Online Resource 1

Status of the Pacific walrus (*Odobenus rosmarus divergens*) in the 21st century; Polar Biology, C V. Jay, B G. Marcot, and D C. Douglas; e-mail of corresponding author: cjay@usgs.gov

Table 1 Title and description of input, intermediate, and output nodes used in a Bayesian network model of Pacific walrus status (unless otherwise indicated, the same states were used for all three seasons in the model)

Node title	**Node description**	**States**	
Input Nodes			
Ice-free months	Mean number of months within a season with no sea ice to support walruses for hauling out over the continental shelf of the Chukchi and Bering Seas.	(Summer/Fall)	(Winter)
		0.0 to 0.5	0.0 to 0.5
		0.5 to 2.0	0.5 to 2.0
	See methods section in the main text for a description of how the input probabilities were calculated for this node.	2.0 to 3.5	2.0 to 4.0
		3.5 to 5.0	
		(Spring)	
		0.0 to 0.5	
		0.5 to 2.0	
		2.0 to 3.0	
Chukchi Sea ice cover	Extent of sea ice in the Chukchi Sea, expressed as a percentage of the Chukchi Sea shelf within the study area.	90-100%	
		70-90%	
	See methods section in the main text for a description of how the input probabilities were calculated for this node.	30-70%	
		10-30%	
		0-10%	

Bering Sea ice cover	Extent of sea ice in the Bering Sea, expressed as a percentage of the Bering Sea shelf within the study area. See methods section in the main text for a description of how the input probabilities were calculated for this node.	90-100% 70-90% 30-70% 10-30% 0-10%
Climate change on benthos	Cumulative impact of various factors related to climate change on the production of benthic prey. Reduced sea ice and ocean acidification are assumed to potentially have the greatest influence on benthic prey production. *Sea ice:* The northern Bering and Chukchi Seas sustain some of the highest benthic faunal soft-bottom biomass in the world oceans. Productivity and structure of benthic communities vary regionally with benthic food supply, depth, substrate type and grain size, salinity, temperature, predation, and physical disturbances to the seafloor. Benthic biomass is primarily determined by the quantity and quality of benthic food supply, which originates mainly from the overlying water column (Grebmeier et al. 2006a; Bluhm and Gradinger 2008). In seasonally ice-covered waters, such as the Chukchi and Bering seas, ice algae contributes 4-26% to primary production (Bluhm and Gradinger 2008), but perhaps more significantly, the onset of sea ice melt and duration of open water plays an important role in the stability of the water column, and the timing and location of primary production and associated grazing by zooplankton. This has a direct influence on the relative amounts of organic carbon retained in the water column and exported to the sediments (Grebmeier et al. 2010). High primary production, with simultaneously low zooplankton grazing, results in much of the organic matter sinking to the seafloor and enhancing benthic production (Grebmeier and Barry 1991). While there is evidence that greater areas of open water and a longer growing season may lead to increased primary production in Arctic waters (Arrigo et al. 2008), the biological processes that govern regional production are complex, and therefore, the effect of future sea ice losses on primary production in the Chukchi and Bering seas is uncertain (Grebmeier et al. 2010). Reductions in sea ice has the potential to reduce benthic production and increase pelagic consumption in Arctic marine ecosystems; however, detailed biological consequences of	positive neutral negative

reduced sea ice are difficult to predict and depend on regional productivity conditions (Piepenburg 2005; Grebmeier et al. 2006a; Grebmeier et al. 2006b; Lalande et al. 2007; Bluhm and Gradinger 2008).

Ocean acidification: Increased loading of atmospheric CO2 is partially responsible for losses of sea ice, but has additionally caused increased carbon loading in the oceans (Meehl et al. 2007). Approximately one-third of the anthropogenic CO_2 produced in the past 200 years has been assimilated by the oceans (Sabine et al. 2004). When carbon dioxide dissolves in sea water it forms carbonic acid, which decreases the amount of calcium carbonate available to marine invertebrates to construct shells or exoskeletons. The average pH of the oceans could fall by 0.5 units (equivalent to a three-fold increase in the concentration of hydrogen ions) by the year 2100 if global emissions of anthropogenic CO_2 continue to rise on current trends (The Royal Society 2005). Calcified adult and larval marine organisms differentially incorporate into their structures the carbonate minerals aragonite (reef-building corals and planktonic pteropod and heteropod molluscs), calcite (coccolithophores, foraminiferans, crustaceans, and echinoderms), and magnesium-bearing calcite (coralline algae). Non-planktonic mollusc shells consist of layers of either all aragonite or inter-layered aragonite and calcite (The Royal Society 2005; Feely et al. 2009). Aragonite and magnesium-bearing calcite are at least 50% more soluble in seawater than calcite, suggesting that organisms that form these types of $CaCO_3$ structures may be particularly affected by increasing levels of CO_2 (Feely et al. 2009). Organismal responses to ocean acidification are likely to vary across species and life stages and include shell dissolution, reduced rates of calcification, growth, and metabolism, and increased mortality in molluscs or reduced fertility for a number of groups (Steinacher et al. 2009). If present trends in anthropogenic CO_2 loading of the oceans continue for the next several hundred years, it is expected that regions of aragonite undersaturation, followed by calcite undersaturation, will develop in the northern subarctic surface waters. These undersaturations are expected to occur first in the winter season, when pCO_2 values are highest because of cold temperatures and wind-driven mixing of subsurface waters into the mixed layer (Feely et al. 2009). Forecasts are uncertain for saturation levels in the Chukchi Sea, Canada Basin, and broader Arctic Ocean because of challenges in predicting future changes in sea ice cover, temperature, stratification and nutrient supply, freshwater inputs of water and organic carbon, and complex physical and biological feedbacks in the region (Bates et al. 2009). Few manipulative

	experiments have been carried out to determine the sensitivity of elevated pCO_2 on marine organisms and their physiological processes. Currently, our understanding of the biological effects of ocean acidification is in its infancy and its long-term consequences on marine ecosystems are speculative (Orr et al. 2005; Guinotte and Fabry 2008). The magnitude and timing of the effects of reduced sea ice and ocean acidification on the abundance and distribution of benthic prey of walruses are difficult to predict. Because these influences are likely to be widespread and chronic, we did not assign different input probabilities by season. Changes to benthic production are expected, and are likely to be negative with decreasing sea ice (decreased benthic-pelagic coupling of primary production) and increasing ocean acidification. Differences in sea ice projections between A1B and A2 GHG scenarios are small. No ocean acidification projections are available that contrast these two GHG scenarios; however, the influence of increasing acidification to benthic prey may be greater for A2 because of projected greater CO_2 loading in the oceans. We assigned slightly higher input probabilities towards the negative state under the A2 scenario than the A1B scenario. Also, we assigned increasingly higher probabilities towards the negative state through the century.	
Resource utilization	Impact to benthic prey production from activities that can perturb the seafloor from extraction of natural resources, such as from commercial fishing and oil and gas development. The effect of perturbations to benthic communities is likely dependent on the magnitude, type, and frequency of the perturbation. These factors will be related to the level of resource utilization in an area. It is possible that perturbation to the seafloor at a low magnitude and frequency could enhance production by releasing nutrients from sediments and by allowing increased recruitment of juvenile organisms. Higher levels of perturbation could be detrimental to benthic communities from habitat degradation and high mortality of benthic organisms. Future summer sea ice losses, and associated increase in number of ice-free days during summer and fall, are likely to lead to future increases in fishing and resource development activities in the Chukchi and Bering seas, including activities that impinge on the seafloor. These activities will be affected by	positive neutral negative

	the abundance of sea ice, but perhaps even more so from changes in human population size. The A2 scenario assumes a population size of 15 billion by 2100, whereas the A1B scenario assumes a maximum population size of 9 billion by 2050. We assigned different input probabilities by season. For the summer season we assigned increasingly higher probabilities towards the negative state. For winter, ice is expected to form throughout the century, thus, hampering resource development and fisheries activities during this season, so probabilities were assigned more heavily toward the neutral state for winter. For spring, input probabilities were set somewhat between values assigned for summer and winter. Differences in human population sizes assumed for the A1B and A2 GHG scenarios and slight differences in sea ice extent between the two scenarios were considered in assigning the probabilities across periods. We assigned increasingly higher probabilities towards the negative state through the century.	
Ship and air traffic	Amount of ship and air traffic from commercial shipping, tourism, and fishing, and oil and gas development. Future sea ice losses, and associated increase in number of ice-free days during summer and fall, are likely to lead to increased ship traffic in the Chukchi and Bering seas (Arctic Council 2009). Most shipping in the Arctic today is destinational, moving goods into the Arctic for community re-supply or moving natural resources out of the Arctic to world markets. A prolonged open water season along the Northern Sea Route (northern Eurasian coast from Novaya Zemlya to the Bering Strait) and Northwest Passage (northern North American coast and through the Canadian Arctic archipelago) will likely lead to a competitive advantage to shipping through these sea routes over the traditional Europe-Asia route through the Suez or Panama Canals by the middle of the 21st century (Khon et al. 2010). Offshore oil and gas exploration and development north of the Bering Strait region in the Chukchi and Beaufort oil and gas lease sale areas could plausibly increase the numbers of support and supply ships transiting through the Bering Strait and into these areas. Ship traffic from commercial fishing is currently restricted to the southern areas of the Bering Sea, because regulations in the U.S. Arctic Fishery Management Plan prohibit commercial fisheries in the Beaufort and Chukchi seas until sufficient information on the Arctic marine environment is available to sustainably manage commercial fishing in these northern waters (National Oceanic and Atmospheric Administration 2009). Potential interactions	low moderate high

