Marine Resources of Whatcom County

Prepared for:
Whatcom County Marine Resources Committee

April 2001

Prepared by:
Anchor Environmental, L.L.C.

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2 INTRODUCTION

This document presents a compilation of historical and current data on the marine resources of Whatcom County. Biological data from the Whatcom County shoreline and marine waters are compiled and summarized in this report. The area covered is from the United States-Canada border near Drayton Harbor and Point Roberts to the southern boundary of the county at Governors Point, including Portage, Lummi, and Eliza Islands (Figure 1). This data compilation report has been prepared to support the Whatcom County Marine Resources Committee (MRC). The Whatcom County MRC is one of seven MRCs that make up the Northwest Straits Commission. The overarching goal of the Northwest Straits Commission is to protect and restore marine and nearshore habitats throughout the area using a science-based approach. At the county level, the MRC's objectives include identifying and prioritizing potential habitat protection and restoration opportunities, and developing a long-term strategy for marine habitat restoration in the county. This data compilation effort is a key first step for the Whatcom County MRC to meet these objectives.

This report is primarily graphical in nature, consisting of Geographical Information System (GIS) maps and written summaries. Each resource group and habitat component is presented in two figures: one for the portion of the county north of Lummi Island and a second depicting Lummi Island south to the Whatcom-Skagit county border. The written summaries focus on reasonable conclusions that can be drawn from the data available. The data compilation and analysis results presented in this report have been conducted to support planning and decision making efforts along the Whatcom County coastline.

2.1 METHODS

The general approach used to complete this report was to compile and summarize existing information from a variety of sources; primarily data collected by the Puget Sound Environmental Atlas (PSEP 1992), Washington Department of Fish and Wildlife publications, Washington Department of Natural Resources (DNR) CD-ROM data (DNR 1995), the Bellingham Bay Demonstration Pilot Project (Pacific International Engineering and Anchor Environmental 1999), and broader marine information, as appropriate. This report is a compilation of data collected by regulatory agencies and professional scientists. Information specific to Bellingham Bay that was compiled for the Bellingham Bay Demonstration Pilot Project is included for each resource group and habitat component. Information on the sources, format, and documentation of the data are provided below.

2.1.1 Sources of GIS Data

The GIS data were gathered from several different sources and in a variety of formats. Sources include:

- Washington Department of Department of Fish and Wildlife
- Washington Department of Natural Resources
- Washington Department of Ecology (Ecology)
- Washington Department of Health (WDOH)
- Puget Sound Water Quality Action Team
- City of Bellingham
- Whatcom County
- Existing documents (e.g., Pacific International Engineering and Anchor Environmental 1999)

Some of the information obtained was in digital format, usually in ArcView or Arc/Info files, which were incorporated directly into the GIS. Other files were obtained in spreadsheet format (e.g., locations of sampling stations) and converted to GIS files. Additional information, primarily from existing documents, was digitized from hard copy into the GIS format using figures from those documents.

2.1.2 Format of GIS Data

The data are presented in State Plane coordinates for the south zone. This format is consistent with that of other similar data compilations and information sources for the area (e.g., DNR 1995). Due to the variety of sources relied upon to obtain information, the data are from different coordinate systems and scales of accuracy. Although the documentation of the datasets was occasionally incomplete, all datasets were rectified for use in the desired coordinate system.

2.1.3 Data Documentation Process

Much of the data used in this compilation were scanned and digitized and the sources identified on the figures. The figures represent a composite of the best available information. The data gathered for use in the GIS were documented. This documentation includes a bibliography of all data sources and a database file integrated into the GIS containing information for each data set. The database file includes information such as file name, content description, data source, scale of data, original coordinate system and datum, format of original data (i.e., digital or document) and notes about the data.

3 MARINE RESOURCES OF WHATCOM COUNTY

3.1 NATURAL AREA PRESERVES

Two currently established Natural Area Preserves are located in the southern portion of Whatcom County: Lummi Island Natural Area Preserve and Chuckanut Island. These areas are depicted in Figure 1.

WDFW established the Lummi Island Natural Area Preserve (NAP) between 1991 and 1993. The NAP is an intertidal and upland preserve located on central Lummi Island and bordering the western shoreline (Murray 1998). The marine extent of the preserve is a narrow intertidal area (approximately 400 feet in length) below steep cliffs. The site features a "marine shoreline – rock and gravel beach" as identified by the WDFW Priority Habitat and Species Program. As a NAP, public access to the site is intended to be restricted. The shoreline area is remote and not subjected to regular public access.

Chuckanut Island was established as a Nature Conservancy Preserve in 1976. The Nature Conservancy owns the second class tidelands at this Preserve and manage the tideland area, with some exceptions, as part of the Preserve (Murray 1998). The area includes intertidal and upland areas and is open to the public from dawn to dusk. As a Nature Conservancy Preserve, the restrictions include no fishing and no collecting plants or animals or their remains.

3.2 BATHYMETRY

As shown in Figures 2 and 3, the bathymetry of Whatcom County includes deep and shallow bays, offshore banks, and gradual and steep slopes. These data are based on hydrographic surveys conducted by the National Oceanic and Atmospheric Administration (NOAA) and compiled in NOAA (1999). These data do not include coverage of the area west of Lummi Island and the offshore area near Point Roberts.

Several distinct bathymetric features are apparent in Whatcom County. Large portions of the marine waters of Whatcom County are no deeper than –100 feet MLLW, including throughout the two largest bays in the county, Semiahmoo Bay in the north and Bellingham Bay in the south. The smaller bays in the county are no deeper than –50 feet MLLW and Lummi Bay is the shallowest with no areas deeper than –20 feet MLLW.

The deepest part of the county documented by NOAA (1999) is more than –700 feet MLLW. The deeper offshore waters of Whatcom County have areas of deep slopes in which depths increase more than 100 feet in less than 0.5 miles. The most extensive steep slope area, where water depths increase from –100 feet MLLW to more than –500 feet MLLW, is along the west slope of Alden Bank. Alden Bank is located approximately four miles west of Lummi Bay and has water depths as shallow as –30 feet MLLW. Steep slopes are also found along the northwest side of Lummi Island. The steepest slopes are located of the southwest tip of Point Roberts and extend in a southeast direction towards Point Whitehorn.

3.3 VEGETATION

Marine vegetation is an important aquatic resource. It provides food for secondary and tertiary producers, provides refuge and rearing habitat, a substrate for reproduction, and habitat for commercially and recreationally important species, and may be harvested for food, chemicals, and fertilizers. Aquatic plants located on state-owned lands are the property of the state and managed by the DNR. Other state and federal agencies regulate the removal of aquatic vegetation while DNR manages aquatic plant resources located on state-owned lands.

The DNR surveyed aerial photographs of 110 miles of Whatcom County shoreline in 1995: from Point Whitehorn in the Strait of Georgia to the southern boundary of the county at Governors Point, including Portage, Lummi, and Eliza Islands. DNR identified eight (8) vegetation types in these sections of the Whatcom County nearshore environment: eelgrass, brown algae, kelp, green algae, mixed algae, salt marsh, spit and berm vegetation, and red algae.

