MARBLED MURRELET

TAXONOMY

Scientific name: *Brachyramphus marmoratus* (Gmelin, 1789)
Common name: Marbled Murrelet
Family: Alcidae

Taxonomic comments:
Tree- and ground-nesting populations exhibit no morphological divergence and little genetic divergence (Pitocchelli et al. 1995). Populations on Asian and North American sides of Beringia exhibit mtDNA differentiation consistent with species-level distinctness (Zink et al. 1995); because sample sizes were small, Zink et al. did not recommend a formal taxonomic change. However, the (Asian) Long-billed Murrelet (*B. perdix*) was subsequently split from the American *B. marmoratus* (Friesen et al. 1996, AOU 1997). Friesen et al. (1996) examined variation in the mitochondrial cytochrome b gene and in 39 allozyme loci for North American and Asian (then *B. perdix*) Marbled Murrelets and Kittlitz's Murrelet (*B. brevirostris*) and found significant genetic variation among Marbled Murrelet populations from different sites within North America.

DESCRIPTION

Basic description: A robin-sized seabird (murrelet).

General description:
A chunky seabird with a black bill and an entirely dark tail. Breeding adult is dark brown above, heavily mottled below. In winter plumage, white below, with white scapular streak on otherwise dark upperparts. Juvenile resembles winter adult but has dusky-mottled underparts, which become mostly white by the first winter (National Geographic Society 1983).

Length (cm): 25
Weight (g): 222

Reproduction:
Nests are usually constructed on a horizontal branch or other platform high in mature conifers. Nesting occurs from late March to late September; downy young and fledged juveniles have been observed June-September. Activity in forest nesting areas is highest from mid-May through early August in Alaska (see Levy 1993). Clutch size is 1. Incubation lasts about 30 days, by both sexes alternately in 24-hr shifts. Nestling is visited and fed by parent 2-4 times each day, fledges in 27-40 days (Marshall 1988, Levy 1993). Entire nesting period lasts about 106 days in Alaska (Nelson 1997). Appears to nest semi-colonially (USFWS 1994, Naslund et al. 1995). In Kachemak Bay,

maximum annual productivity was between 0.32 chicks/pair and 0.46 chicks/pair (Kuletz and Piatt 1999).

Ecology:
Solitary or in pairs, small groups, or loose aggregations. In most areas, generally does not flock with other birds, but may participate in mixed-species feeding flocks in the absence of interference from larger diving birds (Mahon et al. 1992).

The only confirmed record of predation on an adult at its nest involved a Sharp-shinned Hawk in Alaskan old-growth forest (Marks and Naslund 1994).

Species has high fidelity to nesting areas and nest trees (see Nelson 1997).

Despite the urgent need for an assessment of the demographic state of populations, the species is so secretive that reliable estimates of the required vital rates are rare. Survival estimates obtained through capture-recapture data from a population in British Columbia were 0.8289 and 0.9289, based on different samples corresponding to two capture techniques. The study area had been and continues to be heavily logged (Cam et al. 2003).

Migration:
This species is considered a year-round resident along the southern coast of Alaska and the Aleutians (Kessel and Gibson 1978). Some local seasonal movements do occur, however, as is evidenced by lower numbers of birds in Prince William Sound during the non-breeding season (Mendenhall 1992, Agler et al. 1998). Some of these birds may over-winter in the sheltered bays of southeastern Alaska and British Columbia (Isleib and Eberhardt 1975, Piatt and Naslund 1995).

Food:
Global food:
Diet includes fishes, crustaceans (mysids, euphausiids), and mollusks. In British Columbia, adult diet during the breeding season is mostly fishes, primarily Pacific sand lance (*Ammodytes hexapterus*) and Pacific herring (*Clupea harengus*); euphausiids are important in spring at Langara Island; sand lance are the prey most frequently fed to nestlings (Rodway et al. in Carter and Morrison 1992). May feed exclusively on freshwater prey for period of several weeks in some areas; feeds on fingerling sockeye salmon (*Oncorhynchus nerka*) and salmon fry in some British Columbia lakes (Carter and Sealy 1986). Foraging occurs mainly in waters up to 80 m deep and up to 2 km from shore. Foraging dives may be up to about 30 m below surface.

