

# Lummi Intertidal Baseline Inventory

## **Appendix E: Taxonomic Resolution**

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## **Executive Summary**

The Lummi Intertidal Baseline Inventory documented over 250 distinct taxa present across the Lummi Reservation tidelands. This paper lists the taxonomic labels and hierarchies used to identify individual specimens during the LIBI, and discusses the process of identifying the organisms encountered.

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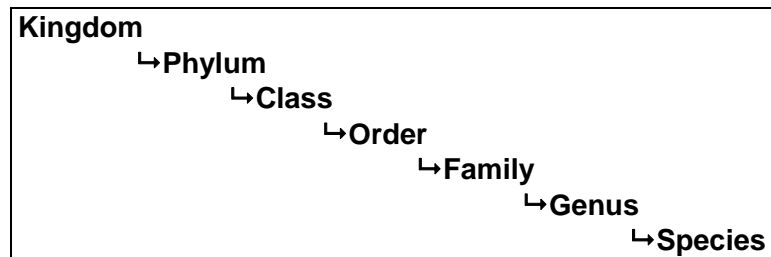
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## 1.0 Introduction

The primary goal of the LIBI was to document the presence of species that utilize the Reservation tidelands. However, it was not always possible to identify all organisms to species-level. Accordingly, the purpose of this appendix is to document the taxonomic labels used in the LIBI surveys described in Appendix A through D, and to specify how these labels relate to one another when a hierarchy exists.

## 2.0 Methods

Organisms encountered in the LIBI project were identified to different taxonomic levels (see Figure E.1) depending on the survey method, conditions, and the identification resources available. At times the ability to make a positive identification was complicated by the age and/or condition of the specimen or by the lack of the required level of specialist taxonomic expertise. Accordingly, the taxonomic resolution of the LIBI depends mainly on the type of organism. Fishes, crabs, echinoderms, shrimps, snails, limpets, chitons, clams, marine mammals, and birds were typically identified to the species level wherever possible. Annelids and amphipods were usually identified to the family level. Other organisms such as bryozoans, hydrozoans, sponges, peanut worms, flat worms, pycnogonids, chironomids, and others were identified only at much higher taxonomic levels (e.g., phylum or order).



**Figure E.1.** Major Taxonomic Levels Used in Biology

Where identifications could not be made at the lowest usual level (because of damage to the specimen or for some other reason), the organism was identified at a higher level depending on the best professional judgment of the investigator.

Portable field guides (Adams and Holmes 2007; 2009) were used to identify sessile epibenthic organisms and macroalgae on rocks during the Intertidal Biota Survey. The primary taxonomic key used to identify sampled organisms in the lab was Kozloff (1999). Where necessary, other identification guides were also consulted, including Harbo (2001), Kozloff (2000), and Shanks (2001). Additional advice on identifying first instar *Cancer* crabs was received from Don Velasquez (WDFW). Brian Bingham and Eugene Kozloff provided advice on several difficult identifications to LIBI personnel working at the Shannon Point Marine Laboratory. LIBI volunteers and personnel conducting the bird survey were experienced in regional bird identification but used Sibley (2003) for an identification reference in the field when necessary.

### 3.0 Results

The taxonomic labels used to identify organisms in the LIBI are described in Tables E.1, E.2, and E.3.

Where possible, organisms were identified to the lowest level in the taxonomic tree. Sometimes this level of identification was not possible because of damage to the organism, difficult-to-identify life stages (i.e., larvae or juveniles), or the need for specialist taxonomic expertise for some organisms.

