Contents lists available at ScienceDirect





Journal of Marine Systems

journal homepage: www.elsevier.com/locate/jmarsys

# Distribution and diet of the bottom dwelling Arctic cod in the Canadian Beaufort Sea



Wojciech Walkusz<sup>a,b,\*</sup>, Andrew Majewski<sup>a</sup>, James D. Reist<sup>a</sup>

<sup>a</sup> Freshwater Institute, Fisheries and Oceans Canada, 501 University Crescent, Winnipeg, MB, Canada R3T 2N6
 <sup>b</sup> Institute of Oceanology, Polish Academy of Sciences, Powstancow Warszawy 55, 81-712 Sopot, Poland

#### ARTICLE INFO

### ABSTRACT

Available online 17 April 2012 Keywords: Arctic cod Beaufort Sea Distribution

Zooplankton

Feeding

Demersal

Distribution and diet of bottom-dwelling Arctic cod were studied in the nearshore Canadian Beaufort Sea in summer of 2006–2009 using a 3 m benthic beam trawl. In total, 82 stations were visited ranging in depth from 8 to 128 m. Fish densities were generally low for benthic habitats; pelagic fish occurrence was not assessed. We observed a gradual increase in both the biomass of daily food rations and their energetic content over fish age. Overall, fish were able to obtain high food rations indicating that the Beaufort Sea Shelf has sufficient food resources for them. Demersal Arctic cod fed mainly on copepods (*Pseudocalanus spp., Calanus glacialis, Calanus hyperboreus, Limnocalanus macrurus* and *Jaschnovia tolli*), amphipods (*Apherusa glacialis* and *Themisto libellula*) and mysids (*Mysis oculata*). Further studies, particularly focused on combined pelagic/benthic sampling, are needed to fully assess ecology of the Arctic cod population in the Canadian Beaufort Sea.

Crown Copyright © 2012 Published by Elsevier B.V. All rights reserved.

#### 1. Introduction

Arctic cod (Boreogadus saida) is considered to be a key element of Arctic marine ecosystems given its wide distribution and integral role in overall biomass and energy pathways (Bradstreet et al., 1986). Its importance is gauged as a result of its role both as a consumer of zooplankton (Orlova et al., 2009; Walkusz et al., 2011) and as a food source for higher trophic animals such as seals (Bradstreet, 1982; Finley et al., 1990; Weslawski et al., 1994a), birds (Cairns, 1987; Lønne and Gabrielsen, 1992; Weslawski et al., 1994b) and whales (Welch et al., 1993). Due to its significance in the ecosystem, Arctic cod has received considerable attention from the scientific community in the recent years, resulting in a number of papers describing its basic biology and ecology (e.g., Bradstreet et al., 1986; Craig et al., 1982; Lønne and Gulliksen, 1989). Arctic cod spawns under the ice in winter, and is primarily pelagic throughout its larval and early juvenile life (Sameoto, 1984). It feeds on a broad range of organism, mainly crustaceans, and although is considered a generalist it modifies its diet along with its growth and gape size (Ajiad and Gjøsæter, 1990; Walkusz et al., 2011). In some location Arctic cod creates large schoolings that create apparent feeding hot-spots for predators (marine birds, seals and whales) which enhance overall transport of energy and biomass up the food chain (Crawford and Jorgenson, 1996; Welch et al., 1993). It has also been shown in the Franklin Bay (Beaufort Sea) that the fish aggregate during winter, particularly in the deeper layers to avoid predation from seals, and that these aggregation are large enough to cover requirements of predators (Benoit et al., 2008).

The majority of papers on Arctic cod distribution are devoted to pelagic (larval and early juvenile) life-stages, however, there has been some indication that Arctic cod may also spend part of their life associated with demersal habitats (Lønne and Gulliksen, 1989; Sameoto, 1984). Mecklenburg et al. (2007) reported catches of demersal Arctic cod in Chukchi Sea and Bering Strait; during their study the species was found mainly on the soft bottom (mud, sand) but clearly avoided hard substrate (gravel, rock). Recent studies from the Alaskan Beaufort Sea (Logerwell et al., 2011; Rand and Logerwell, 2011) show that Arctic cod was by far the most abundant bottom dwelling fish. Although it was virtually found at all stations, Arctic cod displayed the affinity to cold waters found in the offshore Beaufort Sea (depths > 100 m).

The aim of this paper is to describe the ecology of demersally associated Arctic cod in the Canadian Beaufort Sea, including their distribution, meristics and feeding assessed by stomach content analysis. We furthermore infer on the potential impacts of direct anthropogenic (industrial) and indirect (climate change) stressors on Beaufort Sea Arctic cod.

#### 2. Material and methods

Arctic cod were sampled during four cruises to the Beaufort Sea in summer 2006–2009 (mid-July to mid-August) by the CCGS *Nahidik*, as part of Fisheries and Oceans Canada's Northern Coastal Marine Studies (NCMS) programme. In total, 82 stations were sampled between the Canada/Alaska border and the Eastern extent of Amundsen Gulf

<sup>\*</sup> Corresponding author at: Fisheries and Oceans Canada, Freshwater Institute, 501 University Crescent, Winnipeg, MB, Canada R3T 2N6. Tel.: +1 2049845541; fax: +1 2049842403.

E-mail address: walwo@iopan.gda.pl (W. Walkusz).

<sup>0924-7963/\$ –</sup> see front matter. Crown Copyright © 2012 Published by Elsevier B.V. All rights reserved. doi:10.1016/j.jmarsys.2012.04.004

## Table 1

List of stations and environmental parameters recorded. Physical characteristics are presented for the bottom layer (i.e. approx. 1 m above the seafloor). Zooplankton biomass is calculated for the entire water column at the station.

