedstraw
	G. sperrimum	rough bedstraw
	Ruppia maritima	widgeon grass
Salicaceae		
	Populus trichocarpa	cottonwood
	Salix spp.	willow
	S. lucida	Pacific willow
	S. scouleriana	Scouler's willow
	S. sitchensis	sitka willow
Saxifragaceae		
	Tiarella trifoliata	foamflower
Scrophulariaceae		
	Mimulus guttatus	yellow monkey-flower
	Veronica americana	American brookline
Typhaceae		
	Typha latifolia	cattail
Umbelliferae		
	Cicuta douglasii	water hemlock
	Heracleum lanatum	cow parsnip
	Lilaeopsis occidentalis	lilaeopsis
	Oenanthe sarmentosa	water parsley
	Sium suave	water parsnip
Zosteraceae		
	Zoster marina	eelgrass

Appendix B-2 Marine Invertebrate Species and Abundance- Trent River Estuary

Table B-2.1 Marine Invertebrate Species – Trent River Estuary[1]

Species Group	Species	
	Scientific Name	**Common Name**
Sponges	*Haliclona sp.*	Purple sponge
	Heptacarpus sp.	Yellow encrusting sponge
Jellyfish/Anemones	*Aquorea aquorea*	water jellyfish
	Anthopeura artemesia	currowing anemone
	Urticina coreacea	red anemone
Flatworms	*Freemania litoricola*	little leaf worm
Ribbon Worms	*Emplectonema gracile*	green ribbon worm
	Paranemertes peregrina	wandering ribbon worm
	Tubulanus polymorphus	red ribbon worm
Segmented Worms	*Anaitides williamsii*	paddle worm
	Artonoe fragilis	commensal scale worm
	Glycera americana	proboscis or corregated worm
	Hemipodus borealis	coil worm
	Notomastus tenuis	thread worm
	Nereis brandti	giant worm
	Nereis procera	little sandworm
	Polychaetes unidentified	
	Serpula vermicularis	calcareous tube worm
	Spiochaetopterus costarum	jointed tube worm
	Spirobis sp.	Spiral tube worm
	Thelepsus crispus	shell binder
Jointed Limbed Animals	*Amphipoda sp.*	Amphipods
	Balanus glandula	acorn barnacle
	Balanus rostratus alaskensis	ribbed barnacle
	Chthamalus dalli	little acorn barnacle
	Cancer magister	edible crab
	Cancer productus	red rock crab
	Crangon alaskensis	northern crangon shrimp
	Hemigrapsus nudus	purple shore crab
	H. oregonensis	green shore crab
	Heptacarpus sp.	Broken-backed crab
	Idotea wosnesenskii	green isopod
	Lophopanopeus bellus bellus	black-clawed crab
	Pagurus sp.	Hermit crab
	Petrolisthes eriomerus	porcelain crab
	Pinnixa faba	pea crab
	Pugettia gracilis	graceful crab
	P. productus	kelp crab
	Phyllodurus abdominalis	parasitic isopod
		red mite
		rove beetle
	Upogebia pugettensis	blue mid shrimp
	Telmessus cheirogonus	helmet crab
Shellfish	*Alia gouldi*	dove shell
	Anisodoris nobilis	speckled sea lemon
	Batillaria attramentaria	Cuming's batillaria

[1] Source: **Brooks *et al*. 1994.**

Table B-2.1 Marine Invertebrate Species – Trent River Estuary continued

Species Group	Species	
	Scientific Name	**Common Name**
Shellfish continued	*Bittium eschrichtii*	Eschricht's bittium
	Clinocardium nuttallii	cockle
	Collisella instabilis	unstable limpet
	C. pelta	shield limpet
	Crassostrea gigas	Japenese oyster
	Credidula nummaria	northern slipper shell
	Cryptomya california	false mya
	Diplodonta orbellus	round diplodon
	Haminoea vesicula	bubble snail
	Lacuna variegata	chink snail
	Littorina scutulata	checkered periwinkle
	L. sitkana	sitka periwinkle
	Macoma balthica	inconspicuous macoma
	M.inquinata	polluted macoma
	M. nasuta	bent-nosed clam
	Melanochamys diomedia	Diomede's mud snail
	Modiolus rectus	horse mussel
	Mopalis lignosa	woody chiton
	Mya arenaria	mud clam
	Mytilus edulis	edible blue mussel
	Nassarius mendicus	lean dog whelk
	Notacmaea persona	mask limpet
	N. scutum	plate limpet
	Nucella emarginata	short-spired limpet
	N. lamellosa	wrinkled purple snail
	Orbitella rugifera	wrinkled lepton
	Pododesmus cepio	jingle shell, rock oyster
	Polinices lewisii	moon snail
	Protothaca staminea	native littleneck
	Searlesia dira	dire whelk
	Saxidomas gigantea	butter clam
	Semele rubropicta	rose petal semele
	Solen sicarius	jackknife clam
	Tapes japonica	Japanese littleneck clam
	Tonicella lineata	lined chiton
	Trinchesia concina	neat aolid nudibranch
	Tresus capax	horse clam
	T. nuttallii	giant horse clam
Starfish	*Dendraster excentricus*	sand dollar
	Amphiodia occidentalis	long-rayed brittlestar
	Cucumaria miniata	red sea cucumber
	Evasterias troschelii	mottle star
	Eupentacta quinquesemita	white sea cucumber
	Leptosynapta clarki	burrowing sea cucumber
	Pisaster brevispinus	giant pink star
	P. ochraceous	purple star
	Pycnopodia helianthoides	sunflower star
Chardates	*Pyura haustor*	Red Sea squirt

Table B-2.2 Most Abundant Invertebrates Found in Each Tidal Zone of the Trent River[2]

