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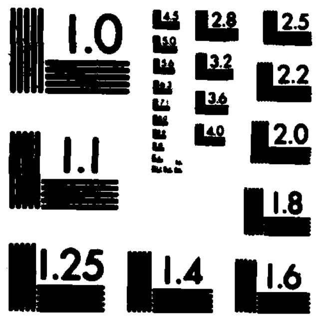

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REPLY TO
ATTENTION OF:

AST-1150R-100-87 | 6 February 1987

LETTER REPORT

COMMANDER

FEASIBILITY REPORT: OPERATION OF LIGHT AIR CUSHION VEHICLE
AT McMURDO SOUND, ANTARCTICA
BY J. STEPHEN DIBBERN

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Purpose

This report explores the viability of the use of an air cushion vehicle (ACV) or hovercraft to perform logistic and scientific support in the area of McMurdo Station, Antarctica.

Summary

After a review of personnel assets and facilities at McMurdo Station to support the ACV plus a reconnaissance of the five major routes selected, it appears that an air cushion vehicle in the 1 to 1 1/2 tonne payload class would be of significant value to support operations. It would reduce transit times for surface vehicle traverses on the routes selected and reduce requirements for expenditure of helicopter flight time in others. Of major significance is the ability to handle passenger/shuttle requirements between the Scott Base transition and Williams Field Skiway. Use of the ACV for high frequency passenger operations would help preserve the snow road for cargo operations during periods of road deterioration.

Purchase of such a vehicle is recommended for field operation during 1987/88 season.

Administrative

The general feasibility of this project was discussed in Letter Report: Vehicular Transport at McMurdo Station, Antarctica, 9 May 1986, AST-1150R-100-86 and by ITT Antarctic Services and National Science Foundation personnel during the previous season. As a result, the author and Mr. Anthony France, representative of the ACV manufacturer Frank W. Hake, Inc. visited McMurdo between 24 November and 8 December 1986 as event V-57. Mr. France will submit a separate report.

Discussion

1. Route Structure

The basic premise upon which this project is based is that an air cushion vehicle can be of value and operate well on a series of routes radiating from the US scientific station at McMurdo Sound. The study is predicated on previous observation of sea ice and ice shelf conditions and perceived needs by both the scientific and support committees.

There are five major routes with subdestinations within several. Briefly they include:

(1) McMurdo Station to Hutton Cliffs, Cape Evans, Cape Royds and Cape Bird. This route is along the east side of McMurdo Sound and is designed to satisfy logistical support for scientists, among them groups studying seals, diving groups observing under ice algae, biologists using fishing huts, penguin biologists, and many others. The previously used methods of transportation for this route were tractors on the short routes and helicopters for the longer ones.

(2) McMurdo Station to the ice edge (edge of annual sea ice). This route is used to support biologists who visit the ice edge to collect specimens using both scuba gear and drilling. Most of these trips were conducted using VXE-6 helicopters.

(3) Scott Base transition ramp to Williams Field Skiway. This route is used after the snow road begins to deteriorate during the second half of the summer season. The ACV would be used to transport passenger traffic now carried by Delta shuttles.

(4) Williams Field to Black Island. The ACV would be used on this route to replace some of the tractor traverses that can take up to 11 hours to transport repair crews and servicing personnel to the INMARSAT satellite communications site.

(5) McMurdo Station to New Harbor and Marble Point. New Harbor is a seasonal base for diving activity and biological collection. Dive holes are disbursed around the area and the ACV could be used both as a research platform and as a logistic vehicle and to facilitate personnel changes. Marble Point just north of New Harbor on the west side of the Sound, is the Navy's helicopter refuel facility. Marble Point is replenished with fuel and supplies early each summer season by tractor train. The ACV would not replace this tractor train as its payload is too small, but it could facilitate crew changes and logistic support, leaving the helicopters more time for scientific support.

2. Route Discussion

A complete reconnaissance was carried out by helicopter of all the routes and by tractor to Cape Evans. The following is a brief discussion of the five routes and their viability as operating areas for an air cushion vehicle.

(1) McMurdo to Hutton Cliffs, Cape Evans, Cape Royds and Cape Bird. The first 25 miles of the route to Cape Royds is crossed by very occasional low pressure ridges that offer almost no problem to ACV operation. The smooth, almost obstacle-free ice will allow high operating speeds and high overload payloads (higher payloads may be carried since in operations over solid surfaces, vs. over water, no wave making drag is experienced). This high-speed operating area will offer very high efficiencies but also will require a