DefinitionUnit <th>Region</th> <th>Station</th> <th>Depth (m)</th> <th>Lat. (°N)</th> <th>Long. (°W)</th> <th>Temp. (°C)</th> <th>Salinity</th> <th>Oxyg. satur. (%)</th> <th>Zooplankton biomass (g <math>m^{-2}</math>)</th>	Region	Station	Depth (m)	Lat. (°N)	Long. (°W)	Temp. (°C)	Salinity	Oxyg. satur. (%)	Zooplankton biomass (g $m^{-2}$ )
Makanze by CAR80.0970.1370.13-1.573.277.947.947.93CAR0.030.017.131-1.153.257.834.63CAR40.030.017.131-1.153.157.834.63CAR40.070.030-1.151.198.222.61CAR30.070.050-1.153.198.222.61CAR30.070.050-1.153.198.222.61CAR30.130.0665-1.153.198.441.83Hendel Jalm1.130.0665-1.153.108.441.83Hif40.070.01377-1.153.208.650.221111210.0454-1.15771.153.208.650.222007Hif4100.650-1.1584-1.153.208.650.222018Hif4100.640-1.1584-1.153.208.650.222017Hif4100.640-1.1584-1.153.208.650.222018Hif4100.640-1.1584-1.163.207.613.2012181210.641-1.1887-1.163.207.613.2012181210.641-1.1887-1.163.207.613.2012181210.641-1.1887-1.163.207.613.2012181210.641-1.1887-1.16 <td< td=""><td>2006</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></td<>	2006								
chair CAR7chair	Mackenzie Bay	GAR 9	109	70.137	- 137.789	- 1.5	32.7	79.4	7.9
GAR 7         62         60270         -17381         -14         32.5         78.9         4.7           GAR 4         67         6828         -173281         -14         32.5         82.1         53           GAR 2         15         6828         -175381         -15         31.6         82.2         53           GAR 2         15         686.67         -115.58         -15         31.7         83.4         1.3           GAR 3         123         692.09         -135.382         -14         32.6         70.7         83.4           Han 4         90         692.09         -135.382         -16         32.6         70.7         7.8           Han 4         90         62.07         -135.78         -16         32.7         67.2         7.8           Han 4         10         664.31         -1138.78         -10         7.4         7.8         9.8         7.8           HS 5A         10         664.41         -138.84         -16         7.9         7.8         9.2           HS 5A         16         604.91         -138.92         7.1         11.1         1.3           HS 5A         16         604.91	-	GAR 8	78	70.044	-137.595	- 1.5	32.6	76.8	5.3
Const         GS         GOUND         Const         Co		GAR 7	62	69.970	-137.381	-1.5	32.5	78.9	4.7
CAR 5         49         6382         -17199         -1.5         32.2         81.4         5.3           CAR 3         72         63.62         -15         31.3         62.4         1.5           CAR 3         12         66.65         -13.588         -1.4         30.0         84.6         1.2           CAR 1         12         66.66         -13.8172         -1.5         32.6         76.7         75.7           CAR 1         12         66.67         -13.8172         -1.6         32.0         86.6         2.2           CAR 1         12         66.67         -13.8172         -1.6         32.2         87.2         7.5           Hill         70         66.44         -138.77         -1.6         32.2         76.2         7.3           Marine         11         69.47         -138.68         -1.6         32.2         75.9         9.2           Marine         12         69.47         -138.68         -1.6         32.9         75.1         1.1           Marine         12         69.41         -138.69         -1.6         32.9         75.1         1.1           Marine         12         69.41         -138.62<		GAR 6	65	69.898	- 137.503	-1.4	32.5	80.8	4.5
CAA 4         37         09.31         -13.839         -1.5         31.9         42.5         5.6           CAA 2         27         00.66         -15.30         10.7         48.2         5.6           CAA 2         00.66         -15.30         -1.6         30.0         94.6         2.8           HB 5         19         08.60         -13.828         -1.5         32.6         70.7         5.2           HB 4         40         0.01.21         -13.60         10.1         2.4         6.6         6.6           HB 4         40         0.01.21         -13.80         -1.0         30.6         96.6         2.8           207         HB 4         10         06.40         -13.80         -1.0         32.4         91.8         3.8           207         HB 5         10         06.40         -13.804         -1.0         32.4         91.8         3.8           207         HB 5         10         06.40         -13.804         -1.0         2.1         91.8         3.8           208         10         06.40         -13.804         -1.0         2.1         91.8         3.2         91.9         3.8         3.2		GAR 5	49	69.882	- 137.199	- 1.5	32.2	81.4	5.3
AA3         27         83.72         -13.838         -13         31.8         84.5         3.0           Herschel Island         12         660.0         -13.838         -1.4         30.0         84.5         3.0           Herschel Island         186         -128         00.00         -13.838         -1.5         2.26         70.7         5.0           Herschel Island         187         69.64         -13.877         -1.6         2.27         67.7         1.6         2.27           Herschel Island         187.42         1         0.64.67         -13.8368         -1.7         0.6         101.0         1.24           Herschel Island         11         0.64.67         -13.8368         -1.6         2.0         78.9         2.2           P18         10         0.65.62         -138.050         -1.6         2.2         78.9         2.2           P18         10         0.65.62         -13.83.62         -1.6         2.2         78.9         2.2           P18         10         0.65.62         -13.83.62         -1.6         2.2         8.4         3.5           P18         10         0.65.62         -13.8.7         -1.6         2.2		GAR 4	37	69.831	- 136.989	- 1.5	31.9	82.2	2.6