Order[3]	Tidal Zone		
	High (3.7 to 4.9m)	**Mid (1.2 to 3.4m)**	**Low (-0.1 to 0.9m)**
1	little acorn barnacle	little acorn barnacle	thread worm
2	checkered periwinkle	checkered periwinkle	mud clam
3	acorn barnacle	acorn barnacle	polluted macoma/acorn barnacle
4	sitka periwinkle	sitka periwinkle	polychaetes unidentified
5	thread worm	edible blue mussel	jointed tube worm
6	Japanese littleneck clam	native littleneck	hermit crab
7	inconspicuous macoma	Japanese littleneck clam	proboscis or corregated worm
8	mask limpet	mask limpet	native littleneck
9	Cuming's batillaria	green shore crab	butter clam
10	edible blue mussel	thread worm	blue mud shrimp/green shore crab
11	polluted macoma	Cuming's batillaria	Japanese littleneck clam
12	green shore crab	rove beetle	shell binder

[2] Source: **Brooks *et al*. 1994.**

[3] Species listed in decreasing order of abundance

Appendix B-3 Fish Species

Table B-3.1 Fish Species Found in or Near the Courtenay and Oyster River Estuaries[1]

Scientific Name	Common Name
Agonus acipenserinus	sturgeon poacher
Anoplopoma fimbria	sablefish
Apristurus brunneus	brown cat shark
Aprodon cortezianus	bigfin eelpout
Asterotheca pentacanthus	bigeye poacher
Atheresthes stomias	arrowtooth flounder
Citharichthys stigmaeus	speckled sanddab
Clupea harengus pallasi	Pacific herring
Cottus aleuticus	coastrange sculpin
C. asper	prickly sculpin
Culaea inconstans	brook stickleback
Cymatogaster aggregata	shiner perch
Dasycottus setiger	spinyhead sculpin
Gadus macrocephalus	Pacific or grey cod
Gasterosteus aculeatus	threespine stickleback
Glyptocephalus zachirus	rex sole
Hippoglossoides elassodon	flathead sole
Hippoglossus stnolepis	Pacific halibut
Hydrolagus collei	ratfish
Icelinus tenuis	spotfin sculpin
Isopsetta isolepis	butter sole
Lampetra tridentatus	Pacific lamprey
Lepidopsetta bilineata	rock sole
Leptocottus armatus	Pacific staghorn sculpin
Lumpenus sagitta	Pacific snake prickleback
Lycodopsis pacifica	blackbelly eelpout
Lyopsetta exilus	slender sole
Malacottus kincaidi	blackfin sculpin
Merluccius productus	Pacific hake
Microgadus proximus	Pacific tomcod
Microstomau pacificus	Dover sole
Oncorhynchus gorbuscha	pink salmon
O. keta	chum salmon
O. kisutch	coho salmon
O. nerka	sockeye salmon
O. n. keenerlyi	kokanee salmon
O. tshawytscha	chinook salmon
Ophiodon elongatus	lingcod
Parophrys vetulus	English sole
Platichthys stellatus	starry flounder
Porichthys notatus	plainfin midshipman
Psettichthys melanostictus	sand sole
Raja kincaidi	black stake
R. rhina	longnose skate
Rhacochilus vacca	pile perch
Salmo clarki clarki	coastal cuthroat trout

[1] Source: **Morris *et al*. 1979**.

Table B-3.1 Fish Species Found in or Near the Courtenay and Oyster River Estuaries continued

Scientific Name	Common Name
S. gairdneri	rainbow or steelhead trout
Salvelinus malma	Dolly Varden char
Sebastes caurinus	copper rockfish
S. diploproa	splitnose rockfish
S. elongatus	greenstriped rockfish
S. maliger	quillback rockfish
S. pinniger	canary rockfish
S. spp.	unidentified rockfish
Squalus acnthias	spiny dogfish
Thaleichthys pacificus	eulachon
Theragra chalcogramma	walleye pollock
Triglops macellas	roughspine sculpin

Table B-3.2 Fish Species Found in the Courtenay River Estuary[2]

Scientific Name	Common Name
Ammodytes hexapterus	Pacific Sand Lance
Citharichthys stigmaeus	Speckled Sandab
Cottus asper	Prickly Sculpin
Cymatogaster aggregata	Shiner Perch
Enophrys bison	Buffalo Sculpin
Leptocottus armatus	Staghorn sculpin
Oncorhynchus gorbuscha	Pink Salmon
O. keta	Chum Salmon
O. kisutch	Coho Salmon
Phanerodon furcatus	White Seaperch
Pholis ornata	Saddleback Gunnel
Pholis laeta	Crescent Gunnel
Porichthys notatus	Plainfin Midshipman
Raja rhina	Longnose Skate
Squalus acanthias	Spiny Dogfish
Syngnathus leptorhynchus	Bay Pipefish
Rhacochilus vacca	Pile Surfperch
Sebastes maliger	Quilback Rockfish
S. caurinus	Copper Rockfish
Embiotoca lateralis	Striped Perch
Hexagrammos lagocephalus	Rock Greenling
H. decagrammos	Kelp Greenling
H. stelleri	White-spotted Greenling
Ophiodon elongatus	Lingcod
Clupea harangus pallasi	Pacific Herring
Coryphopterus nicholsi	Blackeye Goby
Lepidogobius lepidus	Bay Goby
Psettichthys melanostictus	Sand sole
Pleuronichthys coenosus	C-O Turbot

[2] Sources: **Holmes *et al*. 1985; Adams, M.A. 1992**; and **Brooks *et al*. 1994**.