**Table E.1.** Taxa Resolution and Dependencies Used in LIBI Dig Survey Identification

#### Annelids - **Polychaetes**

- Polychaete (Not Identified)
  - Family Arenicolidae (Lug Worms)
  - Family Chaetopteridae (Three-Section Tube Worms)
  - Family Cirratulidae (Spaghetti Worms)
  - Family Flabelligeridae (Bristle Cage Worms)
  - Family Glyceridae (Blood Worms)
  - Family Lumbrineridae (Iridescent Worms)
  - Family Maldanidae (Bamboo Worms)
  - Family Nephytidae (Goddess Worms)
  - Family Nereidae (Pile Worms)
  - Family Onuphiidae (Beach Worms)
  - Family Oweniidae (Sand Worms)
  - Family Pectinariidae (Tusk Worms)
  - Family Sabellidae (Feather Duster Worms)
  - Family Terebellidae (Spaghetti Worms)
  - *Halosydna brevisetosa* (Scale Worms)
  - Opheliidae (Opheliidae)

#### Coelenterates - **Anemones**

- Actiniaria (Sea Anemone Not Identified)
  - *Actiniana* species (Actiniana Anemone)
  - *Anthopleura artesimia* (Moonglow Anemone)
  - *Anthopleura elegantissima* (Aggregating Anemone)
  - *Epiactis* species (*Epiactis* Not Identified)
  - *Metridium* species (Plumose Anemone)
  - *Urticina coriacea* (Stubby Rose Anemone)

## Crustaceans- Amphipods

- Order Amphipoda (Amphipod Not Identified)
  - *Caprella* species (Caprellid Amphipod)
  - Family Corophiidae (Corophiid Amphipod)
  - Family Gammaridae (Gammarid Amphipod)
    - *Trasorchestia traskiana* (Sandhopper)
  - Order Tanaidacea (Tanaid Amphipod)

## Crustaceans - Barnacles

- Infraclass Cirripedia (Barnacle Not Identified)
  - *Balanus crenatus* (Smooth Acorn Barnacle)
  - *Balanus glandula* (Acorn Barnacle)
  - *Chthamatus dalli* (Tiny Brown Barnacle)
  - *Semibalanus cariosus* (Haystack Barnacle)

## Crustaceans – Hermit Crabs

- *Pagurus* species (Hermit Crab Not Identified)
  - *Pagurus granosimanus* (Grainy Hermit Crab)
  - *Pagurus hirsutiusculus* (Hairy Hermit Crab)

## Crustaceans - Isopods

- Isopoda (Isopod Not Identified)
  - *Gnorimospaeroma oregonense* (Pill Bug Isopod)
  - *Idotea montereyensis* (Monterey Idotea)
  - *Idotea resecata* (Eelgrass Isopod)
  - *Idotea wosnesenskii* (Rockweed Isopod)
  - *Phyllodurus abdominalis* (Ghost Shrimp Isopod)

## Crustaceans - Mites

- *Neomolgus littoralis* (Red Velvet Mite)

## Crustaceans - Shrimps

- *Betaus harrimani* (*Betaus harrimani*)
- Family Crangonidae (Crangonid Shrimp)
  - *Crangon alba* (Stout Crangon)
  - *Crangon franciscorum* (California Bay Shrimp)
  - *Crangon nigricauda* (Blacktail Shrimp)
- Family Hippolytidae (Hippolytid Shrimp)
  - *Eualus biunguis* (Hippolytid Shrimp)
  - *Eualus suckleyi* (Shortscale Eualid)
  - *Heptacarpus* species (Broken Backed Shrimp)
    - *Heptacarpus herdmani* (Herdman Coastal Shrimp)
- *Neomysis* species (Mysid Shrimp)
- *Neotrypaena californiensis* (Ghost Shrimp)
- *Pandalus platyceros* (Spot Prawn)
- *Upogebia pugettensis* (Blue Mud Shrimp)

## Crustaceans – True Crabs

- *Cancer oregonensis* (Pygmy Rock Crab)
- *Cancer productus* (Red Rock Crab)
- *Cancer* sp. (*Cancer* Megalops)
  - *Cancer magister* (Dungeness Crab)
- *Hemigrapsus nudus* (Purple Shore Crab)
- *Hemigrapsus oregonensis* (Oregon Shore Crab)
- *Oregonia gracilis* (Graceful Decorator Crab)
- *Pinnixa faba* (Pea Crab)
- *Pinnixa schmitti* (Schmitt Pea Crab)
- *Pinnixa tubicola* (Tube Dwelling Pea Crab)
- *Scleroplax granulata* (*Scleroplax granulata*)
- *Telmessus cheiragonus* (Hairy Helmet Crab)