solution to a problem. The point is that too high speeds can be achieved in this area and maneuver control and braking can be a serious problem. Two solutions are available: first is a requirement for well trained, mature operators, people who can resist the impulse to add too much speed; a second solution is to have a braking device installed in the ACV by the manufacturer. Such a drag-producing device would help considerably but would not eliminate the problem. On the first route as far as Cape Royds, no real obstacles will prevent regular operation (within weather limitations discussed later). However, beyond Cape Royds to Cape Bird does contain some problem areas. This final segment is not considered viable because of open water operations after the ice front moves south of Cape Bird (which is reportedly most of the season). Open water operations (other than across leads through ice pack) are not advised because with a single craft there would be no vehicle capable of safely rescuing the ACV if it were disabled. The VXE-6 helicopters do not have flotation gear and will not operate over water. Also there are no boats at McMurdo to perform rescues. Even allowing for short overwater operations in ideal weather, the ice foot on the beach at Cape Bird is frequently so high from frozen waves and jumbled blocks of pack that the ACV would not be able to come ashore. This problem is not universal along the beach, but a predictable landing area is not available, and a regular schedule could not be maintained. Landing areas need to be chosen at all the destinations that are well sheltered from storm winds. At Cape Evans the ACV should not be brought across the tide crack without some modification of the ice jumble at the transition. Under normal circumstances this would not seem to be necessary anyway since the north side of Cape Evans is a sheltered bay. At Cape Royds, drifts into Backdoor Bay offer a convenient ramp for offloading on the beach. This landing area is also some distance from the protected Adelie Penguin rookery area. It should be noted that overwater operations are quite feasible during the period when the USCG icebreakers are in the area. The Coast Guard helicopters have floating hulls and regularly operate over water thereby providing a safety net for overwater ACV operations. The only additional equipment needed is a spray skirt to reduce ice build-up on the ACV. (The Maryland Natural Resources Police successfully use such a skirt.)

(2) McMurdo to the Ice Front. This is basically included in the route discussed in (1) and will present the same features. The ice is almost obstacle-free other than a few low ice ridges, but the same speed and maneuver cautions are present. Because of the open area to be traversed, added caution concerning weather conditions is warranted (discussed later).

(3) Scott Base Transition to Williams Field. This route offers almost no problems other than speed control. The route is flat and ridge free and can support relatively high-speed operation. Shuttles could be run even in poor visibility using a small marine radar (discussed later) to navigate between simple corner reflectors at each end of the route. This is possible because of the lack of surface obstacles. This is the least trouble prone of the routes to traverse and would probably be hindered only by high winds (30+ mph).

(4) Williams Field (or McMurdo) to Black Island. This route is a similar route to the shuttle route (Scott-Willie) but is more than 50 miles longer. Flagged (or radar reflectored) routes must be used to stay out of crevassed or dirty ice areas, but there are no real obstacles along the selected route that runs between Black and White Islands around the south end and to the west of the island (see map). The route would end on the ice shelf about 1 and 1/2 miles below the INMARSAT location because the ACV cannot navigate the road uphill to the actual site. This has been deemed acceptable since either a small vehicle (such as a 4-wheel all-terrain vehicle, i.e., Honda, etc.) could be left there or even carried on the ACV. The payload to Black Island is frequently light electronic repair and testing equipment and personnel. Therefore even the necessity of walking from the ice shelf up to the site would be better than the 11+ hour drive from McMurdo.

(5) McMurdo to New Harbor and Marble Point. This is the route with the most problems (save Cape Bird) and will not be viable without extensive route preparation or extensive deviation around obstacles. The major obstacle is a large area of pressure ridges about two-thirds of the way out to Marble Point. It happens that this is a yearly recurring problem. The New Zealanders bulldozed a "road" through most of it this year to Butter Point (south of New Harbor). This could also be accomplished for the ACV but the path would need to be much wider (although not so smooth or well manicured) to allow direct passage. A second alternative is to select a more circuitous route through the least hazardous ridge areas and bulldoze only those few ridges while flagging (or again marking with radar reflectors) a route. Either of these alternatives is costly and labor intensive and neither would allow very high speeds. This route is listed as marginal, and careful study will be needed to determine its viability. It should be noted, however, that the possibility still exists in the New Harbor area for an ACV to be used as a dive platform over rotten ice as the season progresses, thereby extending the operating season. It would offer the payload, safety, and platform area to act as a mobile dive (or fishing) station.

3. Facilities and Personnel

Basing facilities should consist of an area to park the machine, storage for daily maintenance items such as filters, belts, and POL consumables, plus a small personnel shelter and workshop. Most of this could be conveniently provided on the ice front near the aquarium using the 40-foot container in which the machine is shipped. It could be converted into a small daily maintenance shop with the addition of electricity and communications. The vehicle itself should be left on the ice rather than daily attempting to cross the tide crack. Provision for tiedowns on the ice should be made in case of severe wind. The vehicle could be carried up to the hill on a flatbed trailer to the vehicle shop for heavy maintenance.