Appendix B-4. Steelhead Harvest Analysis – Puntledge, Trent and Tsolum Rivers[1, 2]

Table B-4.1 Puntledge River

Year	Gazetted Name	Anglers	Days Fished	Hatchery Kept	Hatchery Released	Wild Kept	Wild Released	Landed/Angler Day
1967	Puntledge	764	4075	0	0	1471	0	0.36
1968		578	4559	0	0	516	0	0.11
1969		417	3238	0	0	489	0	0.15
1970		472	4485	0	00	360	0	0.08
1971		399	2544	0	0	276	160	0.17
1972		269	1981	0	0	193	55	0.13
1973		314	2515	0	0	325	212	0.21
1974		232	1637	0	00	147	91	0.15
1975		197	1222	0	0	95	60	0.13
1976		215	1258	0	0	91	86	0.14
1977		99	561	0	0	24	65	0.16
1978		50	347	0	0	44	59	0.30
1979		55	230	0	0	8	68	0.33
1980		38	193	0	0	0	3	0.02
1981		23	228	0	0	0	80	0.35
1982		46	314	0	14	0	167	0.58
1983		159	1219	43	113	0	579	0.60
1984		163	1123	64	607	9	629	1.17
1985		160	1738	148	375	0	480	0.58
1986		164	1209	110	110	0	488	0.59
1987		133	699	8	281	0	443	1.05
1988		105	446	0	173	0	241	0.93
1989		96	354	0	66	0	85	0.43
1990		123	1122	0	136	0	495	0.56
1991		158	926	0	116	0	89	0.22
1992		116	507	0	64	0	82	0.29
1993		118	587	0	243	0	168	0.70
1994		145	634	0	51	0	41	0.15
1995		19	62	0	6	0	34	0.65

[1] Source: **Axford, R**. **1998a**.
[2] Survey methodology: questionnaire distributed to 50% of steelhead licence holders

Table B-4.2 Trent River

Year	Gazetted Name	Anglers	Days Fished	Hatchery Kept	Hatchery Released	Wild Kept	Wild Released	Landed/Angler Day
1967	Trent	152	393	0	0	223	0	0.57
1968		76	385	0	0	148	0	0.38
1969		64	704	0	0	259	0	0.37
1970		77	652	0	0	209	0	0.32
1971		94	566	0	0	105	51	0.28
1972		67	414	0	0	86	34	0.29
1973		75	413	0	0	42	33	0.18
1974		69	234	0	0	31	11	0.18
1975		47	234	0	0	40	68	0.46
1976		58	109	0	0	0	5	0.05
1977		31	165	0	0	31	19	0.30
1978		26	140	0	0	22	29	0.36
1979		40	118	0	0	12	41	0.45
1980		22	66	0	0	7	3	0.15
1981		17	39	0	0	7	28	0.90
1982		4	7	0	0	0	3	0.43
1983		26	39	0	0	0	0	0.00
1984		30	98	4	0	17	137	1.61
1985		24	100	0	0	0	24	0.24
1986		28	88	0	0	0	14	0.16
1987		37	123	0	0	0	38	0.31
1988		18	31	0	4	0	9	0.42
1989		38	186	0	0	0	57	0.33
1990		25	77	0	0	0	8	0.10
1991		19	135	0	0	0	42	0.31
1992		9	100	0	19	0	5	0.24
1993		7	11	0	0	0	0	0.00
1994		15	25	0	5	0	15	0.80
1995		12	25	0	0	0	0	0.00

Table B-4.3 Tsolum River

Year	Gazetted Name	Anglers	Days Fished	Hatchery Kept	Hatchery Released	Wild Kept	Wild Released	Landed/Angler Day
1967	Tsolum	438	2036	0	0	805	0	0.40
1968		436	2130	0	0	393	0	0.18
1969		213	1115	0	0	262	0	0.23
1970		284	1667	0	0	346	0	0.21
1971		214	1150	0	0	122	29	0.13
1972		103	379	0	0	108	41	0.39
1973		176	994	0	0	228	145	0.38
1974		143	741	0	0	93	90	0.25
1975		95	385	0	0	68	71	0.36
1976		160	1982	0	0	38	65	0.05
1977		116	355	0	0	26	31	0.16
1978		42	200	0	0	29	39	0.34
1979		88	462	0	0	24	41	0.14
1980		45	235	0	0	6	3	0.04
1981		3	40	0	0	0	36	0.90
1982		16	52	0	0	0	36	0.69
1983		45	288	0	0	4	43	0.16
1984		30	51	0	0	0	9	0.18
1985		17	300	0	0	0	31	0.10
1986		7	57	0	0	0	7	0.12
1987		8	36	0	0	0	0	0.00
1988		8	22	0	0	0	0	0.00
1989		5	10	0	0	0	0	0.00
1991		8	15	0	0	0	0	0.00
1993		4	7	0	0	0	0	0.00
1994		5	25	0	0	0	0	0.00
1995		3	6	0	0	0	0	0.00

Appendix B-5 Puntledge Hatchery Data[1]

Table B-5.1 Puntledge Hatchery Fry and Smolt Releases

Year	Chinook		Coho	Chum	Pink	Steelhead		Cutthroat
	Summer	Fall				Summer	Winter	
1989	237,484	3,094,751	2,217,720	2,846,983	1,810,744	93,110	28,763	2,441
1990	1,638,731	3,293,420	1,955,918	5,163,162	2,824,479	22,284	59,488	9,762
1991	1,140,069	1,163,536	1,127,259	5,196,952	2,239,445	93,610	38,650	65
1992	702,884	1,400,314	1,038,603	4,915,005	2,531,984	23,038	29,015	9,516
1993	382,377	527,497	1,478,411	3,783,616	2,093,411	99,192	29,220	7,156
1994	482,355	1,881,064	1,211,882	5,032,631	2,627,774	20,571	13,484	725
1995	206,134	990,579	1,749,384	4,622,023	2,328,848	9,731	9,883	124
1996	176,985	791,325	1,179,157	3,892,554	2,352,204	17,906	1,696	1,200
1997	406,013	855,821	1,009,375	5,769,448	2,175,938	85,564	48,772	1,064
1998	227,933	1,197,149	Rearing	4,534,410	3,000,637	4,773	0	840
1999	735,000	2,200,000	2,200,000	5,000,000	4,000,000	Not Spawned yet		5,100

1999 numbers are eggs; all other release numbers except cuts are still rearing.
Fall Chinook numbers are a total of Puntledge returns plus transplants from Quinsan and Qualicum Hatcheries.
Pinks include Puntledge returns plus transplants from Quinsam Hatchery.
No transplants in 1999.