## Echinoderms - Brittlestars

- Brittlestar Not Identified
  - *Amphiodia* species (Brittlestar Long Rayed)
  - *Ophiopholis aculeata* (Red Brittlestar)



## Echinoderms - SandDollars

- *Dendraster excentricus* (Sand Dollar)

## Echinoderms - Seastars

- *Leptasterias* species (Six Rayed Star)
- *Pisaster ochraceus* (Purple Ochre Seastar)

## Finfish - Teleosts

- Unidentified Teleost (e.g., Larval Fish)
  - *Anoplarchus purpurescens* (Cockscomb Prickleback)
  - *Apodichthys flavidus* (Penpoint Gunnel)
  - *Citharichthys sonididus* (Pacific Sanddab)
  - *Clevelandia ios* (Arrow Goby)
  - Cottidae (Sculpin Unidentified)
    - *Leptocottus armatus* (Staghorn Sculpin)
    - *Euophrys lucasi* (Leister Sculpin)
    - *Enophrys bison* (Buffalo Sculpin)
  - *Gasterosteus aculeatus* (Three Spine Stickleback)
  - *Pholis laeta* (Crescent Gunnel)
  - *Pholis ornata* (Saddleback Gunnel)
  - *Porichthys notatus* (Plainfin Midshipman)

## MacroAlgae - Brown

- Class Phaeophyceae (Brown Algae Not Identified)
  - *Alaria marginata* (Short Stipe Alaria)
  - *Chondracanthus exasperatus* (Turkish Towel)
  - *Desmarestia aculeata* (Witches Hair)
  - *Desmarestia viridis* (Green Acid Kelp)
  - *Fucus distichus* (Rockweed)
  - *Leathesia difformis* (Sea Cauliflower)
  - *Saccharina latissima* (Sugar Kelp)
  - *Sargassum muticum* (Wireweed)

## MacroAlgae - Green

- Phylum Chlorophyta (Green Algae Not Identified)
  - *Acrosiphonia* species (Green Rope)
  - *Ulva* species (*Ulva* species)
  - *Urospora* species (Green Hair Algae)

## MacroAlgae - Red

- Phylum Rhodophyta (Red Algae Not Identified)
  - *Chondrus crispus* (Irish Moss)
  - *Cryptosiphonia woodii* (Bleached Burnett)
  - *Hildenbrandia* species (Rusty Rock)
  - *Mastocarpus* species (Turkish Washcloth)
  - *Microcladia borealis* (Coarse Sea Lace)
  - *Palmaria mollis* (Red Ribbon)
  - *Prionitis* species (Bleachweed)

## Miscellaneous – Miscellaneous Animals

- *Amphiphorus* species (White Ribbon Worm)
- *Cerebratulus* species (Tan Ribbon Worm)
- Class Hydrozoa (Hydrozoan)
- Class Pycnogonida (Sea Spider)
- Class Turbellaria (Polyclad Turbellarian)
- Family Chironomidae (Chironomids)
- Phylum Bryozoa (Bryozoan Not Identified)
  - *Dendrobenia* species (Bryozoan (*Dendrobenia*))
  - *Eurystromella bilobata* (Bryozoan Red)
- Phylum Sipunculidae (Peanut Worm)

## Mollusks - Bivalves

- Class Bivalvia (Bivalve Not Identified)
  - *Macoma* species (Macoma Not Identified)
    - *Macoma secta* (Macoma secta)
    - *Macoma nasuta* (Bentnose Clam)
    - *Macoma inquinata* (Macoma inquinata)
    - *Macoma balthica* (Macoma balthica)
  - *Tellina* species (Telina Clam)
  - *Clinocardium nuttalli* (Cockle)
  - *Crassostrea gigas* (Pacific Oyster)
  - *Cryptomya californica* (Cryptomya)
  - *Leukoma staminea* (Native Littleneck)
  - *Lucinoma annulatum* (Western Ringed Lucine)
  - *Mya arenaria* (Softshell Clam)
  - *Mytilus trossulus* (Pacific Blue Mussel)
  - *Nearomya rugifera* (Wrinkled Montacutid)
  - *Nutricula tantilla* (Purple Dwarf Venus)
  - *Nuttalia obscurata* (Mahogany Clam)
  - *Parvalucina tenuisculpta* (Fine Lined Lucine)
  - *Pododesmus macrochisma* (Jingle Shell)
  - *Protothaca tenerrima* (Thin Shelled Littleneck)
  - *Rochefortia tumida* (Robust mysella)
  - *Saxidomus giganteus* (Butter Clam)
  - *Solen sicarius* (Jack Knife Clam)
  - *Tresus* species (Horse Clam)
  - *Venerupis philippinarum* (Manila Clam)