	between ship traffic and marine mammals include ambient and underwater ship noise, ship strikes, entanglement in marine debris, and pollution (including oil spills) (Arctic Council 2009). Potential pollution sources include release of grey water, sewage, ballast, and bilge water, air emissions, and accidental discharge of fuel and oil. Of these, perhaps the most significant threat from ships to Arctic ecosystems is the release of oil through accidental or illegal discharge with immediate and long-term consequences (Arctic Council 2009). Exploration and development of new Arctic natural resources are highly probable, but occur in continually changing and very complex physical, economic, social, and political environments. The high level of uncertainty associated with the interaction of these factors lead to great difficulty in predicting Arctic marine shipping activities in the future (Arctic Council 2009). We assigned different input probabilities by season. Spring, and particularly summer, are likely to be affected most by ship and air traffic with decreasing sea ice. Winter ice is expected to form throughout the century. Ship and air traffic is somewhat low now in summer and spring and almost absent in winter. Ship and supporting air traffic is expected to increase in spring and summer as areas become increasingly ice free in future periods, especially the Northern Sea Route and Northwest Passage (Arctic Council 2009). We assigned input probabilities to reflect these differences. Also, similar to our assignment of input probabilities to Resource Utilization, we considered differences in human population sizes assumed for the A1B and A2 GHG scenarios and slight differences in sea ice extent between the two scenarios in assigning probabilities across periods. We assigned increasingly higher probabilities towards the high state through the century.	
Human settlements	Density of humans along the coasts of Alaska and Russia. We expect this to be related to the amount of exposure walruses would receive at terrestrial haul-outs along the coast and nearshore from humans and concomitant development activities associated with settlements. With increasing resource development and tourism, milder winters, decreasing sea ice, and overall increase in world population, some increase in the number and size of coastal settlements might be expected. We did not assign different input probabilities by season. We assigned input probabilities to the current and near future periods	low medium high

	to reflect low levels of human settlements, and assigned probabilities increasingly toward the medium state thereafter through the century. We assigned slightly higher probabilities toward the medium and high states under the A2 GHG scenario than the A1B scenario to account for the higher human population size assumed for A2.	
Subsistence harvest	Number of walruses killed by Native subsistence hunting in Russia and Alaska. In our model, levels of subsistence harvest and incidental takes are gauged relative to sustainable levels of removal from the population. We considered low and moderate harvest levels to be below a sustainable level of removal, and high and very high harvest levels to be above a sustainable level of removal. Most walrus harvest occurs in spring. Harvest levels that might be expected in future periods are speculative. It is possible that spring hunting in the Bering Strait region may become more difficult because of increases in open water and increased rates of ice melt, so we assigned a moderate level of walrus harvest for spring through the end of century. Harvest in the summer/fall season could increase due to greater access to walruses when they haul out on shore in fall in the absence of offshore sea ice, so we assigned a moderate harvest for summer/fall through the end of century. Harvest is typically low in winter and sea ice conditions in this season are projected to change only slightly through the century, so we assigned a low level of harvest for winter through the end of century. Assigning a constant state of harvest through the end of century implies that harvest levels will vary with population size. For the two observation periods (1984 and 2004), we estimated low, moderate, high, and very high harvest levels in our model in the following way. Marine mammal stock assessments typically apply an estimation of potential biological removal (PBR), where PBR = Nmin*0.5Rmax*Fr, and Nmin = minimum population size, Rmax = maximum theoretical net productivity rate, and Fr represents a species-specific recovery factor (Wade and Angliss 1997). From an individual age-based population model, Chivers (1999) estimated an Rmax of 8% for the Pacific walrus. We considered Rmax values of 1%, 4%, 8%, and 12% to represent low, moderate, high, and very high rates of productivity, and PBRs calculated from these values formed the upper bounds of	low moderate high very high

our low, moderate, high, and very high states of harvest in our model. No Pacific walrus stock assessment is available for the 1984 observation period. During this period, two separate surveys estimated the size of the Pacific walrus population at over 200,000 walruses (U.S. Fish and Wildlife Service 2010). Also, the pre-exploitation size of the Pacific walrus population has been estimated at 200,000 animals (Fay 1982). Furthermore, there is evidence that the population was near carrying capacity by the 1980s (Fay et al. 1997; Garlich-Miller et al. 2006). Therefore, for the 1984 observation period, we assumed an Nmin of 200,000 walruses and Fr of 1.0. These values, and the four Rmax values above, result in PBRs of 1,000, 4,000, 8,000, and 12,000 walruses. For the 2004 observation period, we used an Nmin of 129,000 walruses and Fr of 0.5, the same values used in the most recent Pacific walrus stock assessment (U.S. Fish and Wildlife Service 2010). These values result in PBRs of about 325, 1,300, 2,600, and 3,900 walruses.

The Pacific walrus is harvested for subsistence by Alaskan and Russian Native communities. Estimates of walrus harvest levels from 1960 through 2007 range from 3,184 to 16,127 walruses per year (U.S. Fish and Wildlife Service 2010), which includes adult and juvenile walruses (Fay and Bowlby 1994). Estimates of current harvest levels are 4,960-5,457 walruses per year (2003-2007 harvest records). Factors affecting recent harvest levels include cessation of Russian commercial harvests after 1991, changes in political, economic, and social conditions of subsistence hunting communities in Alaska and Russia, and the effects of variable weather and ice conditions on hunting success (U.S. Fish and Wildlife Service 2010).

Walrus harvest estimates for the two observation periods (1984 and 2004) were provided by USFWS, Marine Mammals Management Office, Anchorage, Alaska. Estimated harvest for each period is the mean annual harvest. Total harvest in Russia and the U.S. is not available by season, so mean harvest by season was estimated by calculating the proportion of walruses harvested by season from monthly Gambell and Savoonga harvests in 1989-2008, and multiplying these proportions by total population harvest.

Differences in sea ice projections between the A1B and A2 GHG scenarios are slight, so we assigned the same input values for both scenarios. Due to the coarseness of the levels within the subsistence harvest node, we did

	not assign a spread of probabilities across states, rather we included subsistence harvest in one of several influence runs of the BN model (see main text).	
Incidental takes	Number of walruses killed from illegal activities and incidentally from fishing, industry, and research activities in Russia and Alaska. Current walrus mortality rates from fisheries interactions and other known human activities are estimated at about 3 walruses per year (U.S. Fish and Wildlife Service 2010) and typically have been low in the past. It is probable that decreasing sea ice will lead to increased shipping, oil and gas exploration, tourism, and research activities, which could result in a greater number of incidental takes in future years, although we expect the level of take to remain in the low category (below 1,000 walruses). We assigned a low level of incidental takes to all seasons and periods. As described for subsistence harvests, differences in sea ice projections between the A1B and A2 GHG scenarios are slight, so we assigned the same input values for both scenarios.	low moderate high very high
Intermediate Nodes		
Suitable ice extent	Potential range of walrus movements and occupancy in the Chukchi and Bering Seas as a function of the nodes "Chukchi Sea ice cover" and "Bering Sea ice cover". Walruses are not able to penetrate and effectively utilize areas with very high ice concentrations, such as current conditions in the Chukchi Sea where ice concentrations of > 90% commonly occur in winter. Similarly, very low ice concentrations are likely to restrict offshore walrus movements and distribution. There is considerable uncertainty as to the lower threshold of sea ice needed to sustain walruses offshore. From radio-tracking studies, walruses have been observed using very sparse, remnant ice during summer in the Chukchi Sea (Jay and Fischbach 2008), although it probably restricts their movements compared to times when more sea ice is available. Although ice concentration is not the same as ice extent in the Chukchi and Bering seas, we used percent ice extent in the two seas as a proxy to the probability of suitable ice for walruses	sufficient both seas sufficient one sea insufficient both seas

	in each sea. For each percent ice extent in each sea (parent nodes), we assigned a probability that the ice extent was suitable for walruses. Then we used these probabilities to directly calculate sufficiency of ice in each sea for each combination of percent ice extent in the Chukchi Sea and percent ice extent in the Bering Sea. For example, we assigned a probability of 0.70 that 70-90% ice in the Chukchi Sea is sufficient for walruses, and a probability of 0.90 that 90-100% ice in the Bering Sea is sufficient for walruses. From this, the calculated probability for the three states of “suitable ice extent” is 0.70*0.90 = 0.63 for sufficient in both seas, 0.30*0.10 = 0.03 for insufficient in both seas, and 1-(0.63 + 0.03) = 0.34 for sufficient one sea.	
Abundance stressors	Stressors to the abundance of the Pacific walrus population as a function of the nodes “body condition” and “total mortality” (and “breeding environment” in the winter submodel, and “birthing platform” in the spring submodel). Body condition reflects the level of individual fitness and is expected to have an impact on walrus reproduction and survival. For example, a decrease in body condition in the population could lead to decreased juvenile survival, decreased birth rate, and an increase in age of sexual maturity. Mortality of females might constitute a greater loss or reproductive potential in the population than changes in body condition, so we weighted “total mortality” to have more influence on abundance stressors than “body condition” when we assigned probabilities. In the winter submodel, “breeding environment” was weighted to have less influence on abundance stressors as “body condition” when we assigned probabilities. In the spring submodel, “birthing platform” was weighted to have an equal influence on abundance stressors as “body condition” when we assigned probabilities.	low stressors moderately low stressors moderately high stressors high stressors
Shelf ice availability	Availability of sea ice to walruses for hauling out during the season as a function of the nodes “ice-free months” and “suitable ice extent”. This reflects two important aspects of sea ice relative to its availability to walruses for hauling out. One is the amount of time no sea ice is present over the shelf (number of “ice-free months”), and hence, the amount of	excellent good fair poor