Table B-5.2 Puntledge Hatchery Adult Returns

Year	Chinook		Coho	Chum	Pink	Steelhead		Cutthroat
	Summer	Fall				Summer	Winter	
1989	345	1,312	11,380	40,000	19,000	217	17	26
1990	1,520	3,500	7,000	75,000	63,000	28	34	40
1991	1,300	1,000	10,000	12,000	42,000	78	21	8
1992	540	476	3,600	76,000	24,000	36	24	42
1993	400	265	7,000	74,000	12,000	147	21	31
1994	346	245	3,000	106,000	7,500	11	10	10
1995	142	144	8,000	55,000	3,500	14	12	14
1996	294	177	3,200	43,000	45,000	82	34	8
1997	260	272	4,700	105,000	7,000	8	0	4
1998	126	290	5,600	170,000	9,000	16	0	8
1999	308	800	8,500	91,000	100,000	12	Not Captured Yet	

[1] Source: **Hilliar, C. 1999.**

Appendix B-6 Bird Species in the Courtenay River Estuary, 1981/82[1,2]

Species Group	Species	
	Scientific Name	**Common Name**
Loons	*Gavia stellata*	red-throated Loon
	G. pacifica	Pacific loon
	G. immer	common loon
	G.adamsii	yellow-billed loon
Grebes	*Podilymbus podiceps*	pied-billed grebe
	Podiceps auritus	horned grebe
	P. grisegen	red-necked grebe
	P. nigricollis	eared grebe
	Aechmophorus occidentalis	western grebe
Cormorants	*Phalacrocorax auritus*	double crested cormorant
	P. pelagicus	pelagic cormorant
Herons	*Ardea herodias*	great blue heron
Swans	*Cygnus columbianus*	tundra swan
	C. buccinator	trumpeter swan
Geese	*Anser albifrons*	greater white fronted goose
	Chen caerulescens	snow goose
	Branta bernicula	brandt
	B. canadensis	Canada goose
Dabbling Ducks	*Anas crecca*	green winged teal (Am.)
	A. platyrhynchos	mallard
	A. Acuta	northern pintail
	A. discors	blue-winged teal
	A. crecca	cinnamon teal
	A. clypeata	northern shoveler
	A. strepara	gadwall
	A. penelope	Eurasian wigeon
	A. americana	American wigeon
Diving Ducks	*Aythya valisineria*	canvasback
	A. collaria	ring-necked duck
	A. marila	greater scaup
	A. affinis	lesser scaup
	Histrionicus histrionicus	harlequin duck
	Clangula hyemalis	oldsquaw
	Melanitta nigra	black scoter
	M. perspicillata	surf scoter
	M. fusca	white winged scoter
	Bucephala clangula	common goldeneye
	B. islandica	Barrow's goldeneye
	B. albeola	bufflehead
	Lophodytes cucullatus	hooded merganser
	Mergus merganser	common merganser
	M. serrator	red-breasted merganser
	Oxyura jamaicensis	ruddy duck
Raptors	*Cathartes aura*	turkey vulture
	Pandion haliaetus	osprey
	Haliaeetus leucocephalus	bald eagle

Appendix B-6 Bird Species continued

[1] **Dawe *et al.* 1998**.

[2] This appendix presents the total number of species identified by Dawe *et al.* 1998 in shorezone units 1 - 25, during the course of their study (1980-81). The One Day Christmas Bird Count for "Comox Valley" lists a total of 147 species observed for the years 1990 to 1998 (Sauer *et al*. 1996).

Species Group	Species	
	Scientific Name	**Common Name**
Raptors continued	*Circus cyaneus*	northern harrier
	Accipiter striatu	sharp shinned hawk
	A. cooperii	Cooper's hawk
	Buteo swainsoni	Swainson's hawk
	B. jamaicensis	redtailed hawk
	Aquila chrysaetos	golden eagle
	Falco sparverius	American kestrel
	F. columbarius	merlin
	F. peregrinus	peregrin falcon
Fowl-Like Birds	*Phasianus colchicus*	ring-necked pheasant
	Callepepla california	California quail
Coots & Cranes	*Fulica americana*	American coot
	Grus canadensis	sandhill crane
Shorebirds	*Pluvialis sqatarola*	black bellied plover
	Pluvialis dominica	lesser golden plover
	Charadrius vociferus	killdeer
	Tringa melanoleuca	greater yellowlegs
	T. flavipes	lesser yellowlegs
	Actitus macularia	spotted sandpiper
	Arenaria melanocephala	black turnstone
	Calidris alba	sanderling
	Calidris mauri	western sandpiper
	Calidris minutilla	least sandpiper
	C. alpina	dunlin
	Limnodromus griseus	short-billed dowitcher
	L. scolopaceus	long-billed dowitcher
	Gallinago gallinago	common snipe
Jaegers and Gulls	*Stercorarius parasiticus*	parasitic jaeger
	Larus pipixcan	Franklin's gull
	L.philadelphia	Bonaparte's gull
	L. canus	mew gull
	L. delawarensis	ringbilled gull
	L. californicus	California gull
	L. argentatus	herring gull
	L. thayeri	Thayer's gull
	L. glaucescens	glaucous winged gull
	L. hyperboreus	glaucous gull
Terns & Alcids	*Uria aalge*	common murre
	Cepphus columbia	pigeon guilemont
	Brachyramphus marmoratus	marbled murrelet
Doves & Pigeons	*Columba livia*	rock dove
	C. fasciata	band-tailed pigeon
Hummingbirds	*Selasphorus rufus*	rufous hummingbird
Kingfishers	*Ceryle alcyon*	belted kingfisher
Woodpeckers	*Sphyrapicus ruber*	red-breasted sapsucker
	Picoides pubescens	downy woodpecker
	P. villosus	hairy woodpecker
	Coaptes auratus	northern flicker
	Dryocopus pileatus	pileated woodpecker
	Contopus borealis	olive sided flycatcher
	Empidonax traillii	willow flycatcher
	E. difficilis	pacific slope flycatcher