## Mollusks - Chitons

- Polyplacophora (Chiton Not Identified)
  - *Lepidozona cooperi* (Coopers Chiton)
  - *Lepidozona mertensi* (Mertens Chiton)
  - *Mopalia lignosa* (Woody Mopalia)
  - *Mopalia muscosa* (Mossy Mopalia)
  - *Tonicella lineata* (Lined Chiton)

## Mollusks - Limpets

- Clade Patellogastropoda (Limpet Not Identified)
  - *Discurria insessa* (Seaweed Limpet)
  - *Lottia parallela* (Eelgrass Limpet)
  - *Lottia* species (*Lottia* sp.)
    - *Lottia pelta* (Shield Limpet)
    - *Lottia instabilis* (Unstable Limpet)
  - *Tectura persona* (Mask Limpet)
  - *Tectura scutum* (Plate Limpet)

## Mollusks - Seaslugs

- Clade Nudibranchia (Nudibranch Not Identified)
  - *Haminoea* species (Bubble Snail)
  - Superfamily Doridoidea (Dorid Nudibranch)
    - *Onchidoris bilamellata* (Barnacle Eating Nudibranch)

## Mollusks - Snails

- *Batillaria attramentaria* (Horn Shell)
- Family Trochidae (Trochid Snail)
- *Lacuna* species (Chink Shells)
- *Littorina* species (*Littorina* species)
  - *Littorina scutulata* (Checkered Periwinkle)
  - *Littorina sitkana* (Sitka Periwinkle)
- *Margarites pupillus* (Puppet Margarites)
- *Odostomia* species (*Odostomia*)
- *Ophiodermella inermis* (Turridae)
- *Orobitella rugifera* (Orobitella)
- *Tegula funebris* (Black Turban)
- *Turbonilla* species (Turbonilla Snail)

## Mollusks - **Whelks**

- *Amphissa columbiana* (Amphissa columbiana)
- *Lirabuccinum dirum* (Dire Whelk)
- *Nassarius fraterculus* (Japanese Nassa)
- *Nassarius mendicus* (Western Lean Nassa)
- *Nucella canaliculata* (Channelled DogWinkle)
- *Nucella emarignata* (Ribbed Dogwinkle)
- *Nucella lamellosa* (Frimled Dogwinkle)
- *Nucella ostrina* (Northern Striped Dogwinkle)

## Porifera - **Sponges**

- Porifera (Sponge Not Identified)
  - *Suberites* species (Sponge)

## VascularPlants - **Eelgrass**

- *Zostera japonica* (Japanese Eelgrass)
- *Zostera marina* (Pacific Eelgrass)

## VascularPlants - **Saltmarsh**

- *Salicornia virginica* (Pickleweed)
-

**Table E.2.** Taxonomic Resolution and Dependencies Used in LIBI Lampara-Net Sampling Identification

## Finfish - Cartilagenous

- *Squalus acanthias* (Pacific Spiny Dogfish)