	time walruses are forced to use terrestrial haul-outs. The second is the extent of sea ice that is available to walruses. Reduced ice extent over the shelf, such as the remnant ice that has occurred in late summer over the Chukchi Sea shelf in recent years, could affect the distances required for walruses to travel to reach favorable benthic foraging areas. We weighted “ice-free months” to have more influence on shelf ice availability as “suitable ice extent” when we assigned probabilities. We also assigned probabilities such that the greatest change in probabilities among combinations of states occurred between the states of 0.0-0.5 and 0.5-2.0 in “ice-free months”.	
Benthic prey abundance	Abundance of benthic prey as a function of the nodes “climate change on benthos”, “resource utilization”, and “oil spills”. Benthic prey abundance can be affected by oil spills directly by fouling benthic organisms or indirectly by causing decreased production in the water column, thereby resulting in less food fall to the benthos. Potential effects on benthic prey abundance from “climate change on benthos” and “resource utilization” are described above under their respective node descriptions. We weighted “climate change on benthos” to have more influence on benthic prey abundance as “resource utilization” or “oil spills” when we assigned probabilities. We assumed that the effects from “climate change on benthos” will be more widespread and have a larger overall effect on prey density than “resource utilization” and “oil spills”.	high moderate low
Energy expenditure	Energy expended by walruses on foraging and swimming as a function of the nodes “shelf ice availability” and “benthic prey abundance”. As benthic prey becomes less abundant, or shelf ice is less extensive to provide access to large areas of the continental shelf for foraging, walruses may spend more time swimming to locate and forage on prey patches. This might be especially true when walruses (particularly females and young) are forced to use terrestrial haul-outs when ice is completely unavailable over the shelf. Walruses might also spend considerable effort swimming in open, rough seas compared to swimming in seas dampened by sea ice. At high levels of benthic	low medium high

	prey abundance, we weighted “shelf ice availability” to have more influence on energy expenditure as “benthic prey abundance” when we assigned probabilities. At low levels of benthic prey abundance, a slightly lesser weight was applied to reflect the decreasing relative influence of ice availability on energy expenditure with diminishing prey abundance.	
Disease and parasites	Incidence of disease and parasites in the walrus population as a function of the node “shelf ice availability”. High levels of disease or parasites could cause a substantial loss of stored energy in individual. The incidence of disease and parasites have not been observed to have been particularly high in walruses, but disease and parasites might be expected to increase with poorer ice availability and a more restricted distribution of walruses. Probabilities of disease and parasites were assigned to shift mostly from low towards moderate with decreasing levels of “shelf ice availability”.	low moderate high
Oil spills	Regularity and severity of hydrocarbons released into the water as a function of the node “ship and air traffic”. Regulatory mechanisms may keep chances of regular and severe oil spills from reaching high levels, even at high ship traffic levels. Probability assignments for this node are highly speculative because they depend greatly on technology and policy. This node is not just an oil and gas extraction node, but is meant to account for all sources of ship traffic. With regards to oil production in the Chukchi Sea, the U.S. Minerals Management Service (MMS) predicted a < 10% chance that commercial fields will be leased, drilled, discovered, and developed in the Chukchi Sea; however, they noted that industry groups could have a much different view of oil potential (U.S. Minerals Management Service 2007, pg. IV-7). MMS also predicted a 40% chance of large oil spills occurring over the life of oil development (U.S. Minerals Management Service 2007, pg. IV-2). This suggests a less than 4% chance that commercial oil fields will be developed and large oil spills will occur during oil production in the Chukchi Sea in the future. Probabilities of oil spills were assigned to shift mostly from low towards moderate with increasing levels of “ship and air traffic”.	low moderate high

Body condition	Amount of body reserves possessed by animals in the population, particularly in the form of fat and muscle, as a function of the nodes "energy expenditure", "disease and parasites", and "oil spills". Contaminants from oil spills can affect walrus body condition through direct contact of oil with individuals or indirectly from its bioaccumulation through the food chain and into walrus prey. Although oil spills might influence a smaller segment of the walrus population than influences from walrus energy expenditure and disease and parasites, its influences could be high within those segments. Walruses are not as geographically confined as are many nearshore species and would be expected to be able to move away from a pollution source to some degree. Disease and parasites could have an influence on body condition throughout large segments of the population, particularly under crowding conditions. The effects from "disease and parasites" and "oil spills" could have a larger influence than "energy expenditure" on the walrus population, so we weighted each of the two nodes to have more influence on body condition as "energy expenditure" when we assigned probabilities. Combinations of moderate-moderate, moderate-high, and high-high "disease and parasites" and "oil spills" were weighted further because those combinations may result in an even greater and prolonged influence on body condition than other combinations.	high medium low
Predation and associated mortality	Number of walruses killed by predators (excluding humans), which are primarily polar bears and killer whales, as a function of the node "shelf ice availability". This includes the potential of walruses being killed indirectly from the predator, such as causing a herd to stampede, which can lead to mortalities from trampling (Kavry et al. 2008; Kochnev et al. 2008, A. Kochnev, pers. comm. 2009). In some circumstances, such as at Wrangel Island, polar bear predation can increase with increasing numbers of walruses using terrestrial haul-outs (Ovsyanikov et al. 2008). Probabilities were assigned to reflect a moderate level of uncertainty in the response of predation to shelf ice availability. They were assigned to shift mostly from low towards high with decreasing levels of "shelf ice availability".	low moderate high
Haul-out	Level of disturbances to hauled out walruses on ice, and particularly, on terrestrial haul-outs as a function of	low

disturbance	the nodes “ship and air traffic”, “human settlements”, and “human-caused direct mortality”. Haul-out disturbances might increase with levels of ship and air traffic, human settlements near haul-outs, and from human-caused direct mortality. We considered human-caused direct mortality to be a more severe disturbance because they are more invasive than disturbances from human settlements and ship and air traffic. We weighted “human-caused direct mortality” to have more influence on haul-out disturbance as “human settlements” and “ship and air traffic” during ranking of the parent node state combinations.	moderate high
Crowding	Number of walruses at a haul-out as a function of the node “shelf ice availability”. Crowding is particularly relevant to juvenile survival when disturbances occur and animal stampedes ensue at terrestrial haul-outs and possibly at large haul-outs on ice floes during much reduced sea ice concentrations. Walruses are very gregarious and most often haul out in very close contact with one another, even when sufficient room exists to spread out. High crowding conditions were observed on terrestrial haul-outs during very poor ice conditions in summer in 2007 and 2009 (Kavry et al. 2008; Kochnev et al. 2008, A. Kochnev, pers. comm. 2009). High levels of crowding on offshore ice have also been observed from opportunistic sightings from ship and aircraft during low levels of shelf ice availability in summer/fall (e.g. an offshore C130 flight by the USGS polar bear crew in fall 2008, S.C. Amstrup, pers. comm.). We assigned probabilities that shift from low towards high crowding with decreasing “shelf ice availability”.	low moderate high
Crowding and disturbance	Intensity of a disturbance on a haul-out as a function of the nodes “crowding” and “haul-out disturbance”. The intensity of disturbances on haul-outs is expected to increase with the level of walrus crowding and the frequency and magnitude of disturbances on the haul-out. We weighted “crowding” and “haul-out disturbance” to have equal influence on crowding and disturbance when we assigned probabilities.	low medium high
Human-caused	Total number of walruses directly killed by humans in Russia and Alaska as a function of the nodes	low to moderate

direct mortality	“subsistence harvest” and “incidental takes”. We used numerical ranges for each state as was prescribed for “subsistence harvest” and “incidental takes”, except we combined the low and moderate states into a single state for this node (low to moderate). Probabilities were assigned across the human-caused direct mortality states based on the amount of overlap of the lowest possible combined take and highest possible combined take for “subsistence harvest” and “incidental takes” with the levels of take under human-caused direct mortality. For example, the lowest and highest possible combined take from a moderate level of take (1000-4000) from “subsistence harvest” and low level of take (0-1000) from “incidental takes” would be 1000 and 5000, respectively. For this combination, we assigned a probability of 0.75 for the low to moderate state (i.e. 0.75 of the range of combined possible take was within the range of the low to moderate state), 0.25 for the high state, and 0.00 to the very high state.	high very high
Total mortality	Total number of walruses killed as a function of the nodes “predation and associated mortality”, “crowding and disturbance” and “human-caused direct mortality”. We weighted “human-caused direct mortality” to have more influence than “crowding and disturbance”, and both to have more influence on total mortality as “predation and associated mortality” when we assigned probabilities.	low moderate high
Breeding environment (node in winter submodel only)	Adequacy of ice habitat for breeding as a function of the node “shelf ice availability”. Breeding occurs in January-February. Leks are formed where breeding males display and vocalize from water alongside groups of females hauled out on sea ice to entice the females into the water to mate (Fay 1985). Little is known of ice preferences for breeding behaviors; however, walruses require ice floes large enough to support their weight (Fay 1982; Simpkins et al. 2003). We assumed that if ice becomes unavailable in the Bering Sea in winter but is still available in the Chukchi Sea, that the Chukchi Sea would be equally adequate for this function. Ice haul-outs provide large areas for effective leks to form. Sea ice availability does not	superior adequate inferior