CMA 1         10         00000 0         -19.558         -1.4         31.0         0.858         -1.3           Herschel Island         HB 5         93         00000 -         -138.471         -1.6         32.0         085.9         6.6           HB 4         0.85.0         -138.471         -1.6         32.0         085.9         6.6           HB 4         0.85.2         -138.471         1.3         32.8         88.7         7.3           2007         HB 4         0.85.40         -138.010         -         1.2         8.8         8.7         7.3           2007         PIS 5.4         1.1         0.6.477         -138.058         -         1.3         7.4         9.1         8.9         9.1         8.9         9.1         1.0		GAR 3	27	69.762	- 136.884	- 1.5	31.8	84.5	5.0
Herscheil stand       HB 5       100       00000       - 138.320       - 1.3       30.20       30.70       30.70       40.70         HB 5       00000       - 138.400       - 138.500       - 1.2       30.00       101.00       12.4         HB 5       102       00.60       - 138.500       - 1.2       30.00       101.00       12.4         HB 5       11       0.02.42       - 138.500       - 1.2       30.00       101.00       12.4         HB 5       11       0.02.40       - 138.500       - 1.2       30.00       100.00       12.4         PB 5.4       10       0.02.400       - 138.300       - 1.0       12.4       91.8       18.9         PB 5.4       10       0.02.400       - 138.300       - 1.0       12.4       91.8       13.9         PB 5.8       54       0.05.13       - 138.500       - 1.0       12.4       94.2       1.6         PB 5.8       54       0.05.13       - 138.500       - 1.3       2.2       76.1       1.1.1         PB 5.10       10       0.02.57       - 138.500       - 1.3       2.2       78.0       1.2         PB 5.10       10       0.02.57       - 138.500<		GAR 2	15	69.663	- 136.586	- 1.5	30.7	88.8	1.9
Picklet Isalut         Pickle Isalut         Picklet Isalut         Picklet	Horeshol Jeland	GAKI	12	69.663	- 130,380	- 1.4	30.0	84.6 70.7	2.8
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	Herschei Island		128	69.603	- 138.382	- 1.5	32.0	/9./	5.9
			95	60 512	- 138.471	- 1.0	20.6	101.0	0.0
		HB 2	49	69.512	- 138.508	- 1.2	30.0	67.2	7.0
North of the other is the ot		HB 1	12	69.428	- 138 878	1.0	28.8	98.6	2.8
Participant of the stand of		112 1	12	001120	1901070	110	2010	2010	210
Herschel IslandBS A2908.493-13801198 A61208433-13.8381-1.02.49.81.8198 A61208433-13.831-1.02.49.81.6198 A1100.6406-138.64-1.62.07.89.2198 B1100.6403-138.64-1.62.07.89.2198 B1230.6131-1.38.74-1.62.07.61.1198 B1230.6131-1.38.74-1.62.07.61.3198 B1230.6413-1.38.74-1.62.07.43.6198 B1160.6327-1.38.75-1.42.14.21.6198 B1570.646-138.67-1.62.07.43.8198 B1570.656-138.76-1.62.07.43.8198 B1570.656-138.76-1.72.07.43.8198 B11100.657-1.33.07.43.83.6198 B11100.657-1.133.28.31.23.4198 B11100.657-1.133.28.31.23.4198 B11100.657-1.143.23.30.23.4198 B1100.649-1.38.74-1.43.23.30.2198 B1100.649-1.38.74-1.43.29.31.6	2007								
Pick of the state of the st	Herschel Island	PBS A2	9	69.496	- 139.010				
Pis A6         12         09,431         -10         32.4         91.8         1.8           Pis A10         00,403         -138,301         -		PBS A4	11	69.477	-138.988				
PRS A8         10         69.406         -138.504           PRS B1         9         69.502         -138.854         -1.6         32.9         75.9         9.2           PRS B3         30         69.513         -1.88.854         -1.6         32.9         76.1         11.1           PRS B3         54         69.513         -1.88.854         -1.6         32.9         76.1         13.1           PRS B3         55         69.441         -1.88.854         -1.6         32.9         76.1         13.1           PRS B6         16         69.512         -1.88.752         -1.3         32.5         94.2         1.4           PRS D6         16         69.466         -138.857         -1.4         32.0         97.7         1.8           PRS D6         51         69.541         -138.532         -0.9         32.8         85.3         89.9           PRS D6         51         69.541         -138.532         -1.6         32.9         75.0         11.2           PRS D6         51         69.514         -138.353         -0.9         32.5         83.3         52.2           PRS D6         11         69.535         -138.477         -1.6 <td></td> <td>PBS A6</td> <td>12</td> <td>69.453</td> <td>-138.941</td> <td>-1.0</td> <td>32.4</td> <td>91.8</td> <td>1.8</td>		PBS A6	12	69.453	-138.941	-1.0	32.4	91.8	1.8
PRS A10         0         0.9.052         -128.954           PRS B3         30         0.9.530         -128.925         -78.9         0.2           PRS B3         54         0.9.131         -138.925         -71.0         32.0         76.1         1.1.1           PRS B3         23         0.9.413         -138.72         -1.6         32.9         76.1         1.1.1           PRS C4         16         0.937         -138.72         -1.6         32.9         76.1         1.3           PRS C4         16         0.937         -138.73         -1.3         32.1         90.7         1.8           PRS C4         55         0.9.44         0.9353         -138.73         -1.3         32.1         90.7         1.8           PRS C4         57         0.9561         -138.737         -1.6         32.9         78.4         7.2           PRS C4         19         0.9328         0.921         -138.47         -1.6         32.9         78.0         1.2           PRS C4         19         0.9359         0.9329         -10.3         3.6         84.3         5.2           PRS C4         10         0.9457         -138.94         -1.4		PBS A8	10	69.431	-138.901				