State food:
Diet during the breeding season is primarily small schooling forage fish: Pacific sand lance, capelin (*Mallotus villosus*), viviparous sea perch (*Cymatogaster aggregata*), Pacific herring, and walleye pollock (*Theragra chalcogramma*); during spring and winter small crustaceans (euphausiids, mysids, squid and shrimp) are important (Burkett 1995, Fraser et al. 1999, Day and Nigro 2000). Murrelet's diets changed dramatically between the 1970's and 1990's, presumably due to changes in fish abundance caused by long-term fluctuations in the Gulf of Alaska marine ecosystem (Nelson 1997, Agler et al. 1999). From 1977 to 1979, murrelets in Prince William Sound fed mostly on sand lance, capelin and herring, but from 1989 to 1991, diets consisted almost entirely of gadids

(cod) (Agler et al. 1999). In Southeast Alaska, birds sometimes travel considerable distances (up to 250 km daily) over water from inland sites (presumably nesting areas) to at-sea foraging areas in Glacier Bay and Icy Strait (Whitworth and Nelson 2000).

Phenology:
Young are fed around dusk or dawn; feeding has also been observed at night (Carter and Sealy 1986). At Redwood Experimental Forest, northwestern California, activity levels were greatest 30 minutes before to 30 minutes after sunrise in May, June, and July (Paton et al. in Carter and Morrison 1992). In old-growth forest on the Queen Charlotte Islands, British Columbia, number of detections peaked in late July; detections were most likely to occur on cloudy mornings (Rodway et al. 1993).

Habitat:
Coastal areas, mainly in salt water within 2 km of shore (Marshall 1988), including bays and sounds; not uncommon up to 5 km offshore; also occasionally observed on rivers and lakes usually within 20 km of ocean (but up to 75 km), especially during breeding season (Carter and Sealy 1986). In Alaska, marine habitats mostly are offshore of large tracts of old-growth coastal coniferous forest, especially Sitka spruce and hemlock (Piatt and Ford 1993, Piatt and Naslund 1995). Prefers glacial-unaffected habitats with no ice cover and sea-surface temperatures >6 d° C, water clarity 2-4 m, water depths <40 m, and areas <50 m and >150 m from shore and 251-1000 m from freshwater and icy substrates (Day et al. 2002).

At sea, murrelets tend to occupy sheltered waters of bays, fjords, and island straits and often aggregate near large river outflows or tide rips (Piatt and Naslund 1995). Species shows a strong preference for feeding in shallow water (Nelson 1997, Ostrand and Joyal 1999, Speckman 1999, Day and Nigro 2000). Foraging occurs most often in the near-shore zone, in the morning, in low ice cover, in higher temperatures, in high or low salinities, near sources of fresh water, and off certain shoreline substrates (Day and Nigro 2000). Sometimes takes advantage of episodic feeding opportunities (i.e. tidal fronts) in marine-sill-affected habitats (Day et al. 2002). In Kachemak Bay, juveniles showed a clear preference for kelp beds approximately 4 km on either side of the mouth of Seldovia Bay, contrasting sharply with adult distribution. Key components of this nursery appear to be shallow water, presence of kelp, and locally productive water (Kuletz and Piatt 1999).

Breeds in coastal forests and sea-facing talus slopes or on cliffs on islands and the mainland. Most nest in large stands of mature/old growth coniferous forest near the coast on a large mossy horizontal branch, mistletoe infection, or other structure providing a platform high in a large mature conifer (Nelson 1997). Nest sites generally have good overhead protection. See Quinlan and Hughes (1990), Singer et al. (1991), and USFWS (1996) for characteristics of tree nests. In Prince William Sound, nesting habitat features include low elevation locations near heads of bays with extensive cover of large old-growth trees (Kuletz et al. 1995, Naslund et al. 1995). Along the Kenai coast, however, heads of bays were recently deglaciated and murrelet activity was highest on outer peninsulas, where forest cover was greatest (Kuletz et al. 1995). In a survey of nest trees on Naked, Kodiak, and Afognak Islands, all nests were in old-growth forests on moss-covered platforms of western hemlock (*Tsuga heterophylla*), mountain hemlock (*T. mertensiana*) and Sitka Spruce (*Picea sitchensis*; Naslund et al. 1995).

A small percentage of the population in Alaska nests on islands on open barren ground or in rock cavities, generally a short distance below a peak or ridge (Day et al. 1983, Carter and Sealy 1986, Marshall 1988, Kuletz 1990, Carter and Morrison 1992, Nelson 1997). Ford (1995) reported a cliff-top nest in old-growth forest in southeastern Alaska. Ground nesting provides an alternative where trees are limited.