## Finfish - Telosts

- Flatfish species
  - *Citharichthys sordidus* (Pacific Sanddab)
  - Soleidae (Sole species)
  - *Citharichthys stigmaeus* (Speckled Sanddab)
  - *Platichthys stellatus* (Starry Flounder)
- Forage fishes
  - *Alosa sapidissima* (American Shad)
  - *Engraulis mordax* (Anchovy)
  - *Spirinchus thaleichthys* (Longfin Smelt)
  - *Clupea pallasii* (Pacific Herring)
  - *Ammodytes hexapterus* (Sandlance)
  - *Hypomesus pretiosus* (Surf Smelt)
- Gadids
  - *Gadus macrocephalus* (Pacific Cod)
  - *Microgadus proximus* (Pacific Tomcod)
- Greenlings
  - *Hexagrammos decagrammus* (Kelp Greenling)
  - *Ophiodon elongates* (Lingcod)
  - *Hexagrammos stelleri* (Whitespotted Greenling)
- Gunnel species
  - *Pholis laeta* (Crescent Gunnel)
  - *Apodichthys flavidus* (Penpoint Gunnel)
  - *Pholis ornata* (Saddleback Gunnel)
- Pricklebacks
  - *Lumpenus sagitta* (Snake Prickleback)
- Salmonids
  - *Oncorhynchus tshawytscha* (Chinook)
  - *Oncorhynchus keta* (Chum)
  - *Oncorhynchus kisutch* (Coho)
  - *Oncorhynchus clarki* (Cutthroat)
  - *Oncorhynchus gorbuscha* (Pink)
  - *Oncorhynchus mykiss* (Steelhead)
- Sculpin species
  - *Enophrys bison* (Buffalo sculpin)
  - *Nautichthys oculofasciatus* (Sailfin sculpin)
  - *Leptocottus armatus* (Staghorn sculpin)
  - *Oligocottus maculosus* (Tidepool sculpin)

- Sticklebacks
  - *Gasterosteus aculeatus* (Three-spine Stickleback)
- Surf Perches
  - *Rhacochilus vacca* (Pile Perch)
  - *Cymatogaster aggregate* (Shiner Perch)
- Syngnathids
  - *Syngnathus leptorhynchus* (Bay Pipefish)
- Toadfishes
  - *Porichthys notatus* (Plain Fin Midshipman)

## Crustaceans - True Crabs

- *Cancer magister* (Dungeness Crab)
- *Telmessus cheiragonus* (Helmet Crab)
- *Pagurus* species (Hermit Crab)
- *Pugettia producta* (Kelp Crab)
- *Hyas lyratus* (Lyre Crab)

## Crustaceans - Shrimps

- Not Identified
-

**Table E.3.** Taxonomic Resolution and Dependencies Used in LIBI Bird/Marine Mammal Survey Identification

## MarineMammals - Pinnipeds

- *Phoca vitulina* (Harbor Seal)
- *Zalophus californianus* (California Sea Lion)

## Shorebirds - Alcids

- Family Alcidae (Alcid species)
  - *Brachyramphus marmoratus* (Marbled Murrelet)
  - *Cephus columba* (Pigeon Guillemot)

## Shorebirds - Buntings and Sparrows

- *Plectrophenax nivalis* (Snow Bunting)

## Shorebirds - Cormorants

- Family Phalacrocoracidae (Cormorant species)
  - *Phalacrocorax auritus* (Double-Crested Cormorant)
  - *Phalacrocorax pelagicus* (Pelagic Cormorant)

## Shorebirds - Corvids

- *Corvus brachyrhynchos* (American Crow)

## Shorebirds - Ducks

- Family Anatidae (Duck species)
  - Subfamily Aythyinae (Diving Duck species)
    - *Aythya marila* (Greater Scaup)
    - *Clangula hyemalis* (Longtailed Duck)
  - Subfamily Anatinae (Dabbling Duck species)
    - *Anas platyrhynchos* (Mallard)
    - *Anas acuta* (Northern Pintail)
    - *Anas americana* (American Widgeon)
    - *Anas carolinensis* (Green-Wing Teal)
    - *Anas penelope* (Eurasian Widgeon)
    - *Anas strepera* (Gadwall)