Key characteristics of these vegetation types are:

- Brown Algae—Division Phaeophyta, Common examples include rockweed (*Fucus* spp.) and *Sargassum muticum*.
- Kelp—Large brown algae belonging to the taxonomic group Order Laminariales. Common examples include floating kelp (*Nereocystis luetkeana*) and understory kelp (*Laminaria* spp.). At concentrations over 75% of vegetative cover, kelp has distinct ecological function.
- Eelgrass--native eelgrass (*Zostera marina)* and introduced dwarf Japanese eelgrass (*Z. japonica*). *Z. japonica* typically occurs above approximately -5 ft MLLW.
- Green Algae—Division Chlorophyta. Common example sea lettuce (*Ulva* spp.).
- Red Algae—Division Rhodophyta. Common example nori (*Porphyra* spp.).
- Mixed Algae—red, green, or brown algae coexisting, with no single type occupying more than 75% of the vegetative cover.
- Salt Marsh–Salt-tolerant, emergent wetland plants such as pickleweed (*Salicornia virginica*), saltgrass (*Distichlis spicata*), and sedge (*Carex lyngbyei*).
- Spit and Berm Communities–Areas dominantly covered with plants such as dune grass (*Elymus mollis*), gumweed (*Grindelia integrifolia*), and yarrow (*Achillea millefolium*), which generally occur above the highest tides, but still receive salt influence. The substrate is usually sand or gravel, and drift logs commonly accumulate.

Additional information on marine vegetation in the northern portion of Whatcom County was provided by a 1994 survey of fish and wildlife habitat in the county (Whatcom County Planning 1994). This report provides eelgrass and macroalgae information for the area.

The intertidal and shallow subtidal macrofauna, kelp, and eelgrass for Whatcom County are presented in Figures 4 and 5.

In Bellingham Bay, most types of marine aquatic vegetation occur, including both types of eelgrass, green algae, mixed algae, salt marsh, and spit and berm communities. Key characteristics of macrofauna, kelp, and eelgrass in Bellingham Bay are as follows:

- Although not shown, twenty genera of phytoplankton have been identified in Bellingham Bay (CH2M Hill 1984). Diatoms comprised of both pelagic and sessile forms dominate the phytoplankton population of the bay. Phytoplankton densities are usually low from January through March and increase rapidly from April to a peak in June. Tollefson (1962) showed that phytoplankton primary productivity within the inner Bay was nearly 1.4 mg chlorophyll/m^3/hr^1. This productivity rate is lower than values typical for greater Bellingham Bay.
- Salt marsh occurs primarily in the Nooksack River delta. Smaller areas or fringes of salt marsh are located within the embayment at the mouth of Chuckanut Creek and in a small pocket along the northern shoreline of Portage Island. Salt marsh also occurs in backshore areas between Padden Creek and Chuckanut Bay that are above mean high water but still receive marine influence through spray or irregular flooding. Overall, the acreage of salt marsh habitat appears

to have increased from approximately 46 acres in 1887 to approximately 272 acres in 1996—an increase of nearly 500 percent. This increase in salt marsh has occurred primarily in the Nooksack River delta and is concurrent with the historical prograding of the Nooksack River delta.

- *Zostera marina* appears to be the most abundant vegetative community within the Bay. It typically occurs from about 0 to -20 ft MLLW. Current *Z. marina* meadows are largely present along the southeastern shore of Lummi Peninsula, extending into Portage Bay and along both sides of the Portage Island spit and in Chuckanut Bay. Smaller eelgrass meadows have been identified along the eastern shoreline of Bellingham Bay near Boulevard Park, Taylor Avenue Dock, Padden Creek, and at Post Point. Eelgrass patches and small meadows have also been identified to the west of Little Squalicum Park Reserve, within the Squalicum Creek Waterway, between the I & J Street Waterway and the G-P ASB, and along the eastern shoreline of the bay from north of the Cornwall Avenue Landfill to south of Post Point.
- Two relatively large (359 acres total) *Z. japonica* beds occur slightly offshore and are located southwest and east of the Nooksack River delta.
- Historical data indicate a large (approximately 225-acre) native eelgrass meadow located on the former delta of Whatcom Creek. The area of this meadow has been reduced as a result of shoreline modifications and dredging in the inner bay. Another smaller historical native eelgrass meadow is located off of Lummi Island. However, the distribution of native eelgrass has increased along the south shore of Lummi Island and around Portage Island.
- Overall, the distribution of native eelgrass in Bellingham Bay appears to have increased over the past 140 years. In 1855, the estimated areal coverage of native eelgrass in the bay was approximately 285 acres. Today, approximately 730 acres of native eelgrass have been mapped in the bay, representing a 156 percent increase. The apparent increases between 1855 and the present may be, in part, an artifact of variations in mapping accuracy. It is likely that the 1855 maps under-represent native eelgrass distribution at that time.
- Since Bellingham Bay is comprised primarily of unconsolidated sediments, there are currently no significant kelp beds identified within Bellingham Bay (Sternberg 1967). Some kelp occurs between Post Point and Clarks Point, at the southeastern end of the bay.
- The only spit and berm community is located at the northeast of Portage Island.

3.4 SUBSTRATE

Using aerial photography, DNR surveyed the intertidal and shallow subtidal substrate of Whatcom County from Point Whitehorn in the Strait of Georgia to the southern boundary of the county at Governors Point, including Portage, Lummi, and Eliza Islands (DNR 1995).

Nine (9) substrate types were identified in the survey per Dethier (1990) and Bailey et al. (1993): artificial, bedrock, boulder, cobble, gravel, mixed coarse, mixed fine, mud, and sand. Key characteristics of these vegetation types are:

- Artificial - Substrates created by humans, including docks, pilings, aquaculture, riprap, bulkheads, and dikes.
- Bedrock - consolidated rock substrate, including sandstone, granite, basalt, etc.
- Boulders - rocks greater than 256 mm (10") in diameter, large enough not to be moved by moderate wave action.

- Cobble - rocks 64 - 256 mm (2.5 - 10") in diameter.
- Mixed Coarse - A mixture of larger substrate types, including sand, gravel, cobble, and boulders, where no one type exceeds 75% surface cover.
- Gravel - small rocks or pebbles, 4-64 mm (0.16 - 2.50") diameter.
- Sand - particles of 0.06-4 mm (0.00236 - 0.16") in diameter.
- Mixed Fine - A mixture of smaller substrate types, including sand, mud, and gravel, where no one type exceeds 75% surface cover.
- Mud - Substrate of very fine particle size (less than 0.06 mm in diameter), including silt and clay.

Additional information on substrate in the areas north of the DNR project area was limited to general classification of mixed coarse and mud material. Ecology (1992) identified sand/gravel beaches and sheltered tidal flats for the area which were considered as mixed coarse and mud, respectively, in this data compilation. These characterizations were consistent with classifications of the DNR survey in area of overlap. Thom et al. (1989) provides additional detail for the Drayton Harbor mudflat. As part of the mitigation plan for expansion of the Blaine marina, a high intertidal mound was created in the southeast corner of Drayton Harbor.

