

Population demography of high arctic caribou on Banks and Melville Islands

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Abstract: Caribou numbers, *Rangifer tarandus pearyi*, (excluding calves) on Banks Island were estimated (standard error of the estimate) at 1005 (SE±133) in 1992, 709 (SE±128) in 1994 and 436 (SE±71) in 1998; no paired estimates were different ($P < 0.05$). On Melville Island caribou numbers were similar in 1987 and 1997 with estimates of 729 (SE±104) and 787 (SE±97), respectively. We conducted annual sex and age classification surveys during July on Banks Island from 1994–2000 and on Melville Island from 1998–2000. The number of calves per 100 ≥two-year-old females ranged from 24.0 in 1994 to 74.3 in 1998 on Banks Island, and from 44.8 in 1999 to 80.0 in 1998 on Melville Island. Recruitment rate ranged from 18.6% during 1997/1998 to 27.5% during 1999/2000 on Banks Island and from 16.7% during 1997/1998 to 25.0% during 1999/2000 on Melville Island. There has been an increasing trend in the rate of recruitment on both islands during the last three years of the study.

Key words: calf production, population size, *Rangifer tarandus pearyi*, recruitment.

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Introduction

Peary caribou (*Rangifer tarandus pearyi*) inhabit the Canadian High Arctic and were designated as an endangered subspecies by the Committee on the Status of Endangered Species in Canada (COSEWIC) in 1991. Current estimates of Peary caribou numbers are lower than the first estimates determined in the 1960s and 1970s. Severe winter weather has been associated with die-offs throughout the High Arctic and is believed to be the major cause of the reduction in numbers (Parker et al., 1975; Gunn, 1992). Unfortunately, data to critically assess causes are lacking. Over much of the Peary caribou range few systematic population surveys have been conducted and the periods between surveys can be measured in decades. Data on estimates of calf production, survival and recruitment are limited (Larter & Nagy, 2000a). Data from Banks Island are a notable exception.

Nagy et al. (1996) described population demography of Peary caribou on Banks Island from 1982–

1992. The decline in numbers over this 10-year period was attributed to the cumulative effects of a combination of factors including human harvest, wolf predation, interisland movement, severe winters, and possible competition from an increasing muskoxen (*Ovibos moschatus*) population. Systematic population surveys for Banks Island caribou continued through the 1990s, and since 1994, annual sex and age classification surveys have been conducted. An annual quota of 36 male only caribou has been in effect for the community of Sachs Harbour since 1992. This quota was met during 1993–94 but harvest has never exceeded 23 animals in any other year.

There are fewer data on the caribou population of neighbouring Melville Island. Although the Melville and Banks Island caribou populations represent two different recovery units in the national Peary caribou recovery strategy, these two populations have little genetic differentiation (Zittlau et al., this issue). Annual sex and age classification surveys of the Melville Island caribou population were initi-