	account for ice qualities such as thickness. We assigned probabilities that shift from superior towards inferior breeding environment with decreasing “shelf ice availability”, although sea ice is projected to form in the Bering Sea through the century and may not reach low levels of availability.	
Birthing platform (node in spring submodel only)	Adequacy of ice habitat for birthing, nursing, and providing protection to newborn calves during severe storms as a function of the node “shelf ice availability”. Most calving occurs in April-June and mothers care for and nurse their newborn calves on the ice (Fay 1985). Little is known of ice preferences for calving activities; however, walruses require ice floes large enough to support their weight (Fay 1982; Simpkins et al. 2003). We assumed that if ice becomes unavailable in the spring in the Bering Sea, but still available in the Chukchi Sea, that the Chukchi Sea would be equally adequate for this function. Sea ice availability does not account for ice qualities such as thickness. However, unlike the breeding environment in winter, spring sea ice could melt out quickly and provide less protection from waves with decreasing ice availability. Also, hunters from the village of Savoonga indicated that a low ice profile is important for calves to be able to move on and off of ice floes. We assigned probabilities that shift from superior towards inferior birthing platform with decreasing “shelf ice availability”.	superior adequate inferior
Output Nodes		
All-season suitable ice extent	Overall suitable ice extent throughout the year, which reflects the potential range and occupancy of walrus movements in the Chukchi and Bering seas, as a function of “suitable ice extent” in summer/fall, winter, and spring. The probability assigned to each parent node state combination was the mean of the three season’s suitable ice extent outcomes, weighted by duration of season.	sufficient both seas sufficient one sea insufficient both seas
All-season abundance	Overall stressors on walrus abundance throughout the year as a function of “abundance stressors” in summer/fall, winter, and spring.	low stressors moderately low stressors

stressors	We weighted “abundance stressors” from each season to have equal influence on all-season abundance stressors during ranking of the parent node state combinations, because there was no reason to weight them otherwise. High levels of abundance stressors from more than one season were considered to have a greater negative influence than high levels of abundance stressors from a single season, and we assigned probabilities to reflect this.	moderately high stressors high stressors
All-season walrus outcome	Walrus population overall outcome as a function of the nodes “all-season suitable ice extent” and “all-season abundance stressors”. We weighted “all-season abundance stressors” to have more influence on all-season walrus outcome as “all-season suitable ice extent” when we assigned probabilities, because walruses are capable of using coastal areas for hauling out when sea ice is limited. Probabilities were assigned across the outcome states based on our definition of each state. Robust infers that the Pacific walrus occurs in numbers and distribution robust enough for the population to use available habitat, relocate if possible and needed, and fully withstand anthropogenic stressors and adverse environmental conditions without significant declines in abundance or distribution. Persistent infers that the Pacific walrus occurs in numbers and distribution adequate enough for the population to use available habitat, although locally adverse conditions of anthropogenic stressors and environmental conditions may lead to some population declines in abundance or occupancy in some areas. Vulnerable infers that the Pacific walrus occurs in numbers and distribution that is likely to make the population susceptible to locally adverse conditions of anthropogenic stressors and environmental conditions resulting in declines in abundance or occupancy in some areas. Rare infers that the Pacific walrus occurs in numbers and distribution that is likely to make the population highly susceptible to locally adverse conditions of anthropogenic stressors and environmental conditions resulting in a population with greatly reduced abundance and occupancy that is more or less restricted to isolated pockets. Extirpated infers that the Pacific walrus population is absent through all, or nearly all, of the Chukchi and Bering Sea region.	robust persistent vulnerable rare extirpated

Online Resource 1 (continued)

Table 2 Probability tables for each input node in a Bayesian network model of Pacific walrus status (unless otherwise indicated, the same probabilities were assigned to the GCM_18 and GCM_SD2 sets)

Table 2.1 Probability table for input node "Resource utilization"

		Summer/Fall			**Winter**			**Spring**		
GHG	**Period**	**Positive**	**Neutral**	**Negative**	**Positive**	**Neutral**	**Negative**	**Positive**	**Neutral**	**Negative**
Observed	1984	0.00	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00
Observed	2004	0.00	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00
A1B	2025	0.10	0.60	0.30	0.10	0.70	0.20	0.10	0.70	0.20
A1B	2050	0.10	0.40	0.50	0.10	0.70	0.20	0.10	0.50	0.40
A1B	2075	0.10	0.30	0.60	0.10	0.70	0.20	0.10	0.40	0.50
A1B	2095	0.10	0.30	0.60	0.10	0.70	0.20	0.10	0.40	0.50
A2	2025	0.10	0.60	0.30	0.10	0.70	0.20	0.10	0.70	0.20
A2	2050	0.10	0.40	0.50	0.10	0.70	0.20	0.10	0.50	0.40
A2	2075	0.05	0.25	0.70	0.05	0.65	0.30	0.05	0.35	0.60
A2	2095	0.05	0.20	0.75	0.05	0.60	0.35	0.05	0.30	0.65

Table 2.2 Probability table for input node "Climate change on benthos"

		Summer/Fall			**Winter**			**Spring**		
GHG	**Period**	**Positive**	**Neutral**	**Negative**	**Positive**	**Neutral**	**Negative**	**Positive**	**Neutral**	**Negative**
Observed	1984	0.00	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00
Observed	2004	0.00	0.65	0.35	0.00	0.65	0.35	0.00	0.65	0.35
A1B	2025	0.05	0.35	0.60	0.05	0.35	0.60	0.05	0.35	0.60

A1B	2050	0.05	0.30	0.65	0.05	0.30	0.65	0.05	0.30	0.65
A1B	2075	0.05	0.25	0.70	0.05	0.25	0.70	0.05	0.25	0.70
A1B	2095	0.05	0.25	0.70	0.05	0.25	0.70	0.05	0.25	0.70
A2	2025	0.05	0.30	0.65	0.05	0.30	0.65	0.05	0.30	0.65
A2	2050	0.05	0.25	0.70	0.05	0.25	0.70	0.05	0.25	0.70
A2	2075	0.05	0.20	0.75	0.05	0.20	0.75	0.05	0.20	0.75
A2	2095	0.05	0.20	0.75	0.05	0.20	0.75	0.05	0.20	0.75

Table 2.3 Probability table for input node “Ship and air traffic”

		Summer/Fall			**Winter**			**Spring**		
GHG	**Period**	**Low**	**Moderate**	**High**	**Low**	**Moderate**	**High**	**Low**	**Moderate**	**High**
Observed	1984	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00
Observed	2004	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00
A1B	2025	0.50	0.35	0.15	0.85	0.15	0.00	0.60	0.30	0.10
A1B	2050	0.20	0.50	0.30	0.80	0.20	0.00	0.40	0.45	0.15
A1B	2075	0.20	0.30	0.50	0.75	0.25	0.00	0.30	0.50	0.20
A1B	2095	0.10	0.30	0.60	0.70	0.30	0.00	0.20	0.55	0.25
A2	2025	0.50	0.35	0.15	0.85	0.15	0.00	0.60	0.30	0.10
A2	2050	0.20	0.50	0.30	0.80	0.20	0.00	0.40	0.45	0.15
A2	2075	0.15	0.25	0.60	0.65	0.35	0.00	0.25	0.45	0.30
A2	2095	0.05	0.20	0.75	0.55	0.45	0.00	0.15	0.45	0.40

Table 2.4 Probability table for input node “Human settlements”

		Summer/Fall			**Winter**			**Spring**		

GHG	Period	Low	Medium	High	Low	Medium	High	Low	Medium	High
Observed	1984	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00
Observed	2004	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00
A1B	2025	0.85	0.15	0.00	0.85	0.15	0.00	0.85	0.15	0.00
A1B	2050	0.65	0.35	0.00	0.65	0.35	0.00	0.65	0.35	0.00
A1B	2075	0.50	0.40	0.10	0.50	0.40	0.10	0.50	0.40	0.10
A1B	2095	0.40	0.45	0.15	0.40	0.45	0.15	0.40	0.45	0.15
A2	2025	0.85	0.15	0.00	0.85	0.15	0.00	0.85	0.15	0.00
A2	2050	0.55	0.40	0.05	0.55	0.40	0.05	0.55	0.40	0.05
A2	2075	0.35	0.50	0.15	0.35	0.50	0.15	0.35	0.50	0.15
A2	2095	0.20	0.55	0.25	0.20	0.55	0.25	0.20	0.55	0.25

Table 2.5 Probability table for input node “Subsistence harvest”

		Summer/Fall				Winter				Spring			
GHG	**Period**	**Low**	**Moderate**	**High**	**Very high**	**Low**	**Moderate**	**High**	**Very high**	**Low**	**Moderate**	**High**	**Very high**
Observed	1984	1.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00
Observed	2004	1.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	1.00
A1B	2025	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
A1B	2050	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
A1B	2075	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
A1B	2095	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
A2	2025	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
A2	2050	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00
A2	2075	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00

A2	2095	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00

Table 2.6 Probability table for input node "Incidental takes"

		Number of walruses											
		Summer/Fall				**Winter**				**Spring**			
GHG	**Period**	**Low**	**Moderate**	**High**	**Very high**	**Low**	**Moderate**	**High**	**Very high**	**Low**	**Moderate**	**High**	**Very high**
Observed	1984	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
Observed	2004	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
A1B	2025	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
A1B	2050	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
A1B	2075	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
A1B	2095	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
A2	2025	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
A2	2050	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
A2	2075	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00
A2	2095	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00

Table 2.7 Probability table for input node "Ice-free months"

			Number of ice-free months						
			Summer/Fall				**Winter**		
GCM	**GHG**	**Period**	**0.0 to 0.5**	**0.5 to 2.0**	**2.0 to 3.5**	**3.5 to 5.0**	**0.0 to 0.5**	**0.5 to 2.0**	**2.0 to 4.0**
Observed	Observed	1984	1.00	0.00	0.00	0.00	1.00	0.00	0.00
Observed	Observed	2004	0.00	1.00	0.00	0.00	1.00	0.00	0.00