The intertidal and shallow subtidal substrate for Whatcom County are depicted in Figures 6 and 7. No substrate information was available for Point Roberts or the Alden Bank area.

3.5 SHELLFISH

3.5.1 Clams, Geoduck, Abalone, Urchins, and Oysters

Several species of shellfish occur in the marine habitats of Whatcom County. Clam species in the area were classified as hardshell or subtidal. Hardshell clam species include: native littleneck (*Protothaca staminea*), Manila littleneck (*Tapes philippinarum*), butter clam (*Saxidomus giganteus*), and cockle (*Clinocardium nuttallii*). Subtidal hardshell clams include: butter clams, piddock (*Zirfaea pilsbryi*), native littleneck, and horse clams (*Tresus capax* and *T. nuttallii*).

General life history characteristics for the species listed above are shown in Table 1.

Figures 8 and 9 show the distribution of these shellfish in Whatcom County. Hardshell clams occur from Semiahmoo Spit at Drayton Harbor south to Point Whitehorn. Hardshell and subtidal clams occur in several locations off Point Roberts, Lummi Island, and Portage Island. Pacific geoduck (*Panapea generosa*) live both intertidally and subtidally, but only subtidal beds are presented. Ecology (1992) reported northern abalone (*Haliotis kamtschatana*) near the Lummi Rocks, on the westside of Lummi Island, although WDF (1992) did not record any in this area. Red and green sea urchins (*Strongylocentrotus franciscanus* and *S. droebachiensis*) occur in two areas of Whatcom County: near Lummi Rocks and Alden Bank, located several miles out from the northern border of the Lummi Reservation. According to Ecology (1992), Drayton Harbor, Sandy Point shores, and the waters between Portage Island and the mainland have Pacific oysters (*Crassostrea gigas*). Although not shown in Figure 9, Palm (1995) noted oysters at all beaches surveyed in Bellingham Bay. However, WDF (1992) did not record any Pacific oysters in Whatcom County.

Table 1. Hardshell clam, mussel, and oyster life history information.

Species	Preferred Habitat	Spawning	Larval Settlement
Abalone	Primarily lower intertidal to –30ft MLLW, hard substrate, bedrock or boulder, exposed/semi-exposed coastline	May occur year-round, but peaks from April to June	Free-swimming, rise for 5-6 days
Macoma spp.	Intertidal and subtidal, brackish area, sandy silt	N/A[1]	Planktonic larvae settle after several weeks
Soft-shell clam	Low salinity areas near mouths or rivers, restricted to upper intertidal sand and mud areas	N/A	N/A
Butter clam	Porous mix of sand, broken shell, mud and gravel between +1 and -6 ft MLLW	N/A	Planktonic larvae are in water column for three to four weeks
Littleneck clam	Firm substrate, mostly intertidal	April – September	Planktonic larvae settle after several weeks
Horse clam	Mix of sand and shell between +1 and -21 ft MLLW	*T. capax* - February - May *nuttallii* - April – August	Planktonic larvae settle after several weeks
Manila clam	Stable substrate of gravel, mud, and sand between +1 and +2 ft MLLW	May and September with a peak in the warmest months	Planktonic larvae settle after 3 to 4 weeks
Cockle	Soft sand-mud, frequent in eelgrass beds, intertidal and subtidal areas, most common between +1 and -0.6 ft MLLW	April - November with a peak in July and August	N/A
Mussel	Typically between +1.2 and +3.5 ft MLLW attached to rocks, gravel, shell, compact mud and man-made materials	Peaks in summer months	Planktonic larvae settle after several weeks
Oyster	Under and upper sides of rocks, oyster shell	Summer, spawning initiated in water above 65° F	Planktonic larvae settle after several weeks
Geoduck	Low intertidal and subtidal mud and sand	March – July	Planktonic larvae settle after a few to several weeks
Red Urchin	Hard substrates, moderate to strong currents, and a supply of marine algae for food	N/A	Planktonic larvae settle after several weeks

[1] N/A - data not available.

Based on the available literature for Bellingham Bay, the following conclusions can be stated about clams, geoducks, and oysters in Bellingham Bay:

- The predominate bivalve resource in Bellingham Bay is intertidal and subtidal hardshell clams. Intertidal hardshell clam resources generally consist of butter, littleneck, horse, and soft-shell clams, and cockles. Subtidal clam resources consist of butter, littleneck, and horse clams.
- Relatively low shellfish abundance was observed in the western portion of Bellingham Bay that is influenced by the Nooksack River. Shellfish densities were also relatively low at beaches within the Bellingham City limits from Post Point to the northern boundary. Clam densities are higher towards the southern portion of the bay.
- Intertidal hardshell clams occur primarily between the southeast end of Lummi Peninsula and the northern shore of Portage Island, on the south side of Portage Island, in Chuckanut Bay, along the western side of Governors Point, and along the shore of Post Point. *Macoma* spp. and *Mya arenaria* are common clam species found in inner Bellingham Bay.
- Subtidal clams occur on the south side of Portage Island and north of the spit.
- Although comprehensive data on the type and distribution of intertidal and subtidal hardshell clams are not available, they are likely to occur in other intertidal areas within Bellingham Bay. For example, in the Nooksack River delta, some butter clams, horse clams, and soft-shell clams can be found, but not in abundance (Webber 1974). On the south shore of Bellingham Bay,

especially from Post Point south all of the intertidal hardshell clam species and the cockle are common. Scattered oysters also occur in this area.

- Although oyster locations within the project study area do not appear in Figure 9, they were noted at all beaches in inner Bellingham Bay surveyed by Palm (1995). Palm (1995) indicated they were more numerous at Little Squalicum and Boulevard parks than at Marine Park, and were seen in other areas of the bay including the Squalicum Harbor breakwater and the Whatcom Creek estuary.
- Oyster and littleneck clam seed are planted on selected tideflats in Portage Bay by the Lummi Nation.

3.5.2 Shellfish Harvest and Certification Areas

The WDOH, Office of Shellfish Programs classifies the health of all actual and potential bivalve shellfish growing/harvesting waters in Washington state. The primary responsibility of the WDOH is to ensure that shellfish grown and harvested in the state and consumed are safe for human consumption. They classify waters based on sanitary surveys, which include water quality and shoreline investigations. In Whatcom County, three health classifications occur:

- Approved – area generally approved for commercial and recreational shellfish harvest.
- Not advised – area where harvesting not advised due to close proximity to urban areas.
- Closed – area closed for commercial and recreational shellfish harvest due to known contamination sources.

Shellfish harvest and certification areas identified in the county for 1999 (WDOH 1999) are shown in Figures 10 and 11.

3.5.3 Shrimp and Crab

Pandalid shrimp, rock crab, and Dungeness crab (*Cancer magister*) occur in Whatcom County. The distribution of these species is shown in Figures 12 and 13.