PRS B1         9         69:52         -138.297         76.9         92.9           PRS B3         34         69:31         -138.824         -1.6         32.9         76.1         11.1           PRS B3         53         69:41         -138.824         -1.6         32.9         76.1         11.1           PRS B1         23         69:41         -138.72         -1.3         32.5         94.2         1.4           PRS D1         05         69:41         -138.737         -1.3         32.1         97.2         1.4           PRS D1         05         69:461         -138.677         -1.3         32.1         97.2         1.4           PRS D2         60:461         -138.677         -1.3         32.1         97.7         1.8           PRS D1         50:5         05.51         -138.327         -0.6         32.9         78.4         -           PRS D10         53         69.495         -138.491         -16         32.9         78.0         1.2           PRS D10         10         69.577         -138.307         -1.4         32.7         79.0         5.4           Cott         117.1         36         69.707         -1		PBS A10	10	69.406	-138.864				
PRS         B3         30         69.53         -13.884         -1.6         32.9         7.89         9.2           PRS         B5         54         69.513         -13.862         -1.3         2.2         8.43         5.3           PRS         B5         53         69.413         -13.875         -1.4         32.1         94.2         1.4           PRS         C1         69.537         -1.3         32.1         90.7         1.8           PRS         C0         15         69.517         -0.33         32.1         90.7         1.8           PRS         D65         51         69.521         -138.370         -0.9         32.3         88.9           PRS         D65         51         69.521         -138.370         -0.9         32.3         88.9           PRS         D65         10         69.57         -138.370         -1.0         32.6         83.3         52.2           PRS         D65         10         69.57         -138.370         -1.2         32.6         83.3         52.2           PRS         D10         0.53         69.57         -138.370         -1.4         32.6         83.3         52.2<		PBS B1	9	69.562	-138.925				
Pick B5         54         69.31         - 138.82         - 1.5         3.2.9         7.6.1         1.1.           Pick G4         16         69.313         - 138.73         -1.3         32.5         84.3         5.3           Pick G4         16         69.512         - 138.75         -1.4         2.1         94.2         1.4           Pick G5         16         64.912         - 138.67         -1.3         32.1         90.7         1.8           Pick G5         0.6         64.935         - 1.38.67         -1.3         32.1         90.7         1.8           Pick G5         0.69.51         - 138.69         -0         32.3         83.9         8.9           Pick G5         10         69.520         - 138.49         -0         32.3         83.9           Pick G5         110         69.570         - 138.40         -1.6         32.9         7.6         12.2           Pick G5         110         69.570         - 138.30         -1.2         2.6         84.3         5.2           Pick G5         110         69.570         - 139.32         1.2         83.3         6.2           Pick G5         110         69.570         - 13		PBS B3	30	69.536	- 138.894	-1.6	32.9	78.9	9.2
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $		PBS B5	54	69.513	- 138.862				
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $		PBS B8	55	69.481	- 138.824	-1.6	32.9	76.1	11.1
Pis C4         0         09.37         - 138.746         - 1.4         22.1         94.2         1.4           Pis C6         16         09.491         - 138.795         -         -         -           Pis D2         64         09.585         - 138.529         -         -         -           Pis D5         51         09.551         - 138.526         -         0.23         85.3         8.9           Pis D6         51         09.551         - 138.526         -         0.23         85.3         8.9           Pis D6         51         09.557         - 138.506         -         1.2         7.8.0         11.2           Pis D6         19         09.557         - 140.057         -         1.2         2.7         63.3         16.2           Pis D6         10         09.557         - 138.370         -         1.4         3.2.7         70.0         5.4           C. Bathurst         67.10         130         69.657         - 139.932         -1.2         32.7         63.3         16.2           20.6         H3.3         30         69.6507         - 139.934         -1.4         32.6         83.3         6.2		PBS B13	23	69.413	- 138./32	- 1.3	32.5	84.3	5.3
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $		PBS C4	16	69.537	- 138.756	1.4	22.1	04.2	1.4
		PBS CO	16	69.512	- 138.710	-1.4	32.1	94.2	1.4
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $		PBS C10	10	69.491	- 138.679	_13	32.1	90.7	1.8
		PBS D2	64	69 585	- 138.629	-1.5	52.1	50,7	1.0
PRS D65169.541 $-138.536$ $-0.9$ $32.3$ $85.3$ $8.9$ PRS D105369.499 $-138.447$ $-16$ $32.9$ $78.0$ $112$ PRS E611969.383 $-138.437$ $-1.6$ $32.9$ $78.0$ $112$ PRS E1011069.557 $-138.309$ $-138.370$ $-16$ $32.7$ $69.3$ $162.1$ PRS E1011069.557 $-138.309$ $-113$ $32.6$ $84.3$ $52.2$ H7.36069.996 $-139.932$ $-12$ $32.7$ $69.3$ $162.1$ H3.56169.705 $-138.183$ $-14$ $32.6$ $80.3$ $122.1$ C. BathurstPRS A2969.705 $-138.935$ $-13$ $32.5$ $83.3$ $62.1$ 2008PRS A81069.457 $-138.935$ $31.2$ $90.4$ $0.4$ Herschel IslandPRS A29 $69.507$ $-138.935$ $31.2$ $90.4$ $0.4$ PRS A81069.452 $-138.935$ $31.2$ $90.4$ $0.4$ PRS A81069.452 $-138.937$ $-14$ $32.6$ $80.2$ $139.16$ PRS A101169.452 $-138.937$ $-14$ $32.6$ $80.2$ $139.16$ PRS A81069.452 $-138.937$ $-14$ $32.6$ $80.2$ $139.16$ PRS A101169.452 $-138.937$ $-14$ $32.6$ $80.2$ $139.16$ PRS A101369.352 $-14$ $32.6$ <		PBS D4	57	69 561	- 138 582	-16	32.9	78.4	
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $		PBS D6	51	69.541	- 138.536	-0.9	32.3	85.3	8.9