GCM_18	A1B	2025	0.56	0.22	0.11	0.11	1.00	0.00	0.00
GCM_18	A1B	2050	0.33	0.17	0.33	0.17	1.00	0.00	0.00
GCM_18	A1B	2075	0.28	0.06	0.33	0.33	1.00	0.00	0.00
GCM_18	A1B	2095	0.11	0.22	0.11	0.56	1.00	0.00	0.00
GCM_18	A2	2025	0.56	0.22	0.17	0.06	1.00	0.00	0.00
GCM_18	A2	2050	0.39	0.28	0.17	0.17	1.00	0.00	0.00
GCM_18	A2	2075	0.17	0.17	0.17	0.50	1.00	0.00	0.00
GCM_18	A2	2095	0.06	0.11	0.17	0.67	0.78	0.22	0.00
GCM_SD2	A1B	2025	0.40	0.40	0.20	0.00	1.00	0.00	0.00
GCM_SD2	A1B	2050	0.00	0.30	0.60	0.10	1.00	0.00	0.00
GCM_SD2	A1B	2075	0.00	0.10	0.50	0.40	1.00	0.00	0.00
GCM_SD2	A1B	2095	0.00	0.10	0.20	0.70	1.00	0.00	0.00
GCM_SD2	A2	2025	0.40	0.40	0.20	0.00	1.00	0.00	0.00
GCM_SD2	A2	2050	0.10	0.50	0.30	0.10	1.00	0.00	0.00
GCM_SD2	A2	2075	0.00	0.10	0.20	0.70	1.00	0.00	0.00
GCM_SD2	A2	2095	0.00	0.10	0.10	0.80	0.70	0.30	0.00

Table 2.7 (continued)

			Number of ice-free months		
			Spring		
GCM	**GHG**	**Period**	**0.0 to 0.5**	**0.5 to 2.0**	**2.0 to 3.0**
Observed	Observed	1984	1.00	0.00	0.00
Observed	Observed	2004	1.00	0.00	0.00
GCM_18	A1B	2025	0.94	0.06	0.00
GCM_18	A1B	2050	0.94	0.06	0.00
GCM_18	A1B	2075	0.94	0.06	0.00

GCM_18	A1B	2095	0.94	0.06	0.00
GCM_18	A2	2025	0.94	0.06	0.00
GCM_18	A2	2050	0.94	0.06	0.00
GCM_18	A2	2075	0.94	0.06	0.00
GCM_18	A2	2095	0.94	0.06	0.00
GCM_SD2	A1B	2025	1.00	0.00	0.00
GCM_SD2	A1B	2050	1.00	0.00	0.00
GCM_SD2	A1B	2075	1.00	0.00	0.00
GCM_SD2	A1B	2095	1.00	0.00	0.00
GCM_SD2	A2	2025	1.00	0.00	0.00
GCM_SD2	A2	2050	1.00	0.00	0.00
GCM_SD2	A2	2075	1.00	0.00	0.00
GCM_SD2	A2	2095	1.00	0.00	0.00

Table 2.8 Probability table for input node “Chukchi Sea ice cover”

			Percent ice extent										
			Summer/Fall					**Winter**					
GCM	**GHG**	**Period**	**90 to 100**	**70 to 90**	**30 to 70**	**10 to 30**	**0 to 10**	**90 to 100**	**70 to 90**	**30 to 70**	**10 to 30**	**0 to 10**	**0 to 10**
Observed	Observed	1984	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
Observed	Observed	2004	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00
GCM_18	A1B	2025	0.06	0.22	0.50	0.22	0.00	1.00	0.00	0.00	0.00	0.00	0.00
GCM_18	A1B	2050	0.06	0.00	0.44	0.39	0.11	0.89	0.11	0.00	0.00	0.00	0.00
GCM_18	A1B	2075	0.06	0.00	0.28	0.33	0.33	0.78	0.22	0.00	0.00	0.00	0.00
GCM_18	A1B	2095	0.00	0.06	0.17	0.17	0.61	0.50	0.39	0.11	0.00	0.00	0.00
GCM_18	A2	2025	0.06	0.22	0.44	0.22	0.06	1.00	0.00	0.00	0.00	0.00	0.00

GCM_18	A2	2050	0.06	0.06	0.56	0.17	0.17	0.89	0.11	0.00	0.00	0.00	0.00
GCM_18	A2	2075	0.00	0.06	0.22	0.22	0.50	0.61	0.39	0.00	0.00	0.00	0.00
GCM_18	A2	2095	0.00	0.06	0.17	0.11	0.67	0.39	0.33	0.28	0.00	0.00	0.00
GCM_SD2	A1B	2025	0.00	0.00	0.80	0.20	0.00	1.00	0.00	0.00	0.00	0.00	0.00
GCM_SD2	A1B	2050	0.00	0.00	0.30	0.60	0.10	0.80	0.20	0.00	0.00	0.00	0.00
GCM_SD2	A1B	2075	0.00	0.00	0.10	0.50	0.40	0.80	0.20	0.00	0.00	0.00	0.00
GCM_SD2	A1B	2095	0.00	0.00	0.00	0.20	0.80	0.30	0.60	0.10	0.00	0.00	0.00
GCM_SD2	A2	2025	0.00	0.00	0.70	0.20	0.10	1.00	0.00	0.00	0.00	0.00	0.00
GCM_SD2	A2	2050	0.00	0.00	0.60	0.30	0.10	0.90	0.10	0.00	0.00	0.00	0.00
GCM_SD2	A2	2075	0.00	0.00	0.10	0.20	0.70	0.50	0.50	0.00	0.00	0.00	0.00
GCM_SD2	A2	2095	0.00	0.00	0.10	0.10	0.80	0.20	0.50	0.30	0.00	0.00	0.00

Table 2.8 (continued)

			Percent ice extent				
			Spring				
GCM	**GHG**	**Period**	**90 to 100**	**70 to 90**	**30 to 70**	**10 to 30**	**0 to 10**
Observed	Observed	1984	1.00	0.00	0.00	0.00	0.00
Observed	Observed	2004	1.00	0.00	0.00	0.00	0.00
GCM_18	A1B	2025	0.94	0.00	0.06	0.00	0.00
GCM_18	A1B	2050	0.83	0.11	0.06	0.00	0.00
GCM_18	A1B	2075	0.67	0.28	0.06	0.00	0.00
GCM_18	A1B	2095	0.56	0.39	0.06	0.00	0.00
GCM_18	A2	2025	0.89	0.06	0.06	0.00	0.00
GCM_18	A2	2050	0.89	0.06	0.06	0.00	0.00
GCM_18	A2	2075	0.61	0.33	0.06	0.00	0.00
GCM_18	A2	2095	0.44	0.33	0.22	0.00	0.00

GCM_SD2	A1B	2025	1.00	0.00	0.00	0.00	0.00
GCM_SD2	A1B	2050	0.80	0.20	0.00	0.00	0.00
GCM_SD2	A1B	2075	0.70	0.30	0.00	0.00	0.00
GCM_SD2	A1B	2095	0.50	0.50	0.00	0.00	0.00
GCM_SD2	A2	2025	0.90	0.10	0.00	0.00	0.00
GCM_SD2	A2	2050	0.90	0.10	0.00	0.00	0.00
GCM_SD2	A2	2075	0.60	0.40	0.00	0.00	0.00
GCM_SD2	A2	2095	0.30	0.50	0.20	0.00	0.00

Table 2.9 Probability table for input node "Bering Sea ice cover"

			Percent ice extent									
			Summer/Fall					**Winter**				
GCM	**GHG**	**Period**	**90 to 100**	**70 to 90**	**30 to 70**	**10 to 30**	**0 to 10**	**90 to 100**	**70 to 90**	**30 to 70**	**10 to 30**	**0 to 10**	**0 to 10**
Observed	Observed	1984	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00
Observed	Observed	2004	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.00
GCM_18	A1B	2025	0.00	0.00	0.00	0.00	1.00	0.00	0.33	0.50	0.17	0.00	0.06
GCM_18	A1B	2050	0.00	0.00	0.00	0.00	1.00	0.00	0.06	0.61	0.22	0.11	0.17
GCM_18	A1B	2075	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.39	0.39	0.22	0.28
GCM_18	A1B	2095	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.33	0.39	0.28	0.39
GCM_18	A2	2025	0.00	0.00	0.00	0.00	1.00	0.00	0.22	0.61	0.11	0.06	0.11
GCM_18	A2	2050	0.00	0.00	0.00	0.00	1.00	0.00	0.11	0.61	0.17	0.11	0.22
GCM_18	A2	2075	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.44	0.33	0.22	0.28
GCM_18	A2	2095	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.28	0.33	0.39	0.50
GCM_SD2	A1B	2025	0.00	0.00	0.00	0.00	1.00	0.00	0.36	0.64	0.00	0.00	0.00
GCM_SD2	A1B	2050	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.82	0.18	0.00	0.09
GCM_SD2	A1B	2075	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.45	0.45	0.09	0.18

GCM_SD2	A1B	2095	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.36	0.55	0.09	0.27
GCM_SD2	A2	2025	0.00	0.00	0.00	0.00	1.00	0.00	0.18	0.82	0.00	0.00	0.00
GCM_SD2	A2	2050	0.00	0.00	0.00	0.00	1.00	0.00	0.09	0.82	0.09	0.00	0.09
GCM_SD2	A2	2075	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.55	0.45	0.00	0.18
GCM_SD2	A2	2095	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.36	0.36	0.27	0.36