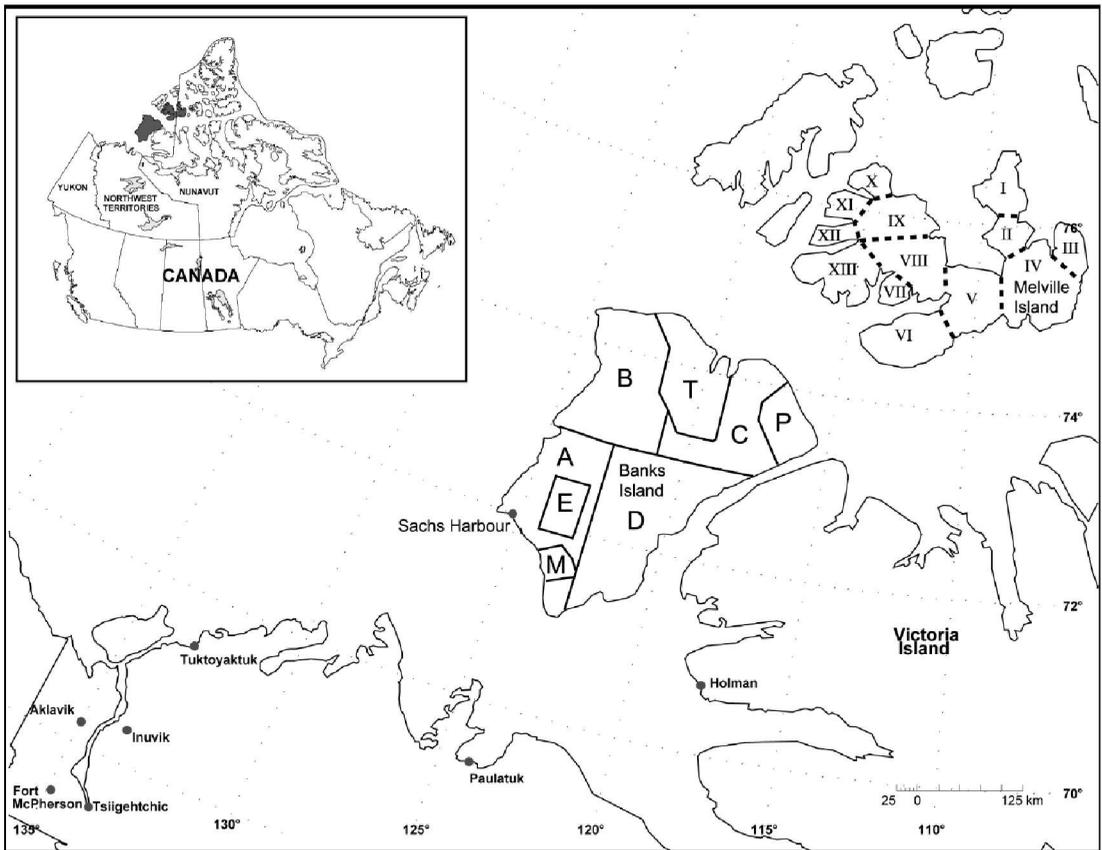


Fig. 1. The study area, Banks and Melville Islands in the western Arctic Archipelago. Note: Banks Island is delineated into the eight survey strata: A, B, C, D, E (Egg), M (Masik), T (Thomsen), and P (Parker). Melville Island is delineated into the 13 survey strata.

ated in 1998. The most recent population survey of Melville Island caribou was conducted in 1997, ten years after the previous survey. There are plans for systematic population surveys to be carried out on Melville Island every five years. There is no settlement on Melville Island and neither caribou nor arctic wolves (*Canis lupus arctos*) are hunted. This paper documents estimates of calf production and recruitment for Banks Island Peary caribou from 1994-2000 and for Melville Island from 1998-2000. The results are discussed in relation to current population estimates.

Study Area

Banks Island is the most western island in the Canadian Arctic Archipelago and covers an area of approximately 70 000 km² (Fig. 1). The climate is Arctic Maritime along coastal areas where weather stations are situated, tending toward Arctic Desert inland (Zoltai et al., 1980). Winters are long, with

mean monthly temperatures below 0 °C from September through May, and cold, with mean minimum daily temperatures of -30 °C to -40 °C from December to March. Summers are short and cool; mean maximum daily temperatures of 5 °C to 10 °C from June through August. There is little precipitation, annual mean nine cm (Zoltai et al., 1980). Sachs Harbour (population 153 in 2000; N.W.T. Bureau of Statistics) is the only permanent settlement. Zoltai et al. (1980) provided a general overview of the geology and glacial history of Banks Island.

There are four major terrestrial habitats: wet sedge meadow (WSM), upland barren (UB), hummock tundra (HT), and stony barren (SB). WSM are generally level lowlands dominated by sedges (*Carex aquatilis* and *Eriophorum scheuchzeri*). UB and HT are well-drained sites found on slopes. Vegetation is dominated by mountain avens (*Dryas integrifolia*) and willow (*Salix arctica*). HT is characterized by individual vegetated hummocks. SB are sparsely vegetat-

ed with a gravelly substrate and are found on wind blown areas, ridges, and gravel and sand bars. A more detailed description of the flora of Banks Island can be found in Wilkinson et al. (1976), Porsild & Cody (1980), and Zoltai et al. (1980).

Muskoxen and caribou are resident ungulates. In 1994 the muskoxen population was at a historic high, estimated at 64 608 (SE \pm 2009) \geq one-year-old animals. Arctic wolves, arctic foxes (*Alopex lagopus*), and polar bears (*Ursus maritimus*) are resident predators.