P85 D10         53         69.499         - 138.447         -         28.9         78.0         11.2           North of Herschel Is.         115         69.570         - 138.370         -         -         32.6         84.3         52.2           North of Herschel Is.         147.1         0.8         68.970         - 139.932         - 1.2         32.7         69.3         16.2           H 7.3         60         69.966         - 139.932         - 1.2         32.7         69.3         16.2           H 7.3         60         69.075         - 139.026         83.3         62.2           C Bathurst         78.6         11         69.452         - 138.957         0.8         31.2         90.4         0.4           P85 A6         11         69.458         - 138.957         0.8         31.2         90.4         0.4           P85 A6         11         69.452         - 138.957         0.8         31.2         90.4         0.4           P85 A6         11         69.457         - 138.957         0.8         31.2         90.4         0.4           P85 A1         16         69.12         - 138.907         -         1.3         59.7         0.4 <td></td> <td>PBS D8</td> <td>52</td> <td>69.521</td> <td>- 138.491</td> <td></td> <td></td> <td></td> <td></td>		PBS D8	52	69.521	- 138.491				
P85 E6         119         69.585         -138.437         -1.6         32.9         78.0         11.2           North of Herschel Is.         H7.1         38         69.857         -138.309         -         -         32.6         84.3         52.2           H7.3         60         69.966         -139.932         -1.2         32.7         69.3         16.2           H3.5         61         69.762         -138.974         -1.4         32.6         80.3         5.4           C. Bathurst         CB 1.2         24         70.05         -139.926         -         32.5         83.3         6.2           P85 A4         10         69.452         -139.926         -         -         32.5         83.3         6.2           P008         -         70.695         -139.926         -         -         -         32.5         83.3         6.2           P08 A2         10         69.452         -139.926         -         -         32.5         83.1         0.4           P18 A1         11         69.412         -138.937         -         1.1         31.8         97.2         -         -         -         -         -         -		PBS D10	53	69.499	- 138.447				
P85 E8         115         69.570         - 138.370           North of Herschel Is.         H 7.1         38         69.977         - 140.005         - 1.0         32.6         84.3         52.2           H 7.3         60         69.966         - 139.932         - 1.4         32.6         84.3         52.2           H 3.5         61         69.762         - 138.937         - 1.4         32.7         69.3         16.2           H 3.3         39         69.705         - 139.183         - 1.4         32.7         79.0         5.4           C Bathurst         P85         A2         79         69.507         - 139.026         - 13         31.2         90.4         0.4           P85         A11         69.458         - 138.945         0.8         31.2         90.4         0.4           P85         A11         69.458         - 138.945         0.8         31.2         90.4         0.4           P85         A3         10         69.453         - 138.945         0.8         31.2         90.4         0.4           P85         A5         C         69.4         69.57         - 138.945         0.8         31.2         90.4         0.4 <td></td> <td>PBS E6</td> <td>119</td> <td>69.585</td> <td>-138.437</td> <td>-1.6</td> <td>32.9</td> <td>78.0</td> <td>11.2</td>		PBS E6	119	69.585	-138.437	-1.6	32.9	78.0	11.2
PBS F10         110         60.557         - 138.309           North of Herschel Is.         H 7.1         38         60.966         - 1.0         32.6         80.3         15.2           H 7.3         60         60.966         - 139.932         - 1.4         32.6         80.3         15.2           H 3.3         99         69.705         - 139.183         - 1.4         32.6         83.3         6.2           C. Bathurst         C B 1.2         24         70.666         - 1.3         32.5         83.3         6.2           2008         -         -         138.945         0.8         31.2         90.4         0.4           PBS A6         10         69.452         - 138.945         0.8         31.2         90.4         0.4           PBS A6         10         69.452         - 138.945         0.8         31.2         90.4         0.4           PBS A6         10         69.452         - 138.945         0.8         31.2         90.4         0.4           PBS A5         62         69.447         - 138.945         0.8         31.2         90.4         0.4           PBS A5         63         69.451         - 138.751		PBS E8	115	69.570	-138.370				
North of Herschel Is.         H 7.1         38         69.877 $-140005$ $-1.0$ 32.6         84.3         52.2           H 35         61         60.762 $-139.932$ $-12$ 32.7         69.3         16.2           H 35         61         60.762 $-138.974$ $-1.4$ 32.6         80.3         12.2           C. Bathurst         C B 1.2         24         70.666 $-128.840$ $-1.4$ 32.7         79.0         5.4           2008		PBS E10	110	69.557	-138.309				
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	North of Herschel Is.	H 7.1	38	69.877	-140.005	-1.0	32.6	84.3	52.2
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$		H 7.3	60	69.996	- 139.932	-1.2	32.7	69.3	16.2
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $		H 3.5	61	69.762	-138.974	-1.4	32.6	80.3	12.2
C. Bathurst       C. B 1.2       24       70.696       -128.840       -1.3       32.5       83.3       6.2         2008       -       -       -139.026       -		H 3.3	39	69.705	- 139.183	-1.4	32.7	79.0	5.4