Table 2.9 (continued)

			Percent ice extent				
			Spring				
GCM	**GHG**	**Period**	**90 to 100**	**70 to 90**	**30 to 70**	**10 to 30**	**0 to 10**
Observed	Observed	1984	0.00	0.00	1.00	0.00	0.00
Observed	Observed	2004	0.00	0.00	1.00	0.00	0.00
GCM_18	A1B	2025	0.00	0.00	0.61	0.33	0.06
GCM_18	A1B	2050	0.00	0.00	0.39	0.44	0.17
GCM_18	A1B	2075	0.00	0.00	0.22	0.50	0.28
GCM_18	A1B	2095	0.00	0.00	0.17	0.44	0.39
GCM_18	A2	2025	0.00	0.11	0.50	0.28	0.11
GCM_18	A2	2050	0.00	0.06	0.33	0.39	0.22
GCM_18	A2	2075	0.00	0.00	0.28	0.44	0.28
GCM_18	A2	2095	0.00	0.00	0.06	0.44	0.50
GCM_SD2	A1B	2025	0.00	0.00	0.73	0.27	0.00
GCM_SD2	A1B	2050	0.00	0.00	0.45	0.45	0.09
GCM_SD2	A1B	2075	0.00	0.00	0.18	0.64	0.18
GCM_SD2	A1B	2095	0.00	0.00	0.18	0.55	0.27
GCM_SD2	A2	2025	0.00	0.00	0.73	0.27	0.00
GCM_SD2	A2	2050	0.00	0.00	0.45	0.45	0.09

GCM_SD2	A2	2075	0.00	0.00	0.27	0.55	0.18
GCM_SD2	A2	2095	0.00	0.00	0.00	0.64	0.36

Online Resource 1 (continued)

Table 3 Conditional probability tables for each output and intermediate node in a Bayesian network model of Pacific walrus status (unless specified in separate tables, the same set of probabilities were used for the corresponding node in all three seasons)

Table 3.1 Percent conditional probability table for node “All-season walrus outcome”

		Outcome				
All season suitable ice	**All season stressors**	**Robust**	**Persistent**	**Vulnerable**	**Rare**	**Extirpation**
sufficient both seas	low	90	10	0	0	0
sufficient both seas	mod low	60	40	0	0	0
sufficient both seas	mod high	0	20	60	20	0
sufficient both seas	high	0	0	20	40	40
sufficient one sea	low	70	30	0	0	0
sufficient one sea	mod low	50	50	0	0	0
sufficient one sea	mod high	0	0	80	20	0
sufficient one sea	high	0	0	10	40	50
insufficient both seas	low	0	50	50	0	0
insufficient both seas	mod low	0	15	70	15	0
insufficient both seas	mod high	0	0	0	40	60
insufficient both seas	high	0	0	0	10	90

Table 3.2 Percent conditional probability table for node “All-season suitable ice extent”

			Overall suitable ice		
Summer/Fall suitable ice	**Winter suitable ice**	**Spring suitable ice**	**Sufficient both seas**	**Sufficient one sea**	**Insufficient both seas**
sufficient both seas	sufficient both seas	sufficient both seas	100	0	0
sufficient both seas	sufficient both seas	sufficient one sea	75	25	0
sufficient both seas	sufficient both seas	insufficient both seas	75	0	25
sufficient both seas	sufficient one sea	sufficient both seas	67	33	0
sufficient both seas	sufficient one sea	sufficient one sea	42	58	0
sufficient both seas	sufficient one sea	insufficient both seas	42	33	25
sufficient both seas	insufficient both seas	sufficient both seas	67	0	33
sufficient both seas	insufficient both seas	sufficient one sea	42	25	33
sufficient both seas	insufficient both seas	insufficient both seas	42	0	58

sufficient one sea	sufficient both seas	sufficient both seas	58	42	0
sufficient one sea	sufficient both seas	sufficient one sea	33	67	0
sufficient one sea	sufficient both seas	insufficient both seas	33	42	25
sufficient one sea	sufficient one sea	sufficient both seas	25	75	0
sufficient one sea	sufficient one sea	sufficient one sea	0	100	0
sufficient one sea	sufficient one sea	insufficient both seas	0	75	25
sufficient one sea	insufficient both seas	sufficient both seas	25	42	33
sufficient one sea	insufficient both seas	sufficient one sea	0	67	33
sufficient one sea	insufficient both seas	insufficient both seas	0	42	58
insufficient both seas	sufficient both seas	sufficient both seas	58	0	42
insufficient both seas	sufficient both seas	sufficient one sea	33	25	42
insufficient both seas	sufficient both seas	insufficient both seas	33	0	67
insufficient both seas	sufficient one sea	sufficient both seas	25	33	42
insufficient both seas	sufficient one sea	sufficient one sea	0	58	42
insufficient both seas	sufficient one sea	insufficient both seas	0	33	67
insufficient both seas	insufficient both seas	sufficient both seas	25	0	75
insufficient both seas	insufficient both seas	sufficient one sea	0	25	75
insufficient both seas	insufficient both seas	insufficient both seas	0	0	100

Table 3.3 Percent conditional probability table for node “All-season abundance stressors”

			All seasons abundance stressors			
Summer/Fall abundance stressors	**Winter abundance stressors**	**Spring abundance stressors**	**Low**	**Mod low**	**Mod high**	**High**
low	low	low	95	5	0	0
low	low	mod low	90	10	0	0
low	low	mod high	25	50	25	0
low	low	high	0	30	50	20
low	mod low	low	90	10	0	0
low	mod low	mod low	60	40	0	0
low	mod low	mod high	25	50	25	0
low	mod low	high	0	20	60	20
low	mod high	low	25	50	25	0
low	mod high	mod low	25	50	25	0
low	mod high	mod high	0	20	60	20
low	mod high	high	0	10	30	60

low	high	low	0	30	50	20
low	high	mod low	0	20	60	20
low	high	mod high	0	10	30	60
low	high	high	0	0	10	90
mod low	low	low	90	10	0	0
mod low	low	mod low	60	40	0	0
mod low	low	mod high	25	50	25	0
mod low	low	high	0	20	60	20
mod low	mod low	low	60	40	0	0
mod low	mod low	mod low	20	60	20	0
mod low	mod low	mod high	0	40	60	0
mod low	mod low	high	0	20	60	20
mod low	mod high	low	25	50	25	0
mod low	mod high	mod low	0	40	60	0
mod low	mod high	mod high	0	10	40	50
mod low	mod high	high	0	0	30	70
mod low	high	low	0	20	60	20
mod low	high	mod low	0	20	60	20
mod low	high	mod high	0	0	30	70
mod low	high	high	0	0	10	90
mod high	low	low	25	50	25	0
mod high	low	mod low	25	50	25	0
mod high	low	mod high	0	20	60	20
mod high	low	high	0	10	30	60
mod high	mod low	low	25	50	25	0
mod high	mod low	mod low	0	40	60	0
mod high	mod low	mod high	0	10	40	50
mod high	mod low	high	0	0	30	70
mod high	mod high	low	0	20	60	20
mod high	mod high	mod low	0	10	40	50
mod high	mod high	mod high	0	10	30	60
mod high	mod high	high	0	0	10	90
mod high	high	low	0	10	30	60
mod high	high	mod low	0	0	30	70
mod high	high	mod high	0	0	10	90
mod high	high	high	0	0	10	90
high	low	low	0	30	50	20

high	low	mod low	0	20	60	20
high	low	mod high	0	10	30	60
high	low	high	0	0	10	90
high	mod low	low	0	20	60	20
high	mod low	mod low	0	20	60	20
high	mod low	mod high	0	0	30	70
high	mod low	high	0	0	10	90
high	mod high	low	0	10	30	60
high	mod high	mod low	0	0	30	70
high	mod high	mod high	0	0	10	90
high	mod high	high	0	0	10	90
high	high	low	0	0	10	90
high	high	mod low	0	0	10	90
high	high	mod high	0	0	10	90
high	high	high	0	0	5	95

Table 3.4 Percent conditional probability table for node “Suitable ice extent”

		Suitable ice extent		
Chukchi Sea ice cover	**Bering Sea ice cover**	**Sufficient both seas**	**Sufficient one sea**	**Insufficient both seas**
90 to 100	90 to 100	0	90	10
90 to 100	70 to 90	0	100	0
90 to 100	30 to 70	0	100	0
90 to 100	10 to 30	0	70	30
90 to 100	0 to 10	0	0	100
70 to 90	90 to 100	63	34	3
70 to 90	70 to 90	70	30	0
70 to 90	30 to 70	70	30	0
70 to 90	10 to 30	49	42	9
70 to 90	0 to 10	0	70	30
30 to 70	90 to 100	90	10	0
30 to 70	70 to 90	100	0	0
30 to 70	30 to 70	100	0	0
30 to 70	10 to 30	70	30	0
30 to 70	0 to 10	0	100	0
10 to 30	90 to 100	63	34	3

10 to 30	70 to 90	70	30	0
10 to 30	30 to 70	70	30	0
10 to 30	10 to 30	49	42	9
10 to 30	0 to 10	0	70	30
0 to 10	90 to 100	0	90	10
0 to 10	70 to 90	0	100	0
0 to 10	30 to 70	0	100	0
0 to 10	10 to 30	0	70	30
0 to 10	0 to 10	0	0	100

Table 3.5 Percent conditional probability table for node “Summer/Fall abundance stressors”