STATUS

Global rank: G3G4 (2001-01-21)
Global rank reasons:
Extensive range along the Pacific coast of North America from Alaska to California; population numbers still high in British Columbia and Alaska, but probably declining; however, abundance and trends are poorly known anywhere; threats from habitat loss due to logging, oil spills, and gill net fisheries are increasing.

State rank: S2S3 (1997-08-01, reviewed 2004-04-01)
State rank reasons:
Population large (about 280,000) but over the past twenty years has declined by 40 to 75% in centers of greatest abundance, Prince William Sound and Glacier Bay. Kenai Fjords population increasing 10% per year since 1989. Threats from habitat loss due to logging of old-growth forests. Other concerns include oil spill contamination and incidental mortality associated with gill net fisheries.

DISTRIBUTION AND ABUNDANCE

Range:
Global range:
Breeding: Breeds from the western Aleutian Islands through coastal southern and southeastern Alaska, British Columbia (up to 100 kilometers inland), Washington, and Oregon to central California (mainly Del Norte and northern Humboldt counties to 15 km inland, southcentral Humboldt County 20-40 km inland, and southern San Mateo and northern Santa Cruz counties up to 20 km inland; Carter and Erickson in Carter and Morrison 1992); few occupied sites are known between Tillamook County in Oregon and the Olympic Peninsula in Washington (USFWS 1994). See USFWS (1994) and Federal Register (10 August 1995) for maps of proposed Critical Habitat in California, Oregon, and Washington.

Non-breeding: Southern Alaska south to central California, mostly adjacent to known or suspected nesting areas. Most of the Alaskan population is concentrated offshore of large tracts of coastal coniferous forests in southeastern Alaska (Alexander Archipelago), Prince William Sound, and the Kodiak Archipelago (Piatt and Ford 1993). See Marshall (1988) and Carter and Morrison (1992) for further details for specific states and provinces.

State range:
Breeding: Breeds from the western Aleutian Islands through coastal southern and southeastern Alaska (Mendenhall 1992, Piatt and Naslund 1995, Meehan 1996, Nelson 1997, Agler et al. 1998). Although murrelets range widely in Alaska, during the breeding season they are concentrated in

three main areas: Prince William Sound, the Kodiak Archipelago, and the Alexander Archipelago (Piatt and Naslund 1995).

Non-breeding: Southern Alaska, mostly adjacent to known or suspected nesting areas. Most of the Alaskan population is concentrated offshore of large tracts of coastal coniferous forests in southeastern Alaska (Alexander Archipelago), Prince William Sound, and the Kodiak Archipelago (Piatt and Ford 1993).

Abundance:

Global abundance:

Global abundance comments:

Total population not known; estimates range from 343,000 to 1,145,000: 5000-6500 in Washington; 6600-20,000 in Oregon; 6450 in California; 50,000+ in British Columbia; and 280,000 to 1,062,000 in Alaska (Carter and Morrison 1992, Mendenhall 1992, Rodway et al. 1992, Speich et al. 1992, Piatt and Ford 1993, Piatt and Naslund 1995, Speich and Wahl 1995, Varoujean and Williams 1995, Ralph and Miller 1995, Agler et al. 1998).

State abundance comments:

The bulk of the world population breeds in Alaska, with most found in Southcentral and Southeast Alaska. The most recent estimate indicates a population of 655,000 – 1,062,000 *Brachyramphus* murrelets (*B. marmoratus* and *B. brevirostris* combined of which 95% are probably *B. marmoratus*), based on randomly distributed at-sea transects within three areas of greatest abundance: Lower Cook Inlet, Prince William Sound, and Southeast Alaska (summer 1994) (Agler et al. 1998). However, other estimates using a variety of at-sea census data suggested a population in the low 100,000s, possibly 280,000 birds (Piatt and Naslund 1995). The difference in these population estimates reflects the difficulty in censusing the species over its vast and complex marine range in Alaska (Burger 2002).