2008           Herschel Island         PBS A2         9         69.57         - 139.026           PBS A4         10         69.482         - 138.945         0.8         31.2         90.4         0.4           PBS A6         11         69.482         - 138.907         0.4         0.4           PBS A6         10         69.435         - 138.907         0.4         0.4           PBS A10         11         69.412         - 138.937         0.4         0.4           PBS B5         62         69.447         - 138.934         0.4         0.4           PBS B7         54         69.512         - 138.934         0.4         0.4           PBS C2         14         69.551         - 138.766         -1.1         31.8         97.2           PBS C6         14         69.551         - 138.766         -1.1         31.5         89.7         0.4           PBS C6         14         69.551         - 138.766         -1.4         32.6         78.7         6.9           Kug a0         33         70.10         - 138.79         -1.4         29.8         95.2         0.8           Kug a0         33         70.10         - 133.78	C. Bathurst	CB 1.2	24	70.696	-128.840	-1.3	32.5	83.3	6.2
Herschel Island       PBS A2       9       69507       -139.026         Herschel Island       PBS A4       10       69.492       -138.985         PBS A6       11       69.435       -138.907       0.8       31.2       90.4       0.4         PBS A8       10       69.435       -138.907       0.8       31.2       90.4       0.4         PBS A10       11       69.412       -138.870       0.8       31.2       90.4       0.4         PBS B5       62       69.447       -138.851       0.8       31.2       90.4       0.4         PBS B7       54       69.512       -138.702       -       -       -       -         PBS C2       14       69.537       -138.756       -1.1       31.8       97.2       0.4         PBS C3       15       69.41       -138.702       -       -       1.8       97.2       0.4         PBS C4       14       69.537       -138.702       -       -       1.9       1.9       1.9       1.9       1.9       1.9       1.9       1.9       1.9       1.9       1.9       1.9       1.9       1.9       1.9       1.9       1.9       1.9       <	2000								
Introduct Island       Ibb 72       5       00.307       - 135280         PBS A4       10       69.458       - 138.985       90.4       0.4         PBS A8       10       69.458       - 138.895       90.4       0.4         PBS A8       10       69.435       - 138.870       90.4       0.4         PBS B5       62       69.447       - 138.830       97.2       98.8         PBS B5       62       69.447       - 138.870       97.2       98.8         PBS C2       14       69.512       - 138.766       -0.1       31.5       89.7       0.4         PBS C6       14       69.512       - 138.766       -0.1       31.5       89.7       0.4         PBS C6       14       69.512       - 138.766       -0.1       31.5       89.7       0.4         PBS C8       15       69.491       - 138.3792       -       -       -       -         Vagmallit Bay       H3.1       25       69.521       - 138.490       -       -       -       -       6.9         Kugmallit Bay       KUG 10       8       69.46       - 133.39       -       -       -       -       6.9       -<	2000 Herschel Island	DBS AD	0	69 507	- 130 026				
Hab Frid       10       69.432       -138.845       0.8       31.2       90.4       0.4         PBS A6       11       69.435       -138.807       10 <t< td=""><td>Tiersener Island</td><td>PBS A4</td><td>10</td><td>69.482</td><td>- 138 985</td><td></td><td></td><td></td><td></td></t<>	Tiersener Island	PBS A4	10	69.482	- 138 985				
Ibbs A8         10         60.43         138.907         10.41         60.41         60.41         60.41           PBS A10         11         69.412         -138.807         -138.907         -138.917           PBS b5         62         69.447         -138.831         -         -           PBS b5         62         69.467         -138.853         -         -           PBS C4         14         69.564         -138.792         -         -           PBS C6         14         69.512         -138.756         -         1.1         31.8         97.2           PBS C6         14         69.512         -138.756         -         1.1         31.8         97.2           PBS C6         14         69.512         -138.756         -         1.1         31.8         97.2           PBS C6         14         69.512         -138.756         -         1.4         32.6         80.2         13.9           PBS C6         14         69.51         -138.356         -         1.4         32.6         78.7         6.9           Kugmallit Bay         KUG 10         8         69.646         -133.39         -         1.1         6.9		PBS A6	10	69.458	- 138,945	0.8	31.2	90.4	0.4
PBS A10       11       69412       -138.870         PBS B5       62       69.447       -138.831         PBS B5       62       69.512       -138.924         PBS B6       68       69.467       -138.853         PBS C2       14       69.564       -1.1       31.8       97.2         PBS C6       14       69.577       -138.716       -0.1       31.5       89.7       0.4         PBS C6       14       69.512       -138.716       -0.1       31.5       89.7       0.4         PBS C6       14       69.512       -138.716       -0.1       31.5       89.7       0.4         PBS C6       14       69.512       -138.730       -       -       -       -         PBS C6       14       69.521       -138.769       -       <		PBS A8	10	69.435	- 138 907	0.0	51.2	50.1	0.1
PBS B5       62       69.447       -138.831         PBS B7       54       69.512       -138.824         PBS B8       68       69.467       -138.824         PBS C2       14       69.567       -138.736         PBS C2       14       69.537       -138.756       -1.1       31.8       97.2         PBS C6       14       69.512       -138.716       -0.1       31.5       89.7       0.4         PBS C6       14       69.512       -138.736       -1.4       32.6       80.2       13.9         PBS C6       50       69.541       -138.736       -1.4       32.6       80.2       13.9         PBS D8       50       69.521       -138.400       -       -       -       -         Kugmallit Bay       KUG 10       8       69.466       -139.395       -       -       -       -         KUG 30       33       70.104       -133.781       4.1       29.8       95.2       0.8         KUG 30       33       70.104       -133.479       -1.2       32.2       89.8       3.3         KUG 400       120       70.891       -134.751       -1.4       32.7       7.6 <td></td> <td>PBS A10</td> <td>11</td> <td>69.412</td> <td>-138.870</td> <td></td> <td></td> <td></td> <td></td>		PBS A10	11	69.412	-138.870				