Appendix B-6 Bird Species continued

Species Group	Species	
	Scientific Name	**Common Name**
Passerines	*Tachycinata bicolor*	tree swallow
	T.thalassina	violet-green swallow
	Stelgidopteryx serripennis	northern rough-winged swallow
	Hirundo pyrrhonota	cliff swallow
	H. rustica	barn swallow
	Cyanocitta stelleri	Steller's jay
	Corvus caurinus	northwestern crow
	C. corax	common raven
	Parus rufescens	chestnut-backed chickadee
	Psaltriparus minimus	bushtit
	Sita canadensis	red-breasted nuthatch
	Certhia americana	brown creeper
	Thryomanes bewickii	Bewick's wren
	Troglodytes aedon	house wren
	T. troglodytes	winter wren
	Regulus satrapa	golden-crowned kinglet
	R. calendula	ruby-crowned kinglet
	Catharus ustulatus	Swainson's thrush
	Turdus migrtorius	American robin
	Ixoreus naevius	varied thrush
	Bombycilla cedrorum	cedar waxwing
	Lanius excubitor	northern shrike
	Sturnus vulgaris	European starling
	Vermivora celata	orange-crowned warbler
	Dendroica petachia	yellow warbler
	D. coronata	yellow-rumped warbler
	D. nigrescens	black-throated grey warbler
	Geothlypis trichas	common yellowthroat
	Wilsonia pusilla	Wilson's warbler
	Pipilo fuscus	rufous-sided towhee
	Spizella arborea	American tree sparrow
	S. passerina	chipping sparrow
	Passerculus sandwichensis	savanah sparrow
	Passerella iliaca	fox sparrow
	Melospiza melodia	song sparrow
	Z. atricapilla	golden crowned sparrow
	Z. leucophrys	white crowned sparrow
	Junco hyemalis	dark-eyed junco
	Agelaius phoeniceus	red-winged blackbird
	Euphagus cyanocephalus	Brewer's blackbird
	Molothrus ater	brown-headed cowbird
	Icterus galbula	northern oriole
	Carpodacus purpureus	purple finch
	C. mexicanus	house finch
	Caruelis pinus	pine siskin
	C. tristis	American goldfinch
	Coccothraustes vespertinus	evening grossbeak

Appendix B-7 Mammals Potentially Found In The Coastal Western Hemlock Maritime Zone On Vancouver Island[1]

Scientific Name	Common Name	Seasonal abundance - Coastal Western Hemlock maritime zone		Status
		Season	Abundance[2]	
Order Insectivora				
Sorex monticolus	dusky shrew	year round	common	
S. palustris brooksi	water shrew	year round	uncommon	red listed
S. vagrans	vagrant shrew	year round	common	
Order Chiroptera				
Eptesicus fuscus	big brown bat	year round	common	
Lasionycteris noctivagans	silver haired bat	year round	common	
Myotis californicus	California myotis	year round	common	
M. lucifugus	little brown myotis	summer	common	
M. yumanensis	Yuma myotis	summer	common	
M. volans	long-legged myotis	year round	uncommon	
M. keenii	Keen's myotis	year long	uncommon	red listed
M. evotis	western long-eared myotis	year long	uncommon	
Plecotus townsendii	Townsend's big-eared bat	year long	uncommon	blue listed
Order Rodentia				
Microtus townsendii	Townsend's vole subspecies	year round	common	
Ondatra Zibethicus	muskrat	year round	common	
Castor canadensis	beaver	year round	common	
Peromyscus maniculatus	deer mouse	year round	common	
Mus musculus	house mouse	year round	common	
Rattus norvegicus	Norway rat	year round	common	
Tamias townsendii	Townsend's chipmunk	year round	common	
Tamiasciurus hudsonicus	red squirrel	year round	common	
Order Carnivora				
Canis lupus crassodon	gray wolf	year round	common	
Felis concolor vancouverensis	cougar	year round	common	
Lontra canadensis	river otter	year round		common
Martes americana	marten	year round	common	
Mustella vison evagor	mink	year round	common	
M. erminea anguinae	Vancouver Island ermine	year round	uncommon	blue listed
Procyon lotor	raccoon	year round	common	
Ursus americanus vancouveri	black bear subspecies	year round	common	
Gulo luscus vancouverensis	wolverine subspecies	year round	uncommon	red listed
Order Artiodactyla				
Cervus elaphus roosevelti	Roosevelt elk	year round	common	blue listed
Odocoileus hemionus columbianus	Mule deer subspecies columbianus	year round	common	

[1] Primary source: **Stevens, V. 1995**. Additional sources: **Burt, W. H. and R. P Grossenheider. 1976**; and, **Morris *et al.*** 1979.

[2] Stevens (1995) groups degrees of abundance into two broad categories: 1) common-very common-abundant; 2) rare, scarce, uncommon, scattered, and sporadic. These two categories are labelled "common" and "uncommon" in Appendix B-7.