Trends:

Global trend:

Population trends: Undoubtedly declining, although rangewide rates of decline are not available. Declines are documented or suspected throughout most of the range where old-growth habitat is being removed by logging (Marshall 1988, Mendenhall 1992, Kuletz pers. com. 1992, Rodway et al. 1992, Leschner and Cummins 1992, Nelson et al. 1992, Carter and Erickson 1992). Beissinger (1995) predicts a 4 % annual decline based on a demographic model. On the southern coast of Washington, north coast of Oregon, and in California south of Humboldt County, murrelets are rare or uncommon where they once were common or abundant in the early 1900s (Ralph and Miller 1995). In British Columbia, a decline of up to 40% was recorded in Clayoquot Sound from 1982 to 1993 (Kelson et al. 1995); however at least some of this decline may be a temporary artifact of El Nino sea conditions in 1993 (A. Burger personal communication, cited in Hull 2000). In the pristine Carmanah and Walbran watersheds of southwestern Vancouver Island, a decline in detections has been noted over a nine year period (V. Bahn and A. Burger unpublished data, cited in Hull 2000). In Alaska, declines of 40-75 % over the twenty years 1972-1991 have been reported, although these estimates have been questioned by some (Klosiewski and Laing 1994, Piatt and Naslund 1995, Piatt 1998, DeGange 1996, Hayward and Iverson 1998a, b). Populations in Prince William Sound, Alaska, declined 67 % from the early 1970s to the early 1990s (Kuletz et al. 1997).

Habitat trends: Most populations dependent on large trees in old-growth forests for nest sites. Ralph (1994) estimated that 80 % of the old-growth forests within the range of this species in the Pacific Northwest had been removed over the last 150 years. The Sierra Club of Canada estimated in 1999 that 53.1 % of British Columbia's "ancient coastal rainforest" has been logged, with 41.1 % of the remainder unprotected and 5.8 % protected (Hull 2000). MacKinnon and Eng (1995) estimated that about 10% of the unlogged forest on the British Columbia coast is protected, but the proportion of unlogged forest in each ecological zone varies widely. Much of the unlogged forest on the British Columbia coast is at higher elevations and fragmented on steep slopes (Sierra Club of Western Canada 1993). The rate of cut in British Columbia has increased over the last 50 years, and the majority of cutting has occurred in the last twenty years (Sierra Club of Western Canada 1993). More than 50% of the 'high-volume old-growth' forest in the Tongass Land Management area, Alaska, is now gone, and substantial areas of potential nesting habitat have been logged elsewhere in Alaska, especially in areas where murrelet densities are highest (Mendenhall 1992, Ralph and Miller 1995, Piatt 1998).

State trend:
In Alaska, declines of 40-75 % over the twenty years 1972-1991 have been reported, although these estimates have been questioned by some (Klosiewski and Laing 1994, Piatt and Naslund 1995, DeGange 1996, Piatt 1998). Populations in Prince William Sound, declined by 63 to 67 % from the early 1970s to the early 1990s; from approximately 300,000 in 1972 to 100,000 between 1989 and 1991 (Klosiewski and Laing 1993, Kuletz et al. 1997, Agler et al. 1999). A minimum of 8,400 *Brachyramphus* murrelets were killed directly by exposure to oil after the *Exxon Valdez* Oil Spill in Prince William Sound, 1989. As of 2001, summer populations showed no sign of recovery (Lance et al. 2001). Along the Kenai Peninsula, Marbled Murrelet populations declined by about 62 % during 1976-1989, but then grew five-fold by 2002 (Van Pelt and Piatt 2003). In Glacier Bay, populations declined by as much as 75 % between 1991 and 1999-2000 (Robards et al. 2003).

EXISTING PROTECTION

Global protection:
Protected under the Migratory Bird Treaty in the United States and Canada and also under the Endangered Species Act in the United States. It is federally listed as a Threatened species in Washington, Oregon, and California and is a former candidate species (Category 2) in Alaska (USFWS 1992a, b). The status of the Alaska population is currently under review (Robards et al. 2003).

The U.S. Fish and Wildlife Service (1996) designated Critical Habitat in Washington, Oregon, and California. The National Audubon Society recently purchased habitat in Oregon along Tenmile Creek, an area that supports the largest concentration of Marbled Murrelets in that state (Ehrlich et al. 1992).

Protected under the federal Species at Risk Act (SARA) in Canada. In British Columbia, the Marbled Murrelet is a "Red" listed species (candidate for official extirpated, endangered or threatened status in BC; Fraser et al. 1999).

State protection:
Protected under the Migratory Bird Treaty in the United States and Canada. A former Category 2 candidate, the status of the Alaska population is currently under review (Robards et al. 2003).