PBS B7       54       69.512       -138.924         PBS B8       68       69.467       -138.853         PBS C2       14       69.564       -138.750         PBS C4       14       69.512       -1.1       31.8       97.2         PBS C6       14       69.512       -1.38.756       -1.1       31.5       89.7       0.4         PBS C6       14       69.512       -138.716       -0.1       31.5       89.7       0.4         PBS C6       14       69.512       -138.716       -0.1       31.5       89.7       0.4         PBS C6       50       69.491       -138.536       -1.4       32.6       80.2       13.9         PBS D6       50       69.521       -138.490       -       -       -       -         KUG 100       8       69.766       -133.339       -1.4       22.6       78.7       6.9         KUG 30       33       70.104       -133.879       -1.2       32.2       89.8       3.3         KUG 100       120       70.390       -134.197       -1.5       32.3       80.6       4.1         Mackenzie Bay       SCR 15       22       69.897       -13		PBS B5	62	69.447	-138.831				
PBS B8       68       69467       -138.853         PBS C2       14       69.564       -138.792         PBS C4       14       69.537       -1.1       31.8       97.2         PBS C6       14       69.512       -138.716       -0.1       31.5       89.7       0.4         PBS C6       14       69.512       -138.716       -0.1       31.5       89.7       0.4         PBS C6       50       69.491       -138.679       - <td></td> <td>PBS B7</td> <td>54</td> <td>69.512</td> <td>-138.924</td> <td></td> <td></td> <td></td> <td></td>		PBS B7	54	69.512	-138.924				
PBS C2       14       69.564       -138.792         PBS C4       14       69.512       -138.756       -1.1       31.8       97.2         PBS C6       14       69.512       -138.756       -0.1       31.5       89.7       0.4         PBS C8       15       69.491       -138.679       -		PBS B8	68	69.467	- 138.853				
PBS C4       14       69.537       -138.756       -1.1       31.8       97.2         PBS C6       14       69.512       -138.716       -0.1       31.5       89.7       0.4         PBS C6       14       69.512       -138.716       -0.1       31.5       89.7       0.4         PBS C6       15       69.491       -138.576       -1.4       32.6       80.2       13.9         PBS D8       50       69.521       -138.490       -       -       -       -         Kugmallit Bay       KUG 10       8       69.766       -133.339       -       -       -       -       -         Kug C30       33       70.104       -133.781       4.1       29.8       95.2       0.8         KUG 30       33       70.104       -133.787       -1.2       32.2       89.8       3.3         KUG 30       33       70.300       -134.197       -1.5       32.3       80.6       4.1         Mackenzie Bay       KUG 100       120       70.891       -137.040       -1.5       31.9       92.2         Franklin Bay       SWB 1       38       70.457       -127.455       5.1       31.7       95.0 </td <td></td> <td>PBS C2</td> <td>14</td> <td>69.564</td> <td>-138.792</td> <td></td> <td></td> <td></td> <td></td>		PBS C2	14	69.564	-138.792				
PBS C6       14       69.512       -138.716       -0.1       31.5       89.7       0.4         PBS C8       15       69.491       -138.679       -       -       32.6       80.2       13.9         PBS D6       50       69.521       -138.490       -       -       32.6       80.2       13.9         Kugmallit Bay       KUG 10       8       69.746       -133.339       -		PBS C4	14	69.537	-138.756	-1.1	31.8	97.2	
PBS C8       15       69.491       -138.679         PBS D6       50       69.541       -138.536       -1.4       32.6       80.2       13.9         PBS D8       50       69.521       -138.490       -		PBS C6	14	69.512	- 138.716	-0.1	31.5	89.7	0.4
PBS D6       50       69.541       -138.536       -1.4       32.6       80.2       13.9         PBS D8       50       69.521       -138.490		PBS C8	15	69.491	- 138.679				
PBS D8       50       69.521       -138.490         Kugmallit Bay       H 3.1       25       69.646       -139.395       -1.4       32.6       78.7       6.9         Kugmallit Bay       KUG 10       8       69.746       -133.339       - </td <td></td> <td>PBS D6</td> <td>50</td> <td>69.541</td> <td>- 138.536</td> <td>-1.4</td> <td>32.6</td> <td>80.2</td> <td>13.9</td>		PBS D6	50	69.541	- 138.536	-1.4	32.6	80.2	13.9
H 3.1       25       69.646       -139.395       -1.4       32.6       78.7       6.9         Kugmallit Bay       KUG 10       8       69.746       -133.339       -       -       129.8       95.2       0.8         KUG 20       21       69.992       -133.781       4.1       29.8       95.2       0.8         KUG 30       33       70.104       -138.879       -1.2       32.2       89.8       3.3         KUG 50       53       70.390       -134.197       -1.5       32.3       80.6       4.1         Mackenzie Bay       SCR 15       22       69.897       -136.344       -1.5       31.9       92.2         Franklin Bay       SWB 1       38       70.457       -127.455       5.1       31.7       95.0         Franklin Bay       SWB 0       70       70.531       -127.555       0.2       32.6       85.2         FRK 1       51       69.867       -125.568       -       -       -       28.4         Damley Bay       CP 1       46       70.220       -124.616       2.8       0.5		PBS D8	50	69.521	- 138.490				