Pandalid shrimp are found in two areas of Whatcom County waters, an area west of Birch Bay, and in Bellingham Bay. Seven species of Pandalid shrimp including, pink (*Pandalus jordani* and *P. borealis*), coonstripe (*P. hypsinotus*), dock (*P. danae*), and spot *(P. platyceros*) occur in Bellingham Bay. Several species of pandalids are known to occur in intertidal areas. Species belonging to the Pandalidae family are commercially important, although currently there is no commercial shrimp fishery in Bellingham Bay.

In Whatcom County, rock crabs are found only in Bellingham Bay. Trawl catches conducted as part of Puget Sound Dredged Disposal Analysis (PSDDA) investigations caught primarily small, non-edible purple or graceful crab (*Cancer gracilis*) and relatively few of the edible red rock crab (*C. productus*) were caught. Those that were caught in spring occurred at shallow (-30 to -45 ft MLLW) nearshore locations, especially in the Post Point and Portage Island areas.

Dungeness crabs support a valuable commercial and sport fishery in Whatcom County. Dungeness crabs are found in nearshore and deep water areas throughout Whatcom County, occupying ecological niches in both marine and estuarine waters as an important predator and prey in all life stages. WDF (1992) reports Dungeness crab throughout much of the nearshore and offshore waters of the county, except on the west side of Lummi Island. Dungeness crab are generally abundant in Whatcom County Marine waters.

General life history information on these resource groups is presented below in Table 2.

Table 2. General crab life history information.

Species	Habitat	Feeding	Reproduction
Pandalid Shrimp	Deep subtidal on fairly open, soft bottoms of mud, sand, or shale	Grasps organic material from water	Mating occurs in August and September. Females extrude eggs in October and November and carry the eggs through the winter. Hatching occurs from February through May. After hatching, the larvae float below the water surface until they metamorphose to the juvenile stage in midsummer and sink to the bottom.
Purple or Graceful Rock Crab	From low intertidal to deep subtidal on sand or mud, low tolerance for low salinity	Feeds on small bivalves and barnacles	Seasonal information is not available. Assume nearshore mating and fertilization followed by egg extrusion. Eggs are thought to remain attached for several months. Eggs hatch and become free-floating planktonic larvae for 3 to 4 months. Larvae metamorphose and settle in nearshore areas.
Red Rock Crab	Mid-intertidal to deep subtidal; occurs on a wide range of substrate types, but is common in gravel areas and protected boulder beaches	Feeds on clams, snails, mussels, barnacles, and smaller crabs.	Nearshore mating in spring and summer. Eggs are extruded in the fall with hatching in spring. Eggs hatch and become free-floating planktonic larvae. Larvae metamorphose and settle in nearshore areas during summer. Males remain in nearshore areas throughout their life while females migrate offshore following mating where they remain until the larvae are released.
Dungeness Crab	From low intertidal to deep subtidal on sand or mud	Feed on fish, shrimp, and bivalves	Beginning at age two, females molt and mate during the summer months. Fertilization takes place in the fall at which time the eggs are extruded and become attached to the female's abdomen. Hatching occurs between February and April, and the first 90 to 120 days after hatching are spent as free-floating planktonic larvae. Larvae settle onto substrate between June and September.

3.6 FISH

A 1997 trawl study recorded a variety of fish in the Strait of Georgia, including Whatcom County (Palsson et al. 1998). Sampling was conducted by towing a 400 mesh Eastern otter trawl along the bottom for ten minutes. Table 3 presents the 62 fish species captured on the Washington side of the Strait of Georgia.

3.6.1 Groundfish

As presented in Table 3, several groundfish species (i.e., marine species that are caught mainly on or near the bottom of the water column) occur in Whatcom County. These species are harvested by the Tribes and other users of the area, and are considered to be economically and ecologically important. The distributions of the three categories of groundfish (i.e., demersal, pelagic, and reef-dwelling) identified by WDF (1992) are presented in Figures 14 and 15. These distributions are based primarily on recreational and fishing areas for the different groups. Key groups of demersal groundfish are flatfish (e.g. sole and flounder), skate, dogfish, and surf perch. Pelagic species are pollock, whiting, and cod. Reef-dwelling species are primarily rockfish, lingcod, greenlings, and cabezon. Ecological characteristics of some of the most abundant species are presented in Table 4.

Table 3. Fish species captured on Washington side of Strait of Georgia.

Species	Common Name	Species	Common Name
Spiny dogfish	*Squalus acanthias*	Big skate	*Raja binoculata*
Sandpaper skate	*Bathyraja interupta*	Longnose skate	*Raja rhina*
Spotted ratfish	*Hydrolagus colliei*	Pacific herring	*Clupea pallasi*
Longfin smelt	*Spirinchus thaleichthys*	Eulachon	*Thaleichthys pacificus*
Plainfin midshipman	*Porichthys notatus*	Pacific cod	*Gadus macrocepahlus*
Pacific tomcod	*Microgadus proximus*	Walleye pollock	*Theragra chalcogramma*
Pacific whiting (Hake)	*Merluccius productus*	Shortfin eelpout	*Lycodes brevipes*
Blackbelly eelpout	*Lycodopsis pacifica*	Tadpole snailfish	*Nectoparis pelagicus*
Copper rockfish	*Sebastes caurinus*	Greenstriped rockfish	*Sebastes elongatus*
Puget sound rockfish	*Sebastes empaeus*	Quillback rockfish	*Sebastes maliger*
Redstripe rockfish	*Sebastes proriger*	Shortspine thornyhead	*Sebastolobus alascanus*
Kelo greenling	*Hexagrammos decagrammus*	Whitespotted greenling	*Hexagrammus Stelleri*
Spinyhead sculpin	*Dasycottus setiger*	Buffalo sculpin	*Enophrys bison*
Northern sculpin	*Icelinus borealis*	Threadfin sculpin	*Icelinus filamentosus*
Pacific staghorn sculpin	*Leptocottus armatus*	Slim sculpin	*Radulinus asprellus*
Great sculpin	*Myoxocephlus polyacanthocephalus*	Cabezon	*Scorpaenichthys marmoratus*
Ribbed sculpin	*Triglops pingeli*	Roughback sculpin	*Chitonotus pugetensis*
Longfin sculpin	*Jordania zanope*	Soft sculpin	*Psychrolutes sigalutes*
Northern spearnose poacher	*Agonopsis vulsa*	Blackfin poacher	*Bathyagonus nigripinis*
Sturgeon poacher	*Podothecus acipenserinus*	Pigmy poacher	*Odontopyxis trispinosa*
Slipskin snailfish	*Liparis fucensis*	Shiner perch	*Cymatogaster aggregata*
Pile perch	*Rhacochilus vacca*	Northern ronquil	*Ronquilus jordani*
Snake prickleback	*Lumpenus sagitta*	Giant wrymouth	*Cryptacanthodes giganteus*
Saddleback gunnel	*Citharichthys sordidus*	Speckled sanddab	*Citharichthys stigmatus*
Arrowtooth flounder	*Atheresthes stomias*	Petrale sole	*Eopsetta jordani*
Rex sole	*Errex zachirus*	Flathead sole	*Hippoglossoides elassodon*
Butter sole	*Pleuronectes isolepis*	Rock sole	*Pleuronectes bilineata*
Slender sole	*Eopsetta exilis*	Dover sole	*Microstomus pacificus*
English sole	*Pleuronectes vetulus*	Starry flounder	*Platichthys stellatus*
Curlfin sole	*Pleuronectes decurrens*	Sand sole	*Psettichthys melanostictus*
Lingcod	*Ophiodon elongatus*	C-O sole	*Pleuronectes decurrens*

From Palsson et al. (1998)

Table 4. Characteristics of groundfish species in Whatcom County.