Recently, large tracts of land have been preserved with funds from the *Exxon Valdez* Oil Spill Council; these are primarily areas of old-growth forests with large trees near coastlines where murrelets are abundant and include 23,800 acres of state park inholdings in Kachemak Bay, 17,166 acres on Seal Bay and 24,383 acres on Tonki Cape, Afognak Island, and timber rights near Orca Narrows in Prince William Sound (Kuletz 1997). Narrow strips of coastal old-growth forest are protected in national and state parks, including approximately 40,000 ha in Glacier Bay National Park, 24,000 ha in Kenai Fjords National Park, 20,000 ha in Wrangell-St. Elias National Park and Preserve, and 40,000 ha in Kachemak Bay State Park (Mendenhall 1992).

CHALLENGES

Global challenges:
Continued harvest of old-growth and mature coastal coniferous forest that reduces critical nesting habitat is a major concern throughout most of the range (Sealy and Carter 1984, Marshall 1988, Mendenhall 1992, Rodway et al. 1992, Leschner and Cummins 1992, Nelson et al. 1992, Carter and Erickson 1992, Carter and Morrison 1992; see also Rodway 1990 COSEWIC report). This species is also highly susceptible to offshore oil spills and marine pollutants (King and Sanger 1979, King 1984, Sealy and Carter 1984, Mendenhall 1992, Rodway et al. 1992, Leschner and Cummins 1992, Nelson et al. 1992, Carter and Erickson 1992) and incidental mortality associated with gill net fisheries (Sealy and Carter 1984, Wynne et al. 1991). The gill-net threat is greatest north of Oregon (Levy 1993). Other threats include direct and indirect mortality associated with the location and operation of mariculture facilities. These threats include: entanglement, displacement of birds from traditional foraging areas, contamination of foods by antibiotics, antifoulants, and alteration of local food supplies due to decomposition of fish food and fish excrement associated with these farms (Vermeer and Morgan 1989, Rodway et al. 1992, Leschner and Cummins 1992). Murrelets in some areas may also be subject to high levels of industrial pollutants (Fimreite et al. 1971, Rodway et al. 1992). Listed populations are currently experiencing very low recruitment rates, due at least in part to nest predation (by edge species that are now more abundant due to forest fragmentation) and probably high mortality in young prior to reaching the ocean (USFWS 1994, 1996). Populations in the Aleutians may have been higher before foxes were introduced there (Mendenhall in Carter and Morrison 1992).

State challenges:
Loss of old growth breeding habitat: One of the most significant factors affecting Marbled Murrelet populations in Alaska is reduction in the availability of nesting habitat as a result of logging of old-growth and mature coastal forests (Kuletz pers. comm.1992, Mendenhall 1992). Coastal forests stretch from the southeastern tip of Alaska to the base of the Alaska Peninsula and northern Kodiak Island (Mendenhall 1992). More than 50 % of the “high-volume old growth” forest in coastal Southeast Alaska coastal has been removed by logging, and substantial areas of potential nesting habitat have been logged elsewhere in Alaska, especially in areas where murrelet densities are the highest (Mendenhall 1992, Piatt 1998).

In southcentral Alaska, there has recently been a rapid loss of large spruce (*Picea* spp.) trees due to infestation by spruce beetles (*Dendroctonus rufipennis*). Spruce trees on about 3 million acres of mature forest have been killed. Some affected forests are known or probable murrelet nesting habitat including coastal areas of Cook Inlet, Kachemak Bay, the Kenai Peninsula, and northern Southeast Alaska. In Kachemak Bay, beetle infestation has caused upwards of 90% mortality of coastal old growth stands, with an apparent reduction in murrelet productivity (Kuletz 1997, Piatt 1998).

Disturbance-induced predation: Increased predator abundance at forest edges and in stands fragmented by logging is of concern (Rodway and Regehr 2002). This species suffers the highest nesting failure of any alcid, largely due to predation (Piatt and Naslund 1995, Nelson 1997). Nest predators include Common Ravens (*Corvus corax*) and Steller's Jays (*Cyanocitta stelleri*) (Nelson 1997). Changes in forested habitat, such as increased amount of edge, may affect productivity by increasing the nest's risk to predation. Because this species has a low reproductive rate (one egg clutch), small increases in predation may have large deleterious effects on population (Nelson and Hamer 1995). Populations in the Aleutians may have been higher before foxes were introduced there (Mendenhall 1992).