- Subfamily Merginae (Seaducks)
  - *Bucephala* species (Goldeneye species)
    - *Bucephala albeola* (Bufflehead)
    - *Bucephala clangula* (Common Goldeneye)
    - *Bucephala islandica* (Barrow's Goldeneye)
  - *Melanitta* species (Scoter species)
    - *Melanitta fusca* (White-Winged Scoter)
    - *Melanitta nigra* (Black Scoter)
    - *Melanitta perspicillata* (Surf Scoter)
  - Mergansers (Merganser species)
    - *Lophodytes cucullatus* (Hooded Merganser)
    - *Mergus merganser* (Common Merganser)
    - *Mergus serrator* (Red-Breasted Merganser)
  - *Histrionicus histrionicus* (Harlequin Duck)

## Shorebirds - Geese

- *Branta bernicla* (Brant)
- *Branta canadensis* (Canada Goose)

## Shorebirds - Grebes

- *Aechmophorus occidentalis* (Western Grebe)
- *Podiceps auritus* (Horned Grebe)
- *Podiceps grisegena* (Red-Necked Grebe)

## Shorebirds - Gulls

- Family Laridae (Gull species)
  - *Larus argentatus* (Herring Gull)
  - *Larus californicus* (California Gull)
  - *Larus canus* (Mew Gull)
  - *Larus delawarensis* (Ring-Billed Gull)
  - *Larus glaucescens* (Glaucous-Winged Gull)
  - *Larus philadelphia* (Bonaparte's Gull)

## Shorebirds - Herons

- *Ardea herodias* (Great Blue Heron)

## Shorebirds - Kingfishers

- Family Alcedinidae (Kingfisher species)
  - *Ceryle alcyon* (Belted Kingfisher)

## Shorebirds - Loons

- *Gavia immer* (Common Loon)
- *Gavia pacifica* (Pacific Loon)
- *Gavia stellata* (Red-Throated Loon)

## Shorebirds - Owls

- *Asio otus* (Long-Eared Owl)

## Shorebirds - Plovers

- Family Scolopacidae (Sandpipers)
  - *Arenaria melanocephala* (Black Turnstone)
  - *Calidris alpina* (Dunlin)
  - *Calidris mauri* (Western Sandpiper)
  - *Charadrius vociferus* (Killdeer)

## Shorebirds - Raptors

- *Buteo jamaicensis* (Red-tailed Hawk)
- *Circus cyaneus* (Northern Harrier)
- *Falco peregrinus* (Peregrin Falcon)
- *Haliaeetus leucocephalus* (Bald Eagle)

## Shorebirds - Swallows

- Family Hirundinidae (Swallows)
  - *Hirundo rustica* (Barn Swallow)
  - *Petrochelidon pyrrhonota* (Cliff Swallow)

## Shorebirds - Terns

- *Sterna caspia* (Caspian Tern)
-

## 4.0 Discussion

Ideally, all organisms would have been identified to genus and species. However, this was not always possible for a number of reasons.

First, identification of organisms in the field was limited to methods that did not require microscopes or reference materials beyond portable field guides (e.g., Adams and Holmes 2007; 2009). Macroalgae identification was only attempted by two out of the four field teams due to differences in previous experience with macroalgae, and limited availability of macroalgae field guides. Field identification of birds was sometimes impeded by distance, visibility, and wave conditions.

Second, definite identification of some invertebrate taxa below higher taxonomic rankings (e.g., order or family level) required specialist knowledge and experience. Lacking such expertise and the budget capacity to have samples analyzed by specialists, it was preferred to restrict the identification of organisms to the lowest level where LIBI personnel were confident of the identifications.

Third, due to the mechanical grinding action of stones and shells during the field sieving of substrates, there was sometimes mechanical damage to specimens that precluded positively identifying all specimens. This was especially true of soft-bodied organisms such as polychaete worms, which typically suffered multiple breakages and missing body parts. Likewise, some individual crustaceans (usually shrimps) sometimes had missing body parts (e.g., antennae, legs) that were required to make a positive identification.

For tubeworms (Oweniidae, Chaetopteridae, and others), the effects of the field sieving of substrates also meant that quantifying the number of individuals in a sample was problematic. Almost all specimens were broken into several pieces and as such, all counts of tubeworms from this survey are estimates derived from counting pieces and then calculating how many pieces are required to constitute an 'average' individual. However, the authors were able to identify and count most polychaetes with distinct cephalic regions (e.g., Neriidae, Lumbrineridae, Maldanidae, Glyceridae) by counting 'heads'.