Species	Relative Abundance in North Puget Sound	Habitat	Spawning
Pacific cod	Abundant	5 to 55 meter depths on mixed substrates	January to March
Rockfish	Abundant; some species are common	Ranges from 0 to over 200 meters in depth depending on species; most species prefer rocky and kelp habitat	Depends on the species; in general from December to March, April, May, and June; pelagic larvae are released near habitat
Lingcod	Common but not considered abundant	0 to 72 meter depth in rocky kelp habitat	December to April; establish subtidal nests on rocky substrates
Rock sole	Abundant	0 to 36 meter depths on flat sand, mud, and cobble substrates	December to March
English sole	Very abundant	To 126 meter depths on flat mud substrates	January to April; documented spawning in Bellingham Bay
Starry flounder	Very abundant	0 to 36 meter depths in flat sand substrates	February to April; documented spawning in Bellingham Bay
Butter sole	Abundant	Flat mud substrates	February to April; documented spawning in Bellingham Bay
Sand sole	Abundant	9 to 54 meter depths on flat sand substrate	January to April; documented spawning in Bellingham Bay
Rex sole	Uncommon	72 meter depths	Winter; documented spawning in Bellingham Bay

Figures 16 and 17 show the distribution reported in Palsson et al. (1998) of five of the most abundant flatfish species:

- English sole
- Starry flounder
- Rock sole
- Sand sole
- Dover sole

Except for the northwest corner of Bellingham Bay, the entire bottom of the bay is considered part of the recreational fishery for marine fisheries resources (CH2M Hill 1984). Commercial fishing for these species occurs primarily in the deeper water of the central part of the bay. Groundfish landings within Bellingham Bay peaked in the late 1970s and have declined since that time. The total commercial catch of marine fish other than salmon in Bellingham Bay was 803,000 pounds in 1983, with a value of almost $300,000 (CH2M Hill 1984). Total landings have averaged approximately 70,000 pounds per year over the past 5 years (Tribal and commercial landings). This trend was influenced by a number of different fisheries management factors.

3.6.2 Forage Fish

Forage fish are small, schooling fish that serve as an important source of food for other fish species, marine mammals, and seabirds (Bargmann 1998). In Puget Sound, Pacific herring (*Clupea harengus pallasi*), surf smelt (*Hypomesus pretiosus*), and Pacific sand lance (*Ammodytes hexapterus*) are important forage fish. Both recreational and commercial fisheries exist for forage fish. These fisheries are seasonal, often occurring on spawning aggregations (Bargmann 1998).

These species depend on the nearshore marine environment and spawn in the intertidal or shallow subtidal waters at very specific locations in Puget Sound (WDFW 2000). Pacific herring, surf smelt, and sand lance spawning grounds and holding areas are shown in Figures 18 and 19. Historically, the largest stock of herring in Puget Sound spawned along a stretch of shoreline near Cherry Point.

Surf smelt and sand lance are a common nearshore forage fishery resource (WDF 1992). Surf smelt stocks were thought to be genetically fairly distinct, each having its own set of biological characteristics, migrations, spawning schedules (either summer of fall-winter), and homing cues. However, recent studies indicate that a number of surf smelt spawning areas, primarily in northern Puget Sound, receive spawning fish year round with an annual several month peak of activity. The status of the Puget Sound surf smelt population is currently unknown. The Washington Department of Fish and Wildlife (WDFW) does not conduct routine spawn deposition surveys to quantify spawning biomass, nor are they sampled with any consistency by the acoustic/trawl method used for stock assessments. Sand lance spawning activity appears to be distributed evenly throughout Puget Sound. The status of the stock is unknown.

General life history information for surf smelt and sand lance is presented in Table 5.

Table 5. General surf smelt and sand lance life history information.

Species	Spawning Habitat	Spawning Time	Incubation	Adults
Pacific Herring	Deposit eggs on vegetation in intertidal and shallow subtidal areas	Location specific; generally mid-January to March; Cherry Point stock April to June	10 to 14 days; larvae are planktonic	Return to spawn at 2 to 4 years
Surf smelt	High intertidal beach with gravel 1-7 mm	Year-round with several month peak	2 to 6 weeks; larvae are planktonic	Return to spawn at about 2 years of age; little known about adult life history
Sand lance	Upper intertidal sandy-gravel beach	November to February	30 days	Known to bury in the sand and occur in nearshore kelp bed zones; very little is known about their adult life history

Key findings on surf smelt and sand lance spawning grounds in Bellingham Bay are:

- Some surf smelt and sand lance spawning areas overlap. Overlapping areas include the high intertidal area along the eastern shore of Lummi Peninsula, along the shoreline by Little Squalicum Creek, north of Padden Creek and along the beach at Post Point.
- No surf smelt or sand lance spawning occurs in the Nooksack River delta, inner Bellingham Bay, or Chuckanut Bay, presumably because suitable substrates are not available.
- Other areas of Bellingham Bay, including the southern end of Lummi Peninsula and portions of beach on the northern shore of Portage Island, are used by sand lance for spawning.

- Surf smelt spawning occurs over approximately 2.6 miles of shoreline in the Bellingham Bay study area.
- Sand lance spawning occurs over approximately 3.0 miles of beach in Bellingham Bay.

Most adult herring spawning in inland marine waters migrate between their spawning areas and feeding areas off the Washington-British Columbia coast through the Strait of Juan de Fuca. The timing of herring spawning is location specific. In most Puget Sound locations, herring spawn between mid-January and March. Spawning among the Cherry Point stock typically occurs between April and June, and is therefore temporally isolated from other stocks. Herring deposit their eggs on marine vegetation, eelgrass, and algae in the shallow subtidal and intertidal zones between 0 and -10 ft MLLW (WDFW 2000). The spawning areas are used by herring stocks which appear to be genetically distinct. After hatching, larvae are planktonic, drifting near the surface of the water column. They are often concentrated in embayment areas by local currents until they metamorphose into juvenile fish. Juvenile herring are abundant in nearshore waters.

Prior to about 1984, a relatively large herring fishery occurred in Bellingham Bay. However, declines in the length and age of fish were observed by WDFW in 1980. These data, along with uncertainties regarding the origin of local stock, prompted closure of the fishery in 1984.