Contamination from oil or other substances: Murrelets are vulnerable to offshore oil spills and marine pollutants (Mendenhall 1992, DeGange 1996, Nelson 1997). The 1989 *Exxon Valdez* oil spill in Alaska caused the largest single mortality of murrelets (about 8,400 birds) in the world and contributed to a decline in murrelet populations in Prince William Sound (Carter and Kuletz 1995); as of 2001, summer populations showed no sign of recovery (Lance et al. 2001). Tanker routes in Prince William Sound, Cook Inlet, and offshore of southeastern Alaska, and offshore oil development in Cook Inlet and the Gulf of Alaska have potential for impact (Mendenhall 1992).

Loss to fishing bycatch: Salmon gill-net bycatch of murrelets in Alaska is about 3,300 birds annually; this represents 1.7 % of the Alaska population killed on an annual basis (Carter and Kuletz 1995, Fry 1995, Piatt and Naslund 1995). The approximate distribution of murrelet mortality is: 1,100 birds in Lower Cook Inlet, 1,000 birds in Prince William Sound, 300 on the Alaska Peninsula, and 900 in Southeast Alaska. More than 80% are killed at night (Carter et al. 1995).

Disturbance by vessel traffic: Disturbance can disrupt feeding birds and persistent boat traffic may prevent murrelets from using important foraging areas (Piatt and Naslund 1995). Marbled Murrelets have been documented consuming prey reserved for chicks when disturbed by skiff traffic (Speckman et al. 2004). Increasing activity by fishing, commercial, tourist and private boats in areas known to be important to murrelets (e.g. Glacier Bay National Park, Prince William Sound, Kenai Fjords National Park, and Kachemak Bay) may have long-term implications for murrelet populations in Alaska (Piatt and Naslund 1995).

RESEARCH AND INVENTORY NEEDS

Global research needs:
Detailed studies are needed regarding ecological requirements, habitat use patterns and existing and potential threats. Much of this work is ongoing (see Ralph et al. 1989, Kuletz 1990, 1991, pers.

comm. 1992, 1992, Kuletz et al. in prep., Carter and Morrison 1992) and is coordinated by the Pacific Seabird Group Marbled Murrelet Committee (Leschner 1990, Carter and Morrison 1992).

State research needs:
Detailed studies are needed regarding ecological requirements, habitat use patterns, and factors that limit population growth in terrestrial and marine habitats. The effects of habitat fragmentation and increasing forest edge on Marbled Murrelet population density needs study (DeGange 1996). Research is needed to determine distribution and abundance of prey species, including effects of physical and biological ocean processes on prey availability (Nelson 1997). Annually assess the impact of bycatch in commercial fisheries. Determine other factors of human-caused mortality at sea (Nelson 1997). Develop appropriate and consistent methods for at-sea sampling (Nelson 1997).

Global inventory needs:
Continue inventory of nesting locations, populations, and preferred foraging areas throughout the range.

State inventory needs:
Monitor populations at sea to determine size, trends, productivity, and distribution (Kuletz 1997, Nelson 1997). Conduct surveys annually or bi-annually at index locations, Southeast Alaska, Kodiak Island, Cook Inlet, and Prince William Sound to assess population trends. Survey forested habitat to identify nesting areas, especially in Southeast Alaska (Nelson 1997). Locate primary breeding areas and obtain more accurate estimates of total numbers. Develop baseline information on murrelet numbers and distribution for assessment of oil impact and develop ways to improve documentation of post-spill damages (Nelson 1997).

CONSERVATION AND MANAGEMENT NEEDS

Global conservation and management needs:
Protect critical old-growth nesting and feeding areas; increase response capability against oil spills; monitor gill net takes and regulate harvests to minimize murrelet mortality; prevent pollution of feeding areas; prevent displacement of murrelets from historic foraging areas by disturbance and development.

See U.S. Forest Service (1993), Thomas et al. (1993), and USFWS (1994) for discussions of management issues.

State conservation and management needs:
Maintaining adequate nesting habitat remains the most direct means of preventing further declines in murrelet numbers (Kuletz 1997). Identify and protect nesting areas and offshore feeding areas. Prevent displacement of murrelets from historic foraging areas by disturbance and development.

Efforts should be made to reduce mortality associated with gill net fisheries. Declining populations of Marbled Murrelets in Alaska cannot sustain the high levels of mortality that occur in fishing nets. Seasonal or temporal gill net fishery closures in high concentration zones would reduce murrelet bycatch (Carter et al. 1995), but other methods such as baited deterrents have been shown to eliminate bycatch in longline fisheries (Melvin et al. 2001), and may be a more acceptable

solution.. Observer coverage should be increased in order to document the actual extent of bycatch (Center for Biological Diversity 2001).

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