Appendix B-8 Discharge Permits within the planning area of the Courtenay River Estuary Management Plan[1]

File Number	Permit Holder	Purpose	Parameters	Review/Expiry
PA-7759	Primex Forest Products	• planer mill and sawmill - discharge of particulate from 3 cyclones	• 23.5m^3/s • quality of 115 mg/m^3	• no review or expiry date
RE-14465	Primex Forest Products	• sawmill site and storage yard - antisapstain chemical waste control requires sampling of logyard runoff		• no review or expiry date
PA-12741	Lafarge Canada Inc.	• cement storage site - discharge of particulate from a baghouse	• 53 m^3/min up to 984 hr/yr • quality of 230 mg/m^3	• no review or expiry date
PE-01931	Jose D. Veloso	• seafood processing - discharge of typical seafood preparation and marketing effluent from a septic tank	• 5.0 m^3/d	• no review or expiry date
PE-0551	Kingfisher Inns Ltd.	• tourist resort - discharge of treated sewage effluent	• 38 m^3/day • BOD = 10 mg/L • TSS = 10 mg/L • Fecal Coliform = 2.2 MPN/100 mL • turbidity = 2 NTU	• no review or expiry date

[1] Source: **Brown, DF. 1998**.

Volume 3
Resource Values

Appendix C

Land and Water Uses

Appendix C-1 Crown Land Tenures[1]

Tenant	File No.	Legal Description	Status	Issue Date	Review Date	Expiry Date	Size (Ha)	Tenure Type	Use
Department of National Defense	0357194	District Lots 113G, 203G & 204G & Unsurveyed Foreshore, Nanaimo District	Active	1944/06/26		Indefinite	39.05	Land Act Section 15 Order in Council 959/44	Military
Department of National Defense	1402887	Uns. F/S. Goose Spit, Nan. Dist.	Active	1988/07/11	1998/07/11	1998/07/11	68.06	Licence of Occupation	Military
Department of National Defense	1403969	DL 469, Nan. Dist.	Active	Application			13.20		
Public Works Canada	1405964	DL 2004 & Uns. F/S. Nan. Dist.	Active	1998/09/09	2003/09/09	2003/09/09	3.42	Section 16 Map Reserve 980030	Commercial Boat Moorage & Breakwater
Public Works Canada	0172374	Lots A, B & C of DL 203 & 468 Nan. Dist.	Active	1974/10/25		Indefinite	5.71	Section 15 OIC 74/529	Commercial Boat Moorage
Public Works Canada	0188166	DL 252	Active	1969/08/17		Indefinite	0.89	Section 15 OIC 1969/69	Commercial Boat Moorage
Transport Canada	1407651	DL 209 & Uns. F/S Nan. Dist.	Active	1997/01/11	2007/01/10	Indefinite	52.00	Section 16 Map Res.	Dredge Channel
Ministry of Environment, Lands & Parks - Land Administration		DL 140, Nan. Dist.	Vacant Crown Land						
MELP-Land Administration		DL 437 BK B	VCL						
MELP-Land Administration		DL 369	VCL						
MELP-Land Administration		DL 212	VCL						
MELP-Land Administration		DL 276	VCL						
MELP-Land Administration		DL 201	VCL						
MELP-Land Administration		DL 173	VCL						

Appendix C-1 Crown Land Tenures continued

[1] Source: **Clermont, T. 1998**.

Tenant	File No.	Legal Description	Status	Issue Date	Review Date	Expiry Date	Size (Ha)	Tenure Type	Use
MELP-Land Administration		DL 151 BK A & B	VCL						
MELP-Land Administration		DL 167	VCL						
MELP-Land Administration		DL 195	VCL						
MELP-Land Administration		DL 413	VCL						
MELP-Land Administration		DL 224, BC A & B	VCL						
MELP-Land Administration		DL 2001	VCL						
MELP- Fish, Wildlife & Habitat Prot.	0344032	DL 190, Nan. Dist. Lot A, PL 19915, Sec 7 & 9, Com. Dist	Active	92/12/22	2002/12/22	Indefinite	12.80	Section 17 Designated Use	Environmental Conservation
Ministry of Transportation & Highways	1402441		Active	1988/01/08	1999/12/13	Indefinite	0.126	Section 16 Map Res.	Public Wharf
Ministry of Small Business, Tourism & Culture – Archaeology Branch	0288786							Notation of Interest – long term	
BC Hydro Corporation	1402475	R/W Pl 44427	Active	1987/10/26	2047/10/26	2047/10/26	0.0849	R/W	Utility – Power
Regional District of Comox-Strathcona	1402346	Right-of-way over bed of Courtenay River	Active	1984/10/01	2014/10/01	2014/10/01	0.1366	R/W	Utility – Sewer
Regional District Comox-Strathcona	1402163	Uns. F/S	Active	1987/03/31	2047/03/31	2047/03/31	4.24	R/W	Utility – Sewer
Regional District Comox-Strathcona	0239216	Uns. F/S Comox Harbour as shown on PL 3511	Active	1988/04/28			10.28	R/W	Utility – Sewer
Regional District Comox-Strathcona	0295372	DL 83G	Active	1992/01/15		2002/01/15	6.105	Licence	Park
Regional District Comox-Strathcona	1403157	Lot A PL3261, Sec. 7 Lot B PL2243, Sec. 7 Lot A PL2243, Sec. 7 Lot 1 PL 3290, Sec. 7 All Comox District	Active	97/10/12	2107/10/12	2017/10/12	1.00	Licence	Park