3.6.3 Salmonids

The following economically important species spawn in at least one drainage in the County: coho salmon (*Oncorhynchus kisutch*), chum salmon (*O. keta*), chinook salmon (*O. tschawytscha*), pink salmon (*O. gorbuscha*), sockeye salmon (*O. nerka*), steelhead trout (*O. mykiss*), cutthroat trout (*O. clarkii*), and bull trout/Dolly Varden (*Salvelinus confluentus/S. malma*). Table 6 presents the species distributions in Whatcom County streams entering Puget Sound.

Table 6. Salmonid occurrence in Whatcom County streams

Stream	Coho Salmon	Chum Salmon	Chinook Salmon	Pink Salmon	Sockeye Salmon	Steelhead Trout	Cutthroat Trout	Bull Trout/ Dolly Varden
Dakota Creek	X	X				X		
California Creek	X	X						
Terrell Creek	X	X						
Lummi River	X	X						
Nooksack River	X	X	X	X[1]	X	X	X	X
Silver Creek	X	X		X[1]				
Squalicum Creek	X	X				X		
Whatcom Creek	X	X	X		X	X	X	X
Padden Creek	X	X	X			X		
Chuckanut Creek	X	X				X		

[1] Adults return predominantly in odd years(i.e., 1997, 1999, and 2001), although a few are known to return during even years.

Much of the information on juvenile salmon migration routes, schooling and avoidance areas and length of juvenile residence time is based on historical studies in Bellingham Bay (Tyler 1964 and Sjolseth et. al. 1968) and on the 1975 Stream Survey (WDF 1975). At the time of Tyler (1964) and Sjolseth et al. (1968) study the following conclusions about juvenile salmon use of the shoreline were drawn:

- The peak of juvenile salmon migration occurred in May and June.
- The Nooksack River had the largest salmon runs, and Squalicum Creek was second in importance. Whatcom Creek had no known salmon runs in the early 1960s and Padden Creek had minor runs of coho and chum salmon.
- At that time many chum remained in the Nooksack River after emergence and migrated downstream as relatively large fish. The concentrations of chum, coho, and chinook salmon along the shoreline and in offshore waters in Bellingham Bay peaked in mid May and then declined.
- A substantial portion of the migration was distributed in offshore waters of Bellingham Bay during May. Schools of migrating juvenile salmon were also found along all shoreline beach areas including the urbanized portion of Bellingham Bay, but the manner of migration to the shoreline was not determined.
- Juvenile coho and chinook salmon appeared to have different migration habits. Coho appeared in the bay about two weeks longer than chinook, which moved out of the bay in a 20 day period. Both species were caught in shallow waters throughout the Bay. Chinook salmon were caught in the Whatcom Waterway within the navigable portion of the waterway as well as outside of the channel.
- Drayton Harbor, Birch Bay, Lummi Bay, Bellingham Bay, and Chuckanut Bay were the most important acclimatization areas found.
- Chuckanut Bay, Portage Bay, and the area off Post Point were the most important schooling areas found.

More recent studies on predation on chinook salmon (Ballinger et. al. 1995) indicate relatively high numbers of juvenile chinook salmon and average numbers of coho salmon use the urbanized portion of Bellingham Bay between about Cornwall Avenue and the Squalicum marina.

General life history information on these economically important species is described in Table 7.

3.6.4 Salmonid Fishing Areas

Whatcom County has sport, tribal, and commercial salmon fishing for a number of anadromous salmon species (Shea et al. 1981). Salmon fishing areas are shown in Figures 20 and 21. The sport fishing areas delineated on the map are the preferred areas in the county where recent fishing has occurred (WDF 1992). Tribal and non-tribal commercial fishing occurs throughout Whatcom County. Fishing within the Reservation Border is restricted to members of the Lummi Nation. The reservation border was established as follows in a 1990 U.S. District Court Decision (WDFW 1999):

> *"the eastern boundary of the Lummi Indian Reservation is deemed to proceed along the low water mark around Portage Island and, following the meanderings of the shore to a point south of Treaty Rock, then north to Treaty Rock."*

In accordance with this decision, WDFW advises "that non-Indian fishers operating near reservation boundaries should stay offshore from the line of extreme low water (generally ~4.5 feet in Puget Sound) or they may be subject to federal laws." In Bellingham Bay, sport fishing is generally restricted to an area south of Post Point to Chuckanut Bay and off Governors Point. Table 8 identifies the timing of salmon fisheries.

Table 7. General life history information on anadromous fish in Whatcom County.

Species	Spawning Habitat	Return Migration	Spawning	Age at Return	Juvenile Residence
Coho	Clean gravel riffles; smaller tributary streams in large rivers; all habitat in small coastal streams	August - November, peak in October	October – January	2 to 3 years	Reside in freshwater for about 1 year; enter the ocean May - June
Chum	Clean gravel riffles and upwelling areas in low to moderate gradient areas of mainstems, side channels, sloughs, and small tributaries	October – December	Soon after entering freshwater	2 to 6 years; mostly 3 to 4 years	2 to 3 months; February - June
Chinook	Clean gravel riffles with swift water velocities; mainstem and lower reaches of larger tributaries; Spring runs tend to use highest accessible habitat; Summer runs tend to use mid-reaches of all suitable habitat; Fall run tend to use lower available habitat	Spring run: April – September Summer run: July – September Fall run: August – December	Spring run: August – September Summer run: September – November Fall run: October – February	2 to 6 years; mostly 3 to 5 years	In general Chinook reside in freshwater for about 90 days to 1 year and enter the ocean from June – September
Pink	Clean gravel riffles in mainstems and side channels	July – September	August – October	2 years; adult returns primarily odd years	2 to 4 months in freshwater; enter ocean in spring
Sockeye	Clean gravel riffles in mainstems and side channels; tributary to large lakes; clean gravel beaches in lakes	March – December	September - January	3 to 4 years	1 to 2 years in lakes; enter ocean March - July
Steelhead	N/A[1]	N/A	N/A	N/A	N/A
Cutthroat	N/A[1]	N/A	N/A	N/A	N/A
Bull trout/ Dolly Varden	Clean, cold areas often in headwaters of river	Spring – Summer	September – mid-November	Typically 5 years; repeat spawners over multiple years	Juveniles of anadromous stocks may occur in estuary throughout year

[1] Data not available.

Table 8. Salmonid fisheries in Bellingham Bay.

Species	Fishery
Coho	mid-September to mid-November
Chum	early November to mid-December
Chinook	fall Chinook: late July to mid-September
Pink	July in odd years
Sockeye	no fishery
Steelhead	mid-December to January
Cutthroat	no commercial fishery
Dolly Varden	no fishery

Pacific salmon fisheries including chinook, coho, and chum salmon fisheries are the most lucrative fisheries in Bellingham Bay. Although there are no targeted fisheries for pink and sockeye salmon, these species are incidentally caught in the bay. Sockeye salmon are also caught incidentally in the Nooksack River fisheries. Over the past 15 years, salmon has represented the largest portion of total catch from Bellingham Bay. The total commercial catch of Salmon in Bellingham Bay in 1983 was approximately 2 million pounds, with a value of $1.8 million (CH2M Hill 1984). However, local salmon landings appear to have declined in recent years, and have averaged approximately 779,000 pounds per year over the past 5 years (Tribal and commercial landings). A number of different fisheries management factors have influenced this trend.