A fourth issue was that the available keys were often designed to identify adult specimens and sometimes relied on characteristics that were imperfectly developed or absent in larval or juvenile specimens which were common in the samples. For example, megalops larvae belonging to the crab genus *Cancer* were observed at several sites in the latter part of the survey. Although these keyed out as Dungeness crabs (*Cancer magister*) based on carapace size (Shanks 2001), the investigators were reluctant to commit to this identification due to feedback received from Brian Bingham at the Shannon Point Marine Laboratory who suggested that neither timing nor size provides a reliable means of identification for larval-stage *Cancer* sp. The investigators are more confident about the identification of first instar juvenile *Cancer* crabs based on characteristics provided by Don Velasquez (WDFW, personal comment)

Likewise, young clams in the *Macoma* genus proved very difficult to identify. All *Macoma* clams were presumed to be either in the *M. inquinata*, *M. nasuta*, or *M. secta* species. *Macoma* clams that were less than 20 millimeters in shell length were generally not identified to species. The only exception to this rule was for Baltic *Macoma* (*Macoma balthica*) specimens, which tended to be readily identifiable due to having a pink or mottled pink shell color. Additionally, this species was usually found associated with purple varnish clams (*Nuttallia obscurata*). However, this pink shell coloration was not always true for all Baltic *Macoma* individuals, and it is possible that white-colored *M. balthica* were not properly identified and were assigned to *Macoma* sp. instead.

Other taxa that were challenging to identify included teleost fish, shrimps, and amphipods.

The experience of identifying the samples over a span of time along with periodic inputs of advice from outside experts meant that LIBI investigators learned to better differentiate some species during the course of the study. As a result, certain taxa were more reliably identified in later-sorted samples than in early-sorted samples. To overcome this dynamic level of experience, specimens from the most problematic taxa were re-examined at the end of the sorting phase of the study to correct any early misidentifications. However, some of the earliest sorted samples were not retained due to logistical constraints, and three sites with potentially erroneous identifications could not be re-checked. In those three samples, California softshell clams (*Cryptomya californica*) might have been confused with either *Tellina* sp. or juvenile eastern softshell clams (*Mya arenaria*) at two sites, and chink shells (*Lacuna* sp.) may have been confused with *Odostomia* sp. at one site.

The last reason that identification to species level was not pursued across all taxa was a matter of prioritization of available resources and the time available to complete the work.

Because the achievable taxonomic resolution of the study varied between taxonomic groups, and sometimes between individual specimens, normal indicators of biological diversity such as species richness, or indices of diversity that depend on assumptions of uniform taxonomic resolution (e.g., Shannon/Shannon-Wiener) could not be properly applied to the resultant dataset.

Instead, 'taxonomic richness' was used as a substitute for species richness. Taxonomic richness in this report is a count of the types of taxa found at a site based on the lowest-level of taxonomic hierarchy that was found at that site (excluding Macroalgae).

As an example, if both '*Cancer* sp', and '*Cancer magister*' were present at a site, the higher-level group '*Cancer* sp' would be ignored and only '*Cancer magister*' would be counted towards the total taxonomic richness of the site. On the other hand, if '*Cancer* sp' were the only cancer crab found in a sample, then it would count towards the overall taxonomic richness of that site.

Macroalgae are excluded from the site-specific taxonomic richness scores calculated for the Intertidal Biota Survey (Appendix A), because the identification of macroalgae was performed solely in the field, and only half the sites were actually surveyed for macroalgae. Including macroalgae in the taxonomic richness scores would have the effect of making some sites appear richer than others simply because of differences in the survey methodology between sites.

In total, the LIBI documented more than 250 distinct taxonomic groups that utilize the Lummi Reservation tidelands (invertebrates, birds, finfish, marine mammals, and flora combined). The total number of species present in some of these groups would require additional funding and specialist expertise to determine.

## 5.0 References

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