Appendix C-1 Crown Land Tenures continued

Tenant	File No.	Legal Description	Status	Issue Date	Review Date	Expiry Date	Size (Ha)	Tenure Type	Use
City of Courtenay	1402968	DL 310	Active	1985/12/18		2015/12/18	5.099	Lease	Park
Town of Comox	0327399	Uns. F/S	Active	1983/04/01		2013/04/01	0.1163	R/W	Utility- Sewer
Town of Comox		L 380, Nan. Dist.							Marina
Sailaway Enterprises	0159500	DL 203 BK D	Active	1987/08/31	2000/08/31	2017/08/31	3.94	Lease	Commercial Marina
Tarnowski, J.	0256966	DL 355	Active	1987/10/19		2007/10/19	3.8446	Lease	Aquaculture
Raincoast Seafarm Ltd.	1402723	DL 347, BK B Nan. Dist.	Active	1995/03/21	2000/03/21	2005/03/21	2.46	Licence	Aquaculture
Bradley, W. (Strait Oysters Ltd.)	1402271	DL 369, BK A Nan. Dist.	Active	1983/02/16		2003/02/16	12.54	Lease	Aquaculture
Veloso, J.	0255027	L 450, Nan. Dist.	Active	1987/04/30	2002/04/30	2017/04/30	0.1285	Lease	General Commercial
Billie, E. (Kwantum Boatways)	1401759	L 82, Nan. Dist.	Active	1987/12/10	2002/12/10	2017/12/10	0.0445	Lease	Gen. Comm.
Lafarge Cement Co.	0174411	DL 250, BK A Nan. Dist.	Active	1985/06/11		2015/06/11	0.08	Lease	General Industrial
Primex Forest Products - Field Sawmill	0230277	DL 258 & DL 346, BK A-D	Active	1984/06/08	1999/06/08	2004/06/08	1.052	Lease	Ind. Log Hand. & Storage
Field Sawmill/Primex Forest Products	1406504	Uns. F/S	Active	1994/11/25	1999/11/25	2004/11/25	1.545	Licence	Ind. Log Hand. & Storage
Field Sawmill/Primex Forest Products	0084561	DL 169, 2016 & 2017	Active	1997/05/09	2002/05/09	2027/05/09	36.68	Lease	Ind. Log Hand. & Storage
Riverhouse Enterprises Ltd (Old House Restaurant)	0203529	DL 291	Active	1979/11/30		1999/11/30	0.647	Lease	Commercial Foreshore
Shell Canada Inc.	0136155	DL 184	Active	1982/07/29	2002/07/29	2012/07/29	1.137	Lease	Comm. F/S.
Jiggers Cabaret	0289123	DL 93	Active	1997/04/15		2027/04/15	0.01	Lease	Gen. Comm.
Kirk, R.	0289513	DL 85, Nan. Dist.	Active	1987/04/30		2017/04/30	0.016	Lease	Comm. Wharf
Patricia Halliday	1407869	Uns. F/S near Comox Marina	Active	1997/01/15	2007/01/15	2007/01/15	0.017	Licence	Residential Moorage

Appendix C-2 Statistical Area 14 Commercial Salmon Catch Data Over Time[1]

Table C-2.1 Statistical Area 14: Pieces of Catch by Species

Year	Chinook	Chum	Coho	Pink	Sockeye	Total
1982	50,376	197,357	55,342	356	2,563	305,994
1983	29,955	123,681	44,708	11,014	5,395	214,753
1984	32,379	164,157	60,842	2,037	1,007	260,422
1985	28,580	526,633	143,526	6,280	20,418	725,437
1986	26,180	370,832	135,506	1,596	3,648	537,762
1987	18,829	352,909	143,716	9,621	5,810	530,885
1988	8,802	38,773	164,905	1,696	1,939	216,115
1989	10,706	99,560	50,027	3,849	1,862	166,004
1990	15,867	149,478	90,650	952	2,556	259,503
1991	16,947	269,518	13,829	3,118	336	303,748
1992	16,987	429,332	94,743	1,628	75	542,765
1993	19,941	381,479	209,329	6,197	1,950	618,896
1994	7,263	369,107	40,725	976	749	418,820
1995	204	20,759	19	0	0	20,982

Table C-2.2 Statistical Area 14: Weight of Catch (by Species) in Millions of Pounds

Year	Chinook	Chum	Coho	Pink	Sockeye	Total
1982	0.26	2.00	0.18	0.00	0.01	2.45
1983	0.16	1.40	0.20	0.03	0.03	1.82
1984	0.20	1.83	0.22	0.01	0.01	2.27
1985	0.18	5.08	0.58	0.02	0.09	5.95
1986	0.24	3.90	0.51	0.01	0.01	4.67
1987	0.17	3.99	0.49	0.03	0.02	4.7
1988	0.09	0.41	0.50	0.00	0.01	1.01
1989	0.08	1.11	0.19	0.01	0.01	1.4
1990	0.15	1.64	0.35	0.00	0.01	2.15
1991	0.14	2.82	0.07	0.01	0.00	3.04
1992	0.14	4.19	0.33	0.00	0.00	4.66
1993	0.16	3.61	0.68	0.01	0.01	4.47
1994	0.06	3.60	0.15	0.00	0.00	3.81
1995	0.00	0.22	0.00	0.00	0.00	0.22

[1] Source: **BC Salmon Marketing Council. 1996**. Catch data are derived from Commercial Catch Statistics as prepared by Fisheries and Oceans Canada. Data to 1994 are final. Data for 1995 are preliminary as of September 04, 1998.

Table C-2.3 Statistical Area 14: Value of Catch (by Species) in Millions of Dollars

Year	Chinook	Chum	Coho	Pink	Sockeye	Total
1982	0.46	0.81	0.21	0.00	0.02	1.5
1983	0.24	1.01	0.23	0.02	0.04	1.54
1984	0.38	1.32	0.30	0.01	0.01	2.02
1985	0.32	2.92	0.80	0.01	0.26	4.31
1986	0.43	2.19	0.78	0.00	0.05	3.45
1987	0.45	4.86	1.10	0.04	0.10	6.55
1988	0.29	0.39	1.59	0.00	0.05	2.32
1989	0.12	0.90	0.24	0.01	0.02	1.29
1990	0.26	1.18	0.51	0.00	0.03	1.98
1991	0.18	1.68	0.07	0.01	0.00	1.94
1992	0.23	2.14	0.51	0.00	0.00	2.88
1993	0.23	2.19	0.95	0.01	0.01	3.39
1994	0.11	1.51	0.24	0.00	0.01	1.87
1995	0.00	0.08	0.00	0.00	0.00	0.08