3.7 MARINE MAMMALS AND PINNIPED HAUL-OUT SITES

Several species of marine mammals occur in the marine waters of Whatcom County. The species reported in the county are:

- Killer whale (*Orcinus orca*)
- Gray whale (*Eschrichtius robustus*)
- Minke whale (*Balaenoptera acutorostrata*)
- Harbor porpoise (*Phocoena phocoena*)
- Harbor seal (*Phoca vitulina*)
- California sea lion (*Zalophus californianus*)
- Northern sea lion (*Eumetopias jubatus*)

Marine mammal distributions are presented in Figures 22 and 23. Killer whales and minke whales occur in the offshore waters between Lummi Island and Point Roberts. Gray whales occupy Chuckanut and Bellingham bays and this spring have been sited in the waters just off downtown Bellingham. Pinnipeds (primarily harbor seals) haul out at discrete locations throughout the county. Haulout sites range from two in Drayton Harbor to the north to one on the south tip of Eliza Island and another at Larabee State Park near the Whatcom-Skagit county line. Harbor porpoise occur in nearshore and offshore locations south of an approximate line from Point Roberts to Birch Point. The eastern margin of their distribution in the county is the approximate easternmost part of Lummi Island. Harbor porpoise are not reported in any of the bays of the county.

Table 9 summarizes the life history information of the marine mammal species reported in Whatcom County.

3.7.1 Seabird Nesting

Bird colonies are reported on Drayton Harbor's Semiahmoo Spit, on the north and south sides of Point Whitehorn, about 1000 feet southeast of Cherry Point, on Migley Point (the northernmost tip) of Lummi Island, along the central Bellingham Waterfront, at Post Point, in Chuckanut Bay (Ecology 1992).

The greater Bellingham Bay area (including Chuckanut and Portage Bays) represent important shallow estuarine habitats and other significant areas, which support a number of birds at all seasons. Although Bellingham Bay is not used extensively by large populations of waterfowl, wintering populations tend to be 10 to 15 times higher than summer populations for migratory species (Manual et al. 1979). The bay is located on the flight path between the Fraser River estuary and Skagit Bay and is used as a stopover for seabirds and waterfowl migrating between these two areas. Waterfowl sited in Bellingham Bay include brant, snow geese, mallard, widgeon, green-winged teal, and pintail. Bellingham Bay is also used as an

Table 9. Marine mammals life history information.

Species	Feeding	Habitat	Status
Harbor Seal	Opportunistic and eats a wide variety of schooling fish, flatfish, crustaceans, and squid	Near-coastal and estuarine. May be seen mile up rivers. Haul out on intertidal sandbars and rocky shores	Healthy throughout its range
Killer Whale	Marine mammals, shark, birds, squid, turtles; has very diverse diet	Coastal waters to 500+ miles offshore	Population probably stable
Gray Whale	Dredge through mud and use baleen to filter out bottom-dwelling amphipods and crustaceans	Coastal, shallow waters over continental shelf	Removed from endangered species list; numbers have increased to record high of over 21,000
Harbor Porpoise	Schooling fish including herring, mackerel, smelt, and squid, and invertebrates	Coastal waters, usually in waters less than 300 ft deep	No current abundance estimates
California Sea Lion	Opportunistic; eat schooling fish, squid, rockfish, flatfish, hake, salmon, lamprey, dogfish	Coastal; remote sandy island beaches used for rookeries; haul out on shore, buoys, docks, rafts, etc.	Numbers are increasing. Minimum estimate from California to Washington is over 67,000
Northern Sea Lion	Opportunistic; eat fish, squid, and shrimp	Primarily coastal; use secluded rocks for haul outs and rookeries	Threatened; no rookeries occur in state of Washington
Dall's Porpoise	Squid and variety of fish	Pelagic and coastal in cool temperate to cold waters	Seasonally common in some areas
Minke Whale	Feed primarily in summer on schooling fish and zooplankton	Pelagic and common in bays and shallow coastal waters	Status is unknown

overwintering area for diving birds such as scoter and golden eye. A variety of both natural and man-made shoreline types found in Bellingham Bay provide habitat to migrant and wintering birds by providing protection from winter storms. Table 10 summarizes information on seabirds that occur in or use Bellingham Bay.

Figures 24 and 25 identify documented nesting beaches and areas for threatened, endangered, or sensitive species. Species depicted include: bald eagle, great blue heron, marbled murrelet, osprey, pigeon guillemot, glaucous-winged gull, and black oystercatcher. Also indicated are the "areas of significant importance and vulnerability" for bird species identified in the late 1970's by Wahl et al. (1981).

Table 10. Seabirds and their use of Bellingham Bay.

Species	Occurrence in Bay	Feeding	Habitat	Other
Common Loon	Winter resident from September to May	Small and medium sized fish such as flounders, herring, and sculpin and amphipods, crabs, and shrimp	Forage in nearshore and open-water habitats; rests in open water	
Arctic Loon	Winter resident from September to May	Small fish	Forage in open water; feeding and resting habitat tend to be in passages with strong tidal rips	
Yellow-billed Loon	Winter resident from September to May; rare winter resident	Fish such as sculpin, rockfish, and tom cod, and shrimp and small crabs	Often found in areas near eelgrass meadows, protected waters of bays and inlets	
Red-necked Grebe	Winter resident from September through April	Herring, sticklebacks, smelt, shiner perch, and small crustaceans	Prefers deep ocean waters and forages in estuaries, bays, harbors, and mudflats	Resides on periphery of study area
Western Grebe	Winter resident from September through April; some may remain through summer	Herring, sticklebacks, smelt, shiner perch, and small crustaceans	Prefers deep ocean waters and forages in estuaries, bays, harbors, and mudflats	Estimates of 20,000+ birds present during winter months. Bellingham Bay may have one of the largest recorded wintering populations on the Pacific Coast.
Great Blue Heron	Year-round resident	perch, sculpin, starry flounder, sand dabs, crustaceans	Forage on sand and mud beaches, shallow intertidal pools, salt marshes, and in offshore kelp beds	Great Blue Herons are a state monitor species. Nests may occur in the Nooksack River delta.
Whistling Swan	Between October and March; some remain through winter	Aquatic plants and waste crops, mollusks and macroinvertebrates	Concentrate on the Nooksack River delta	Over 200 individuals, the largest in the area, are known to migrate here during winter
Brant	Spring and fall migrant to the bay	Fish	Eelgrass and macroalgae habitats are very important to brant	May use the bay during spring to rest before moving to summer breeding habitat at the Arctic Circle
Mallards	Fall migration and wintering	plant matter, small crustaceans and macroinvertebrates	Feed in estuarine waters, over mudflats and along sand and gravel shores	About 6,000 individuals use Bellingham Bay and the Nooksack river delta
Pintail	Winter resident	plant matter, small crustaceans and macroinvertebrates	Feed in estuarine waters, over mudflats and along sand and gravel shores; reside in slat marshes and estuary of Nooksack River delta	