		Abundance stressors			
Body condition	**Total mortality**	**Low**	**Mod low**	**Mod high**	**High**
high	low	90	10	0	0
high	moderate	30	60	10	0
high	high	0	25	50	25
medium	low	60	30	10	0
medium	moderate	10	60	30	0
medium	high	0	10	30	60
low	low	25	50	25	0
low	moderate	0	10	60	30
low	high	0	0	10	90

Table 3.6 Percent conditional probability table for node “Winter abundance stressors”

			Abundance stressors			
Body condition	**Total mortality**	**Breeding environment**	**Low**	**Mod low**	**Mod high**	**High**
high	low	superior	90	10	0	0
high	low	adequate	90	10	0	0
high	low	inferior	60	40	0	0
high	moderate	superior	60	40	0	0
high	moderate	adequate	30	60	10	0
high	moderate	inferior	10	60	30	0
high	high	superior	10	60	30	0

high	high	adequate	0	30	60	10
high	high	inferior	0	10	60	30
medium	low	superior	60	40	0	0
medium	low	adequate	60	40	0	0
medium	low	inferior	30	60	10	0
medium	moderate	superior	10	60	30	0
medium	moderate	adequate	10	60	30	0
medium	moderate	inferior	0	30	60	10
medium	high	superior	0	10	60	30
medium	high	adequate	0	10	60	30
medium	high	inferior	0	0	40	60
low	low	superior	30	60	10	0
low	low	adequate	10	60	30	0
low	low	inferior	10	60	30	0
low	moderate	superior	0	30	60	10
low	moderate	adequate	0	10	60	30
low	moderate	inferior	0	10	60	30
low	high	superior	0	0	40	60
low	high	adequate	0	0	10	90
low	high	inferior	0	0	10	90

Table 3.7 Percent conditional probability table for node "Spring abundance stressors"

			Abundance stressors			
Body condition	**Total mortality**	**Birthing platform**	**Low**	**Mod low**	**Mod high**	**High**
high	low	superior	90	10	0	0
high	low	adequate	70	30	0	0
high	low	inferior	30	60	10	0
high	moderate	superior	60	40	0	0
high	moderate	adequate	25	50	25	0
high	moderate	inferior	10	60	30	0
high	high	superior	10	60	30	0
high	high	adequate	0	30	60	10
high	high	inferior	0	10	60	30
medium	low	superior	70	30	0	0
medium	low	adequate	30	60	10	0

medium	low	inferior	10	60	30	0
medium	moderate	superior	25	50	25	0
medium	moderate	adequate	10	60	30	0
medium	moderate	inferior	0	25	50	25
medium	high	superior	0	30	60	10
medium	high	adequate	0	10	60	30
medium	high	inferior	0	0	30	70
low	low	superior	30	60	10	0
low	low	adequate	10	60	30	0
low	low	inferior	0	30	60	10
low	moderate	superior	10	60	30	0
low	moderate	adequate	0	25	50	25
low	moderate	inferior	0	0	40	60
low	high	superior	0	10	60	30
low	high	adequate	0	0	30	70
low	high	inferior	0	0	10	90

Table 3.8 Percent conditional probability table for node “Summer/Fall shelf ice availability”

		Ice availability			
Number of ice-free months	**Ice extent**	**Excellent**	**Good**	**Fair**	**Poor**
0.0-0.5	sufficient both seas	100	0	0	0
0.0-0.5	sufficient one sea	95	5	0	0
0.0-0.5	insufficient both seas	0	25	50	25
0.5-2.0	sufficient both seas	0	15	50	35
0.5-2.0	sufficient one sea	0	10	50	40
0.5-2.0	insufficient both seas	0	0	15	85
2.0-3.5	sufficient both seas	0	10	20	70
2.0-3.5	sufficient one sea	0	5	20	75
2.0-3.5	insufficient both seas	0	0	10	90
3.5-5.0	sufficient both seas	0	0	15	85
3.5-5.0	sufficient one sea	0	0	10	90
3.5-5.0	insufficient both seas	0	0	0	100

Table 3.9 Percent conditional probability table for node “Winter shelf ice availability”

		Ice availability			
Number of ice-free months	**Ice extent**	**Excellent**	**Good**	**Fair**	**Poor**
0.0-0.5	sufficient both seas	100	0	0	0
0.0-0.5	sufficient one sea	95	5	0	0
0.0-0.5	insufficient both seas	0	25	50	25
0.5-2.0	sufficient both seas	0	15	50	35
0.5-2.0	sufficient one sea	0	10	50	40
0.5-2.0	insufficient both seas	0	0	15	85
2.0-4.0	sufficient both seas	0	10	20	70
2.0-4.0	sufficient one sea	0	5	20	75
2.0-4.0	insufficient both seas	0	0	10	90

Table 3.10 Percent conditional probability table for node “Spring shelf ice availability”

		Ice availability			
Number of ice-free months	**Ice extent**	**Excellent**	**Good**	**Fair**	**Poor**
0.0-0.5	sufficient both seas	100	0	0	0
0.0-0.5	sufficient one sea	95	5	0	0
0.0-0.5	insufficient both seas	0	25	50	25
0.5-2.0	sufficient both seas	0	15	50	35
0.5-2.0	sufficient one sea	0	10	50	40
0.5-2.0	insufficient both seas	0	0	15	85
2.0-3.0	sufficient both seas	0	10	20	70
2.0-3.0	sufficient one sea	0	5	20	75
2.0-3.0	insufficient both seas	0	0	10	90

Table 3.11 Percent conditional probability table for node “Breeding environment”

	Breeding environment		
Ice availability	**Superior**	**Adequate**	**Inferior**
excellent	90	10	0

good	50	50	0
fair	0	50	50
poor	0	10	90

Table 3.12 Percent conditional probability table for node "Birthing platform"

	Birthing platform		
Ice availability	**Superior**	**Adequate**	**Inferior**
excellent	90	10	0
good	50	50	0
fair	0	50	50
poor	0	10	90

Table 3.13 Percent conditional probability table for node "Total mortality"

			Total mortality		
Predation and associated mortality	**Crowding and disturbance**	**Direct mortality**	**Low**	**Moderate**	**High**
low	low	low to moderate	95	5	0
low	low	high	65	35	0
low	low	very high	15	60	25
low	medium	low to moderate	80	20	0
low	medium	high	25	60	15
low	medium	very high	0	35	65
low	high	low to moderate	65	35	0
low	high	high	15	60	25
low	high	very high	0	20	80
moderate	low	low to moderate	95	5	0
moderate	low	high	50	45	5
moderate	low	very high	5	45	50
moderate	medium	low to moderate	65	35	0
moderate	medium	high	20	60	20
moderate	medium	very high	0	35	65
moderate	high	low to moderate	50	45	5

moderate	high	high	5	45	50
moderate	high	very high	0	5	95
high	low	low to moderate	80	20	0
high	low	high	25	60	15
high	low	very high	0	35	65
high	medium	low to moderate	65	35	0
high	medium	high	15	60	25
high	medium	very high	0	20	80
high	high	low to moderate	25	60	15
high	high	high	0	35	65
high	high	very high	0	5	95

Table 3.14 Percent conditional probability table for node "Human-caused direct mortality"

		Direct mortality		
Incidental takes	**Subsistence harvest**	**Low to moderate**	**High**	**Very high**
low	low	100	0	0
low	moderate	75	25	0
low	high	0	80	20
low	very high	0	0	100
moderate	low	75	25	0
moderate	moderate	33	67	0
moderate	high	0	43	57
moderate	very high	0	0	100
high	low	0	80	20
high	moderate	0	43	57
high	high	0	0	100
high	very high	0	0	100
very high	low	0	0	100
very high	moderate	0	0	100
very high	high	0	0	100
very high	very high	0	0	100

Table 3.15 Percent conditional probability table for node "Crowding and disturbance"

	Level of crowding and disturbance

Crowding	Disturbance	Low	Moderate	High
low	low	90	10	0
low	moderate	60	35	5
low	high	15	70	15
moderate	low	60	35	5
moderate	moderate	15	70	15
moderate	high	5	35	60
high	low	15	70	15
high	moderate	5	35	60
high	high	0	10	90

Table 3.16 Percent conditional probability table for node "Crowding"

	Level of crowding		
Shelf ice availability	**low**	**moderate**	**high**
excellent	95	5	0
good	70	25	5
fair	30	40	30
poor	0	5	95

Table 3.17 Percent conditional probability table for node "Disturbance"

			Level of disturbance		
Settlements	**Ship and air traffic**	**Direct mortality**	**Low**	**Moderate**	**High**
low	low	low to moderate	85	15	0
low	low	high	70	25	5
low	low	very high	30	50	20
low	moderate	low to moderate	70	25	5
low	moderate	high	30	50	20
low	moderate	very high	20	50	30
low	high	low to moderate	60	30	10
low	high	high)	20	60	20
low	high	very high	10	30	60
medium	low	low to moderate	70	25	5
medium	low	high	30	50	20

medium	low	very high	20	50	30
medium	moderate	low to moderate	60	30	10
medium	moderate	high	20	60	20
medium	moderate	very high	10	30	60
medium	high	low to moderate	30	50	20
medium	high	high	20	50	30
medium	high	very high	5	25	70
high	low	low to moderate	60	30	10
high	low	high	20	60	20
high	low	very high	10	30	60
high	moderate	low to moderate	30	50	20
high	moderate	high	20	50	30
high	moderate	very high	5	25	70
high	high	low to moderate	20	50	30
high	high	high	5	25	70
high	high	very high	0	15	85

Table 3.18 Percent conditional probability table for node "Predation and associated mortality"