Melville Island, located northeast of Banks Island, is the largest island of the Parry Islands group and covers an area of approximately 42 000 km² (Fig. 1.). Winters are long and summers cool and short. Although there are no weather stations on Melville Island, records from Mould Bay (76°14'N; 119°20'W) and Resolute Bay (74°43'N; 94°59'W) show that the mean maximum daily temperature is below 0 °C starting in September with mean monthly temperatures of -34 °C in February and 4 °C in July, the coldest and warmest months. The island is geologically divided into three distinct structural provinces (Tozer & Thorsteinsson, 1964). Eastern and central Melville Island (east of 112 °W) is generally low, <150 m above mean sea level (amsl), and flat. Western Melville Island is mainly plateau ranging from 300-600 m amsl with steep walled drainages and some peaks rising to 1100 m amsl.

Vegetation cover is prostrate and generally sparse consisting of lichens, bryophytes, graminoids, herbs, cushion plants and shrubs (Babb & Bliss, 1974; Edlund & Alt, 1989). Babb & Bliss (1974) describe four general cover types: polar desert, polar semi-desert, diverse terrain, and wet sedge-moss meadows. Polar deserts are devoid of woody shrubs and have 0-10% plant cover. Polar semi-deserts may have some moister areas and 5-20% cover of vascular plants including *Luzula* spp., *Papaver* spp., *Saxifraga* spp., and *Draba* spp. Diverse terrain areas are more mesic than polar semi-deserts. Mats of woody species (*Cassiope tetragona*, *Dryas integrifolia*, and *Salix arctica*) are interspersed throughout and in moist depression areas patches of moss-graminoid meadows occur. Wet sedge-moss meadows are large areas dominated by a continuous layer of mosses and sedges or grasses. A more detailed description of the flora of Melville Island can be found in Thomas et al. (1999).

Muskoxen and caribou are resident ungulates on Melville Island. In 1997 the muskoxen population was estimated (standard error of the estimate) at 2258 (SE \pm 268) \geq one-year-old animals (A. Gunn & J. Dragon, unpubl. data), and had declined since the previous estimate of 4761 (SE \pm 372) in 1987 (Miller,

1988). Arctic wolves, arctic foxes, and polar bears are resident predators.

Methods

Population Estimates

Banks Island

Islandwide surveys were conducted during summers 1992, 1994, and 1998 and were designed to estimate muskox and Peary caribou population sizes. Surveys were conducted in July-early August, except in 1992 when the survey was conducted in late August. Censuses were conducted using fixed-wing aircraft (Helio-Courier and Cessna 185) and strip-transect techniques with a stratified design; the transect was the sampling unit (Norton-Griffiths, 1978). Banks Island was stratified into eight strata based upon a combination of geographic area and muskox density determined from previous surveys (see Fig. 1). Transect lines were flown at fixed altitudes. We attempted to maintain an altitude of 150 m above ground level (agl). Animals were counted within fixed strips on either side of the aircraft. Markers were placed on the aircraft wing struts to bound the strips (following Norton-Griffiths, 1978). Strip width was 500 m on each side of the aircraft. We attempted to maintain an airspeed of 160 km/hr.

Each stratum was flown at 20% coverage except for the Egg (E) and Masik (M) (Fig. 1) where coverage was 40%. After the initial islandwide survey was completed, areas of high caribou density were blocked off and reflown at 40% coverage. Population estimates (animals \geq one-year-old) for all years were derived by the Jolly (1969) method for unequal sized sampling units. We present estimated population number and the standard error of the estimate (Norton-Griffiths, 1978). Observations from the reflown blocks of high caribou density were used for the population estimate. Observations from the original coverage of areas blocked off as high density caribou areas were not included in the population estimate being replaced by the reflown observations.

We tested for differences in population estimates between years following the formula described in Norton-Griffiths (1978) and adapted from Cochran (1954).

Melville Island

Islandwide aerial surveys were conducted in 1987 and 1997 to estimate caribou and muskox populations (Miller, 1988; A. Gunn & J. Dragon, unpubl. data). Both surveys used a strip-transect technique with a stratified design; the transect was the sampling unit (Norton-Griffiths, 1978). The island was stratified into 13 strata based upon geographic area

Table 1. The number of calves, yearlings, adult (\geq two-year-old) females, males, and unclassified adults from each classification survey conducted in July on Banks and Melville Islands.