Species	Occurrence in Bay	Feeding	Habitat	Other
Green-winged Teal	Winter resident	plant matter, small crustaceans and macroinvertebrates	Feed in estuarine waters, eelgrass and sedge marshes; sand and gravel shores; resides along Nooksack River delta	
American Widgeon	Winter resident	plant matter such as sea lettuce and eelgrass; terrestrial grasses	Feed in estuarine waters, over mudflats and along sand and gravel shores	
Bufflehead	Winter resident from October through May	Mollusks, crustaceans, small fish	Quiet waters with inlets and bays	
Harlequin Duck	Resident	Small crustaceans, mollusks, and occasionally fish	Nooksack Delta	Breed inland and males make short migrations to the bay in late summer and females and offspring in October, stay in/by the bay until May
White-winged and Surf Scoters	Common migrant and winter resident; some non-breeding individuals are year-round residents	Mollusks, crustaceans, occasionally herring spawn	Areas that support shellfish; often found in marinas where pilings support mussels.	
Red-breasted Merganser	Migrant and winter resident from August into May	Small fish, especially herring roe in the late winter	Offshore areas for diving; protected bays for courtship during late winter	
Common Merganser	Year round resident with larger concentrations in fall and winter	Small fish, especially herring roe in the late winter	Offshore areas for diving; protected bays for courtship during late winter	
Bald Eagle	Year-round resident	Wide variety of prey including marine birds and their offspring, and small terrestrial mammals	Forage on tidal flats and beaches	This is a threatened species
Marsh Hawk	Year round resident	Small terrestrial mammals and small birds along the edge of mudflats	Breed in fields, hedgerows, and marshes; forages along mudflats	The Nooksack River delta supports several pairs of marsh hawks
Black Merlin Falcon	Migratory	Wintering shorebirds, sparrow, juncos, blackbirds	Nooksack delta; trees to launch attack at prey	
American Coot	Migrant and winter resident	Vegetable matter	Mudflats and shore beaches	

3.8 DRIFT CELLS

Net shore-drift describes the longshore sediment transport along the coast. Drift cells refer to the partially compartmentalized zones along the coast that act as closed or nearly closed systems with respect to transport of beach sediment (Schwartz et al. 1991). Each drift cell is composed of an origin that provides a sediment source, such as an erosional bluff, a transport zone, and a terminus in which sediment is deposited. Terminus areas are usually a relatively wide beach or spit. Shore-drift is primarily driven by wind-generated waves (Schwartz et al. 1991). The direction of shore-drift at a given site may change frequently (e.g., daily, weekly, or seasonally) due to change in wave approach. Over the long term, the direction of shore drift one of the two directions along the coast will be the direction of net shore-drift.

Drift cells are often used to define shoreline segments useful for habitat assessment and are useful because they incorporate natural and anthropogenic effects on shoreline processes. For example, stream mouths and shoreline bulkhead both impact shore-drift processes. Schwartz et al. (1991) identify 33 drift cells in Whatcom County (Figures 26 and 27). However, the delineation of drift cells can be open to interpretation and is it important to review Schwartz et al. (1991) rationale or evidence for the determined delineations. This text is provided in Appendix A.

4 RECOMMENDATIONS FOR FOCUSING PROTECTION AND RESTORATION EFFORTS

A diverse assemblage of fish and shellfish resources occupies the marine waters of Whatcom County. In recent years, declines in populations of all major fish groups represented in this report (i.e., groundfish, forage fish, and salmon) have been recorded in Puget Sound (e.g., WDFW 1995, Bargmann 1998). Although the causes for these declines are not always well understood, most appear to be attributable to a combination of natural and manmade disturbances (e.g., Puget Sound Water Quality Action Team 2000).

The task of the Whatcom County MRC to identify areas to focus restoration and/or protection efforts provides a significant opportunity to maintain/enhance the ecological functions of key areas in the county. As shown in the figures in Section 2, the fish and shellfish resources of the county occupy all areas of the marine environment. Based on the fish and shellfish information presented, key areas can be identified, although final determinations depend on the objectives to be set forth by the MRC. Recommendations of areas in Whatcom County most in need of protection and promising areas for restoration can be based on a combination of existing information on habitat/species distribution in the County and criteria for identifying candidate areas. This information can be used to define habitat objectives. The following provide a starting point for evaluating the existing resource information and can help identify areas to focus protection and restoration efforts.

Habitat Objectives:

- Restrict use/development in shoreline areas providing critical vegetation and habitat areas
- Maximize shoreline vegetation in historically vegetated areas
- Maximize eelgrass in historical eelgrass areas
- Maximize viability of estuarine areas
- Maximize habitat connectivity
- Achieve net gains in highly ecologically productive nearshore, intertidal, and estuarine habitat within the county, as well as no significant loss of existing, high-value habitat
- Protect nearshore habitat and prevent harm from upland activities through local and state ordinances and shoreline plans

Resource Objectives:

- Reduce catch limits in areas with recent low productivity and historically high productivity (may be based on local knowledge)
- Maintain productivity in healthy areas
- Help ensure a net reduction in shellfish harvest areas within the county closed due to contamination
- Contribute to measurable increases in factors supporting bottom fish recovery (such as rockfish) -- including numbers of fish of broodstock size and age, average fish size, and abundance of prey species -- as well as sufficient amounts and quality of protected habitat
- Contribute to increases in other key marine indicator species (could be prey items or lower trophic level indicator species)

Based on the resource information presented, the following list identifies some key areas that may be considered for protection/restoration.

- The intertidal and nearshore areas provide necessary habitat for forage fish spawning and juvenile fish and shellfish rearing, yet water quality and habitat in these areas are susceptible to continued degradation associated with increasing human populations.
- Extensive and isolated areas of eelgrass and other marine vegetation are identified throughout the county. These eelgrass beds support many fish and shellfish resources that at varying life history stages rely on the presence of the vegetation.
- The waters surrounding Lummi, Portage, and Eliza Islands support a wide range of fish and shellfish resources and provide a diverse array of habitats. Lummi Rocks and the tombolo connecting Portage Island to the mainland are unique features in the county.
- Alden Bank, where depths are as shallow as –30 ft mean lower low water, provides a unique offshore habitat in the county that provides habitat for isolated populations of geoduck, sea urchins, and clams. These isolated populations of shellfish in areas offshore from the mainland can be an important source population for recolonization in the event that nearshore populations decrease due to water quality changes or disturbances.
- The reef and nearshore areas off the south shore of Point Roberts provide habitat for reef-dwelling groundfish and supports isolated populations of sea urchins and clams.
- Any nearshore or openwater sensitive habitat areas critical to marine fish and herring survival-both candidate species groups for ESA listing.

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