	Level of predation		
Shelf ice availability	**Low**	**Moderate**	**High**
excellent	90	10	0
good	85	15	0
fair	50	30	20
poor	20	40	40

Table 3.19 Percent conditional probability table for node "Body condition"

			Body condition		
Energy expenditure	**Disease**	**Oil spills**	**High**	**Moderate**	**Low**
low	low	low	95	5	0
low	low	moderate	90	10	0
low	low	high	0	30	70
low	moderate	low	90	10	0
low	moderate	moderate	0	40	60

low	moderate	high	0	10	90
low	high	low	0	30	70
low	high	moderate	0	10	90
low	high	high	0	0	100
medium	low	low	90	10	0
medium	low	moderate	80	20	0
medium	low	high	0	30	70
medium	moderate	low	80	20	0
medium	moderate	moderate	0	30	70
medium	moderate	high	0	10	90
medium	high	low	0	30	70
medium	high	moderate	0	10	90
medium	high	high	0	0	100
high	low	low	80	20	0
high	low	moderate	70	30	0
high	low	high	0	20	80
high	moderate	low	70	30	0
high	moderate	moderate	0	30	70
high	moderate	high	0	10	90
high	high	low	0	20	80
high	high	moderate	0	10	90
high	high	high	0	0	100

Table 3.20 Percent conditional probability table for node “Oil spills”

	Regularity and severity of oil spills		
Ship and air traffic	**Low**	**Moderate**	**High**
low	90	10	0
moderate	70	20	10
high	50	30	20

Table 3.21 Percent conditional probability table for node “Disease and parasites”

	Incidence of disease and parasites		
Shelf ice availability	**Low**	**Moderate**	**High**
excellent	90	10	0

good	80	20	0
fair	70	20	10
poor	60	30	10

Table 3.22 Percent conditional probability table for node "Energy expenditure"

		Walrus energy expenditure		
Prey abundance	**Shelf ice availability**	**Low**	**Medium**	**High**
high	excellent	90	10	0
high	good	60	35	5
high	fair	20	60	20
high	poor	5	35	60
moderate	excellent	75	20	5
moderate	good	35	60	5
moderate	fair	5	60	35
moderate	poor	5	20	75
low	excellent	20	60	20
low	good	5	60	35
low	fair	5	20	75
low	poor	0	10	90

Table 3.23 Percent conditional probability table for node "Benthic prey abundance"

			Prey abundance		
Effect of climate change on benthos	**Resource utilization**	**Oil spills**	**High**	**Moderate**	**Low**
positive	positive	low	90	10	0
positive	positive	moderate	80	20	0
positive	positive	high	60	35	5
positive	neutral	low	80	20	0
positive	neutral	moderate	60	35	5
positive	neutral	high	35	60	5
positive	negative	low	60	35	5
positive	negative	moderate	35	60	5
positive	negative	high	15	70	15

neutral	positive	low	60	35	5
neutral	positive	moderate	35	60	5
neutral	positive	high	15	70	15
neutral	neutral	low	35	60	5
neutral	neutral	moderate	15	70	15
neutral	neutral	high	5	60	35
neutral	negative	low	15	70	15
neutral	negative	moderate	5	60	35
neutral	negative	high	5	35	60
negative	positive	low	15	70	15
negative	positive	moderate	5	60	35
negative	positive	high	5	35	60
negative	neutral	low	5	60	35
negative	neutral	moderate	5	35	60
negative	neutral	high	0	20	80
negative	negative	low	5	35	60
negative	negative	moderate	0	20	80
negative	negative	high	0	10	90

Online Resource 1 (continued)

Table 4 General circulation models comprising the GCM_18 and GCM_SD2 ensembles used for sea ice projections in the current study (see Douglas 2010). Models were selected for the GCM_SD2 subset (indicated with an "X") if both their mean ice extent and seasonality during a 30-year observation period (1979–2008) were respectively within 2 standard deviations (SD2) of observed means; models selected for the Chukchi Sea were also required to simulate at least 1 ice-free month during the observation period

Country	**CMIP3 GCM ID**	**Bering Sea**	**Chukchi Sea**
Norway	BCCR-BCM2.0		
USA	CCSM3	X	X
Canada	CGCM3.1(T47)		
France	CNRM-CM3	X	X
Australia	CSIRO-Mk3.0		
Australia	CSIRO-Mk3.5		X
Germany	ECHAM5/MPI-OM	X	
Germany	ECHO-G		X
USA	GFDL-CM2.1	X	X
USA	GFDL-CM2.0	X	X
USA	GISS-ER	X	
Italy	INGV-SXG	X	
Russia	INM-CM3.0	X	
France	IPSL-CM4		X
Japan	MIROC3.2(medres)	X	X
Japan	MRI-CGCM2.3.2	X	
UK	UKMO-HadCM3	X	X
UK	UKMO-HadGEM1		X

Online Resource 1 (continued)

Table 5 Probabilities of all-season walrus outcomes projected from a Bayesian network model of Pacific walrus status

			Probability (%)				
GCM	**GHG**	**Period**	**Robust**	**Persistent**	**Vulnerable**	**Rare**	**Extirpated**
Observed	Observed	1984	61	32	5	1	0
Observed	Observed	2004	58	32	7	2	1
GCM_18	A1B	2025	53	32	11	2	1
GCM_18	A1B	2050	45	31	17	4	3
GCM_18	A1B	2075	36	30	23	6	5
GCM_18	A1B	2095	31	29	26	7	7
GCM_18	A2	2025	50	32	13	3	2
GCM_18	A2	2050	44	31	17	4	3
GCM_18	A2	2075	35	29	24	6	6
GCM_18	A2	2095	29	28	27	8	8
GCM_SD2	A1B	2025	59	32	7	2	1
GCM_SD2	A1B	2050	48	30	15	4	3
GCM_SD2	A1B	2075	36	30	23	6	5
GCM_SD2	A1B	2095	31	29	27	7	6
GCM_SD2	A2	2025	57	32	9	2	1
GCM_SD2	A2	2050	50	31	13	3	2
GCM_SD2	A2	2075	34	29	25	6	6
GCM_SD2	A2	2095	31	28	26	7	7

Online Resource 1 (continued)

Table 6 Results of sensitivity analyses of a Bayesian network model of Pacific walrus status

Node name	**Entropy reduction**	**Season**
All season abundance stressors	0.88761	All
Abundance stressors	0.12739	Summer/Fall
Abundance stressors	0.11544	Winter
Abundance stressors	0.11498	Spring
Suitable ice extent	0.0984	All
Total mortality	0.06108	Summer/Fall
Total mortality	0.04838	Winter
Total mortality	0.03993	Spring
Birthing platform	0.03301	Spring
Shelf ice availability	0.03182	Spring
Shelf ice availability	0.02712	Winter
Breeding environment	0.02677	Winter
Crowding	0.02562	Spring
Human-caused direct mortality	0.02475	Summer/Fall
Crowding and disturbance	0.02334	Winter
Crowding and disturbance	0.02262	Spring
Crowding	0.02243	Winter
Body condition	0.0208	Spring
Body condition	0.02073	Winter
Body condition	0.02036	Summer/Fall
Ice free months	0.01832	Spring
Crowding and disturbance	0.01773	Summer/Fall
Energy expenditure	0.0172	Spring
Human-caused direct mortality	0.01667	Winter
Suitable ice extent	0.01649	Summer/Fall
Predation and associated mortality	0.01515	Spring
Suitable ice extent	0.01509	Winter
Energy expenditure	0.01506	Winter
Ice free months	0.01417	Winter
Predation and associated mortality	0.01376	Winter
Human-caused direct mortality	0.01237	Spring
Suitable ice extent	0.0112	Spring

Disease and parasites	0.01072	Spring
Haul-out disturbance	0.01035	Summer/Fall
Shelf ice availability	0.00918	Summer/Fall
Disease and parasites	0.00917	Winter
Incidental takes	0.00856	Summer/Fall
Subsistence harvest	0.00856	Summer/Fall
Crowding	0.00852	Summer/Fall
Disease and parasites	0.00739	Summer/Fall
Haul-out disturbance	0.00703	Winter
Oil spills	0.00674	Summer/Fall
Predation and associated mortality	0.00594	Summer/Fall
Oil spills	0.00582	Winter
Incidental takes	0.00574	Winter
Subsistence harvest	0.00574	Winter
Bering Sea ice cover	0.00567	Summer/Fall
Energy expenditure	0.00546	Summer/Fall
Haul-out disturbance	0.00533	Spring
Bering Sea ice cover	0.00516	Winter
Oil spills	0.00481	Spring
Subsistence harvest	0.00426	Spring
Incidental takes	0.00426	Spring
Ice free months	0.00382	Summer/Fall
Bering Sea ice cover	0.00381	Spring
Chukchi Sea ice cover	0.00287	Summer/Fall
Chukchi Sea ice cover	0.00256	Winter
Chukchi Sea ice cover	0.00187	Spring
Ship and air traffic	0.00127	Summer/Fall
Ship and air traffic	0.00101	Winter
Ship and air traffic	0.00085	Spring
Benthic prey abundance	0.0004	Summer/Fall
Benthic prey abundance	0.00036	Winter
Benthic prey abundance	0.00031	Spring
Human settlements	0.00009	Summer/Fall
Human settlements	0.00006	Winter
Human settlements	0.00004	Spring
Climate change on benthos	0	Winter
Climate change on benthos	0	Spring

Climate change on benthos	0	Summer/Fall
Resource utilization	0	Winter
Resource utilization	0	Spring
Resource utilization	0	Summer/Fall

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