	Banks Island					Melville Island				
	calves	yrlngs	ad. fem.	ad. mal.	unk. ad.	calves	yrlngs	ad. fem.	ad. mal.	unk. ad.
1994	6	9	25	7	0					
1995	3	2	5	3	16					
1996	8	4	12	10	0					
1997	6	4	15	23	4					
1998	52	16	70	18	0	12	3	15	16	0
1999	55	25	78	16	0	13	9	29	22	0
2000	21	14	37	8	0	17	9	27	4	0

(Fig. 1). In 1987, a Bell 206B helicopter was used. Transect lines were flown at 90 m agl and an airspeed of 160 km/hr. Parallel lines were flown 6.4 km apart; animals were counted within fixed strips of 857 m on each side of the aircraft resulting in an overall coverage of 27% (Miller, 1988). In 1997, a fixed-wing aircraft (Helio-Courier) was used. Transect lines were flown at 100 m agl at an airspeed of 160 km/hr. Parallel lines were flown that provided an overall coverage of 20% with animals being counted within fixed strips of 500 m on each side of the aircraft (A. Gunn & J. Dragon, unpubl. data). Population estimates (animals \geq one-year-old) for both surveys were derived by the Jolly (1969) method for unequal sized sampling units. We present estimated population number and the standard error of the estimate (Norton-Griffiths, 1978).

Classification Surveys

Banks Island

Surveys were conducted annually during July from 1994-2000. Three to six h flights were made by helicopter aircraft (Bell 206B or 206L) over the major historical calving and summer range located to the northwest of Banks Island (Urquhart, 1973). Caribou were spotted from the air and the survey crew, generally an observer and a recorder, was positioned on the ground in such a way as to minimize disturbance of the animals. The survey crew moved into a position where the animals could be observed with a spotting scope (15-45x) or binoculars (7x24). Caribou were classified into calves, yearlings, adult females (\geq two-years-old), and adult males (\geq two-years-old). Occasionally, small groups of adult males (one-three) or dam-calf pairs were classified from the air. In 1994 and 1998, aerial reconnaissance by fixed-wing aircraft involved in the Banks Island population survey identified areas of local caribou concentration in the summering grounds prior to the

classification survey and the helicopter flew directly to these areas.

Melville Island

Surveys were conducted annually in mid-July from 1998-2000. In 1998, the survey was based on opportunistic observations made during flights with a rotary aircraft (Bell 206L) concentrated over the Dundas Peninsula (Fig. 1; VI). This was in an area where Miller et al. (1973) had reported high densities of Peary caribou in August, 1972. In 1999, we flew over a much larger area of central and western Melville Island in an attempt to confirm that the majority of caribou were distributed on Dundas Peninsula during mid-July (Larter & Nagy, 2000b); the flight confirmed this. We blocked off a survey area bounded by 74°46'N to the north and 74°32'N to the south and flew eight parallel line transects, 26 km in length and spaced ca. 5.6 km apart, from 113°40'W eastward to 112°23'W. All groups of caribou observed within this area and during flights to and from the survey area were classified as described above. During the 2000 survey we added a ninth parallel transect to the east of the survey area on 112°12'W.

Demographic characteristics

We estimated calf production as the number of calves per 100 adult females determined in the July classification surveys. We realize that this estimate does not address neonatal mortality but surveys were conducted during the same three-week period in July and we believe any biases would be similar for each survey. We used the number of yearlings per 100 adult females divided by the sum of 100 plus the number of yearlings per 100 adult females to estimate annual recruitment rate, which we expressed as a percent. Because fewer than 15 animals were classified during the 1995 survey on Banks Island (Table 1), we made no estimates of pro-