Kugmalint Bay       KUG 10       8       69.746       - 133.39         KUG 20       21       69.992       - 133.781       4.1       29.8       95.2       0.8         KUG 30       33       70.104       - 133.879       - 1.2       32.2       89.8       3.3         KUG 50       53       70.300       - 134.197       - 1.5       32.3       80.6       4.1         KUG 100       120       70.891       - 134.751       - 1.4       32.7       73.6       15.7         Mackenzie Bay       SCR 15       22       69.897       - 136.344       - 1.5       31.9       92.2         Franklin Bay       SWB 1       38       70.457       - 127.455       5.1       31.7       95.0         Franklin Bay       SWB 0       70       70.531       - 127.555       0.2       32.6       85.2         FK 1       51       69.867       - 125.568       -       -       -       -         Damley Bay       CP 1       46       70.220       - 124.616       -       2.8       -         CP 2       70       70.251       - 124.654       -       0.5       0.5		H 3.1	25	69.646	- 139.395	-1.4	32.6	78.7	6.9
K0G 20       21       05.992       -133.781       4.1       29.8       95.2       0.8         KUG 30       33       70.104       -133.879       -1.2       32.2       89.8       3.3         KUG 50       53       70.390       -134.197       -1.5       32.3       80.6       4.1         KUG 100       120       70.891       -134.751       -1.4       32.7       73.6       15.7         Mackenzie Bay       SCR 15       22       69.897       -136.344       -1.5       31.9       92.2         GRY K       45       69.913       -137.040       -1.5       32.5       73.0         Franklin Bay       SWB 1       38       70.457       -127.455       5.1       31.7       95.0         SWB 0       70       70.531       -127.555       0.2       32.6       85.2         SWB 0       70       70.531       -127.556       0.2       32.6       85.2         MFA 1       55       71.156       -128.495       -1.0       32.7       83.4         Damley Bay       CP 1       46       70.220       -124.616       2.8       0.5	Kugmallit Bay	KUG 10	8 21	69.746	- 133,339	A 1	20.9	05.2	0.8
K0G 50       53       70.104       -135.679       -1.2       52.2       58.6       5.3         KUG 50       53       70.390       -134.197       -1.5       32.3       80.6       4.1         KUG 100       120       70.891       -134.751       -1.4       32.7       73.6       15.7         Mackenzie Bay       SCR 15       22       69.897       -136.344       -1.5       31.9       92.2         GRY K       45       69.913       -137.040       -1.5       32.5       73.0         Franklin Bay       SWB 1       38       70.457       -127.455       5.1       31.7       95.0         KK 1       51       69.867       -127.555       0.2       32.6       85.2         Franklin Bay       SWB 0       70       70.531       -127.556       0.2       32.6       85.2         FRK 1       51       69.867       -125.568		KUG 20	21	69.992	- 133./81	4.1	29.8	95.2	0.8
K03 50       55       70.550       -134.157       -1.5       32.5       60.0       4.1         KUG 100       120       70.891       -134.757       -1.4       32.7       73.6       15.7         Mackenzie Bay       SCR 15       22       69.897       -136.344       -1.5       31.9       92.2         GRY K       45       69.913       -137.040       -1.5       32.5       73.0         Franklin Bay       SWB 1       38       70.457       -127.455       5.1       31.7       95.0         SWB 0       70       70.531       -127.525       0.2       32.6       85.2         FRK 1       51       69.867       -125.568       -10       32.7       83.4         Damley Bay       CP 1       46       70.220       -124.616       2.8       2.8         CP 2       70       70.251       -124.654       0.5       0.5		KUG 30	52 52	70.104	- 133.879	- 1.2 - 1.5	32.2 33 3	09.0 80.6	د.د 4 1
Mackenzie Bay       SCR 150       22       69.897       - 136.344       - 1.5       31.9       92.2         Franklin Bay       GRY K       45       69.913       - 137.040       - 1.5       32.5       73.0         Franklin Bay       SWB 1       38       70.457       - 127.455       5.1       31.7       95.0         Franklin Bay       SWB 0       70       70.531       - 127.525       0.2       32.6       85.2         FRK 1       51       69.867       - 125.568       -       -       -       2.8         Damley Bay       CP 1       46       70.220       - 124.616       2.8       2.8         CP 2       70       70.251       - 124.654       0.5       0.5		KUG 30	120	70.350	- 134.197	-1.5 -1.4	32.5	73.6	15.7
GRY K     45     69.913     -137.040     -1.5     32.5     73.0       Franklin Bay     SWB 1     38     70.457     -127.455     5.1     31.7     95.0       SWB 0     70     70.531     -127.525     0.2     32.6     85.2       FRK 1     51     69.867     -125.568	Mackenzie Bay	SCR 15	220	69.897	- 136 344	-15	31.9	92.2	13.1
Franklin Bay     SWB 1     38     70.457     -127.455     5.1     31.7     95.0       SWB 0     70     70.531     -127.525     0.2     32.6     85.2       FRK 1     51     69.867     -125.568     -       WFA 1     55     71.156     -128.495     -1.0     32.7     83.4       Damley Bay     CP 1     46     70.220     -124.616     2.8       CP 2     70     70.251     -124.654     0.5	mackenizie bay	GRY K	45	69.037	- 137 040	-15	32.5	73.0	
Sime     Sime     Sime     Sime       SWB 0     70     70.531     -127.525     0.2     32.6     85.2       FRK 1     51     69.867     -125.568	Franklin Bav	SWB 1	38	70.457	- 127.455	5.1	31.7	95.0	
FRK 1     51     69.867     -125.568       WFA 1     55     71.156     -128.495     -1.0     32.7     83.4       Damley Bay     CP 1     46     70.220     -124.616     2.8       CP 2     70     70.251     -124.654     0.5	- ramani buy	SWB 0	70	70.531	-127.525	0.2	32.6	85.2	
WFA 1         55         71.156         -128.495         -1.0         32.7         83.4           Damley Bay         CP 1         46         70.220         -124.616         2.8           CP 2         70         70.251         -124.654         0.5		FRK 1	51	69.867	- 125.568				
Damley Bay         CP 1         46         70.220         -124.616         2.8           CP 2         70         70.251         -124.654         0.5		WFA 1	55	71.156	- 128.495	-1.0	32.7	83.4	
CP 2 70 70.251 - 124.654 0.5	Darnley Bay	CP 1	46	70.220	-124.616				2.8
		CP 2	70	70.251	- 124.654				0.5

Download English Version:

https://daneshyari.com/en/article/4548083

Download Persian Version:

https://daneshyari.com/article/4548083

Daneshyari.com