Appendix C-3 Parks and Recreation Areas

Table C-3.1 Town of Comox[1]

Site	Legal Description	Status	Use Description
Pioneer Memorial Park	PL 25217, Lot A	- owned by Town of Comox - zoned Park	- unorganized recreation - primarily open field; access to waterfront
Port Augusta Park	PL 3648,Lot 12	- owned by Town of Comox - zoned Park	- unorganized recreation' - Port Augusta Creek with riparian buffer; open field areas; access to waterfront
Marina Plaza Park	PL 24638	- owned by Town of Comox - zoned Park	- unorganized recreation - open field; amenities; access to Comox Harbour boardwalk & wildlife viewing structure
Filberg Park	PL 2657, Lot 4,5,6 PL 32509, Lot A	- owned by Town of Comox - zoned Park	- unorganized recreation - Filberg Centre; amenities; wooded and open field areas; access to waterfront
Mack Laing Park	PL 3387,Lot 2 PL 35090,Lot 2	- owned by Town of Comox - zoned Park	- natural/wooded passive - Brooklyn Creek; remnant floodplain forest; access to waterfront, trails
McDonald Woods Park	PL 2657,Lot 20	- owned by Town of Comox - zoned Park	- natural/wooded passive - remnant floodplain forest; access to waterfront, trails

Table C-3.2 City of Courtenay[2]

Site	Legal Description	Status	Use Description
Condensory Rd Bridge & Puntledge River.	PL 51091, Lot B	- owned by City of Courtenay - zoned Park	-special use park - part of Courtenay Riverway concept
Riverside Park	PL 4308, Lot Pt 1 PL 472A	- owned by City of Courtenay - zoned Park	-special use park - part of Courtenay Riverway concept
Lagoon Park	District Lot 310	- owned by Province of BC - leased to City of Courtenay zoned Park	-special use park - part of Courtenay Riverway concept - marsh; landscaped fill; paved greenway, walkways, wildlife viewing structure; access to waterfront
Lagoon Park to Millard Creek estuary on waterfront	PL 14521, part PL 55151, Lot 14 PL 31530, Lot 2 part	- PL 14521 and 55151 Lot 14 owned by City of Courtenay - designated greenway in OCP; partly zoned as Park	-special use park - part of Courtenay Riverway concept - paved pedestrian/cycling route to 31st St.
Standard Park	PL 311, Lot 71 & 72	- owned by City of Courtenay - zoned Park	- neighbourhood park - playground & gazebo
Lewis Park	PL 3335 PL 3518 Lot A PL 3517 Lot A	- owned by City of Courtenay - zoned Park	- community park - playing fields; full amenities; access to river
Simms Millennium Park	PL 48898 Lot 1	- owned by City of Courtenay - zoned Park	-community park - development in progress

[1] **Town of Comox. 1997**.
[2] **City of Courtenay. 1998**.

Table C-3.2 **City of Courtenay** continued

Comox Rd & Courtenay River	PL 19915, Lot A Sec. 9	- owned by Province of BC - BC *Land Act Section 17* 'Designated Use': environmental conservation - zoned Park by City of Courtenay	- special use park - high marsh and remnant floodplain forest no permanent trails

Table C-3.3 Regional District of Comox-Strathcona[3]

Site	Legal Description	Status	Use Description
Goose Spit Coastal Recreation Park	District Lot 83G	- owned by Province of BC - leased by RDCS (current tenure 1992 - 2002) - designated as protected area/upland habitat greenway in Electoral Area Plan (1999)	- foreshore and upland dunes bisected by road - area used for walking, beach activities, paddling, sailing, nature study, special events
Comox Road Roadside Rest Area	PL 3261 Lot A PL 2243 L A & B PL 3290 Lot 1	- owned by Province of BC - leased to RDCS for park purposes (current tenure 1997 - 2017)	- road side rest area - wildlife viewing structure/shelter; amenities; access to waterfront

[3] **Regional District of Comox-Strathcona. 1998**.

Appendix C-4 Strait of Georgia Creel Survey[1] - Statistical Area 14 Results

Table C-4.1 Statistical Area 14 - 1997 Effort and Catch Survey Results

1997	Effort	Released Salmon	Retained Salmon	Chinook Retained	Coho Retained	Rockfish	Lincod	Dogfish	Other Fish
April	529	151	217	217	0	23	0	0	105
May	8,215	3,450	3,480	3,478	0	1,118	0	0	455
June	7,551	3,847	4,147	4,120	28	893	30	0	339
July	7,717	5,198	1,821	1,566	171	1,326	172	10	790
August	18,948	24,422	8,412	5,211	342	2,348	102	152	731
September	5,643	7,918	1,914	1,388	342	471	20	1	239
October	323	109	32	0	3	10	0	0	0
Total	48,926	45,095	20,023	15,980	886	6,189	324	163	2,659

Table C-4.2 Statistical Area 14 - 1987 Effort and Catch Survey Results

1987	Effort	Released Salmon	Retained Salmon	Chinook Retained	Coho Retained	Rockfish	Lincod	Dogfish	Other Fish
April	1,446	497	3,353	128	3,225	47	8	0	31
May	15,472	3,449	31,178	4,394	26,765	1,555	1,183	91	589
June	30,381	5,099	77,436	6,990	70,109	2,674	1,665	46	1,461
July	27,367	42,756	58,912	2,493	55,850	7,309	3,305	145	1,599
August	33,349	116,651	37,356	3,553	31,609	9,993	3,039	300	2,953
September	10,429	44,607	8,691	1,337	6,219	665	941	47	1,110
October	2,241	12,512	2,187	538	1,644	353	137	0	123
Total	120,685	225,571	219,113	19,433	195,421	22,596	10,278	629	7,866

[1] Source: **Fisheries and Oceans Canada. 1998g**.