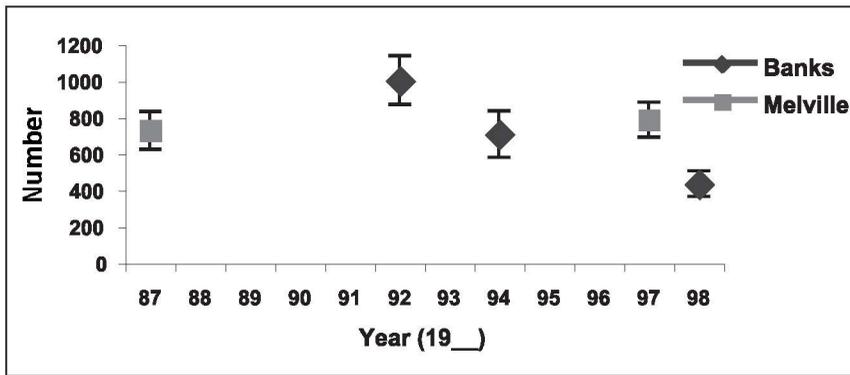


Fig. 2. Population estimates (\pm SE) of Peary caribou \geq one-year-old for Banks and Melville Islands.

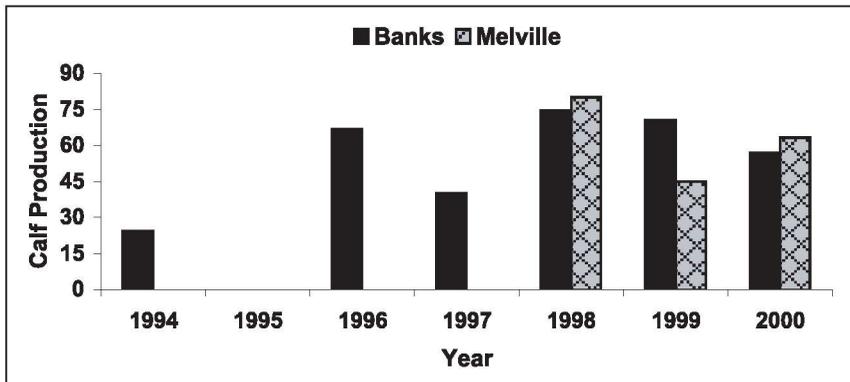


Fig. 3. Calf production (number of calves per 100 females \geq two-year-old) for caribou on Banks and Melville Islands.

duction or recruitment for this year. The four unknown adults from the 1997 survey on Banks Island (Table 1) were also excluded from the calculations. We used correlation analysis to assess any potential trends in calf production and recruitment rate over time for Banks and Melville Islands.

Results

Population estimates for Banks Island caribou were 1005 (SE \pm 133), 709 (SE \pm 128), and 436 (SE \pm 71) for 1992, 1994, and 1998, respectively (Fig. 2). None of the three estimates were different ($P < 0.05$). Population estimates for Melville Island caribou were 729 (SE \pm 104) and 787 (SE \pm 97) for 1987 and 1997, respectively (Fig. 2).

From 1994 to 2000, excluding 1995, we classified 34-174 animals per survey on Banks Island, and from 1998 to 2000 we classified 46-73 animals per survey on Melville Island (Table 1). Calf production on both Banks and Melville Islands had considerable variability, showing a slight increasing trend ($r = 0.64$; $P = 0.17$) from 1994-2000 on Banks Island

but a slight decreasing trend ($r = -0.48$; $P = 0.68$) from 1998-2000 on Melville Island (Fig. 3). Recruitment rate varied less than calf production, showing no trend on Banks Island from 1993/1994 to 1999/2000 ($P = 0.90$; Fig. 4) but a strongly increasing trend on Melville Island from 1997/1998 to 1999/2000 ($r = 0.93$; $P = 0.24$). A strongly increasing trend in recruitment rate occurred during the same three-year period for Banks Island ($r = 0.99$; $P = 0.10$).

Discussion

Although current population estimates of Banks and Melville Island caribou are lower than those of 20 years ago, both populations have remained

relatively stable since 1987 for Melville and since 1991 for Banks Island (Nagy et al., 1996). Annual calf production has been highly variable for both populations. The slight increasing trend in calf production on Banks Island is likely a result of low calf production in 1994. Larter & Nagy (2000a) documented 11 years of calf production on Banks Island and production in 1994 was the lowest recorded. The decreasing trend in calf production on Melville Island is likely a result of small sample size (three years) in combination with annual variability. Values reported for Melville Island fall well within those reported for Banks Island and other high arctic caribou and Svalbard reindeer populations reported elsewhere (Tyler, 1987; Miller, 1992).

High calf production does not necessarily translate into high recruitment. Calf mortality is one of the main factors affecting population growth of caribou and reindeer populations (Bergerud, 1971; Parker, 1972; Skogland, 1985; Tyler, 1987). Calf production and calf survival are both components of recruitment rate, therefore recruitment rate may provide better information on the potential for population change

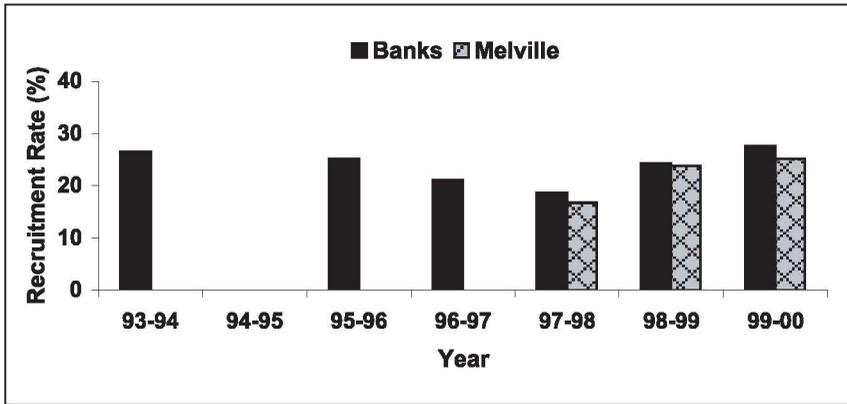


Fig. 4. Annual recruitment rate (%) of caribou on Banks and Melville Islands.

as our data suggest. Since 1998, the recruitment rate for both populations has shown a positive trend. Winter 1997/1998 was one of the mildest in recent years and had the least severe snow conditions, particularly snow depth, recorded on Banks Island during the period 1992/1993 to 1997/1998 (Larter & Nagy, 2000c; 2001a; R. Kuptana pers. comm). Whether snow conditions on Melville Island were of lesser severity during winter 1997/1998 is unknown.

During winter, legumes (*Astragalus* spp. and *Oxytropis* spp.) are an important dietary item for Banks Island caribou with their proportion in the diet being greater during years of shallower snow depth (Larter & Nagy 1997; N. Larter & J. Nagy unpubl. data). Shallower snow likely increases legume availability. During winter legumes remain highly digestible, and have a high crude protein content (ca. 13%), much higher than sedge and mountain avens which make up much of the remaining proportion of the winter diet (Larter & Nagy, 2001b). Improved access to a high quality winter diet may have had a positive effect on overwinter survival and/or calf production, which translated into increased recruitment. Whether improved access to a high quality winter diet continued during winters following 1997/1998 is unknown as comparative snow data collection ended.

The effect of wolf predation on these caribou populations remains unknown. Both Banks Island and neighbouring Victoria Island have a substantial alternate prey source, i.e. large muskoxen populations, which could sustain substantial wolf numbers. Harvest records and observations from local residents of both Sachs Harbour (Banks Island) and Holman (NW Victoria Island) indicate that wolf numbers have been increasing throughout the 1990s (Nagy & Larter, 2000; N. Larter & J. Nagy, unpubl. data). Between 40 and 50 wolves are generally observed on

whole island surveys of Banks Island and it is not uncommon to observe groups of 15-20 individuals. The alternate prey source is not as substantial on Melville Island, however during the whole island survey in 1997, 20 adult wolves and 12 pups were observed (A. Gunn & J. Dragon, unpubl. data).

Limited information on wolf diet from

Banks and Melville Island shows that muskoxen predominates (Nagy & Larter, 2000). However, wolf diet has been determined from opportunistic collections of wolf scats and the stomachs from harvested wolves, mostly collected during winter. Such sampling may not address wolf diet at key times of the year and from key locations. For example, on Banks Island, when caribou make their southerly migration from the calving and summer range (NW Banks Island), they pass adjacent to a high wolf density area. Non-selective predation on calves, yearlings, and adult females as caribou migrate through this area could go undetected by the current sampling regime. Nor would this type of predation be noticeable in our estimates of production or recruitment. Therefore, it is crucial that whole island population surveys be conducted at regular intervals so that production and recruitment estimates can be evaluated in their proper context.

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