For one craft for a full season's operation it is felt that a crew of four could handle the entire workload: one full-time mechanic, one scheduler/clerk/mechanic/general helper and two operators. All four should receive basic operator training to help with moving the craft during maintenance and during heavy usage times when the shuttle is needed continuously on route (3) to Williams Field. Operators, as discussed before, should be chosen for their maturity. A good general background in mechanics would be of great value in operating the craft and training should include basic craft repairs. On any of the longer routes [(2), (4), and (5)] or during poor weather, a crew of two: operator and radar operator/relief crew will be required.

If the craft is delivered to the ice on the cargo ship (not flown) then it is recommended that an experienced operator be retained for limited late season operations and demonstrations. It would not be worthwhile to hire and to train operators for such a short period. Mechanical support could be obtained using local McMurdo light vehicle mechanics.

Seasonal overhaul and major repair work can be done with normal garage personnel. No special skills are required. Storage for the winter should be indoors, but it is not necessary to be in a heated area. The requirement would be for a space 35 feet long and 15 feet wide (reducible to about 8 feet when side decks are folded for shipment). A quick survey of the buildings at McMurdo showed that a number of buildings are suitable if space were made available in them. (Bldgs No. 340, 341, 342, 141, 185, etc.)

During operations there will be a requirement that the ACV group be fed frequent surface weather data and predictions from as many points on McMurdo Sound as is practical. During the visit it appeared that the wind on the ice was averaging 5 to 10 mph higher than in McMurdo (which is in the naturally protected bowl of Winterquarters Bay). Because of the limitations on operations in wind speeds of more than 30 mph, it is critical to know the surface conditions at both origin and destination. This information is already collected but the ACV operations people will need to have ready access to it.

4. Vehicle Features and Requirements

The reasoning behind the use of the ACV is based on both unique operating characteristics and economics. The ACV has a unique light footprint or ground pressure of less than 18 lb/ft^2. It is also amphibious. The light ground pressure allows it to operate over very weak surfaces such as the compacted snow on the route to Williams Field without either becoming immobilized or damaging the surface itself. It is a safety factor over areas of thin ice or over crevassed surfaces. Since it also floats it can safely be used in areas of even the thinnest ice for research or for rescue.

Since the ACV relies on aerodynamic propulsion it is limited in slope-climbing capability and braking. The slopes are taken into account by the route selection but the braking as mentioned should be of great concern. It is worth reiterating that driver selection is of paramount importance and that thought should be given to influencing the manufacturer to develop a drag producing or braking device.

Since the recommended vehicle uses a standard Deutz air cooled diesel engine, no specialized repair or maintenance personnel, equipment, or facility will be needed such as are required for aircraft or helicopter gas turbines. The same extends to the vehicle hull. The hull as it exists, however, is fabricated from sheet aluminum which would be somewhat vulnerable on the underside to damage by ice ridges and hummocks. Piercing the floor could cause the vehicle to lose its flotation and the safety factor which that affords. It is therefore recommended that the lower surface of the vehicle be reinforced by thicker plating even at the expense of payload. Since the rated payload is much higher over solid surfaces (such as ice) this should not adversely affect performance. It is also recommended that heavy duty skids be built onto the underside of the vehicle to allow towing it short distances without starting the engine. A winch for self-extraction when immobilized should be carried.

Operating costs also are reduced by use of the diesel engine. The normal craft has a payload over water of 1 1/2 metric tonnes (3300 lbs) and burns only 7 to 9 gallons of fuel per hour. The reduced cost of fuel and maintenance added to the lower pay scale and training costs of operators and mechanics mean that the ACV can be operated in temperate climates at between 7% and 10% of the cost per hour of a helicopter. (Estimates based on ACV usage vs. a commercial twin-engine helicopter--$125 vs. $1800/hr.) Although the cost estimates are based on temperate climate operations, it is felt that both would escalate by a like percentage at McMurdo and can therefore be used as a valid comparison.

The craft should be constructed according to Coast Guard certification standards. Regarding operators, the manufacturer should be contracted to provide sufficient training to insure an appropriate level of confidence. (The Maryland Natural Resource Police in Annapolis, MD have more experience in the operation of such a craft over water as well as ice and might be a good judge of driver skills.)

Finally, a hoist should be considered with the capability to load and unload at a minimum a full 55-gallon drum of DFA. Provision by hoist or by ramp should also be made to carry one or two Bombardier Alpine Snowmobiles.

Recommendations

It is recommended that the National Science Foundation fund the purchase of a single Hake/Griffon 1500 air cushion vehicle with a manufacturer-recommended spares package for use during the 1987-88 season at McMurdo Sound. Various options should be exercised or investigated: first is a marine radar to be used for navigation and obstacle avoidance in conditions of poor visibility; as already discussed, the bottom of the craft should be "armored" to prevent damage when operating over ice ridges. Skids also should be fabricated for the underside. Radios with sufficient capability to keep the craft in contact with one of the bases at all times should be installed.

Although the powerplant normally supplied will be adequate to perform the desired functions, an optional V-8 engine (from the same Duetz air cooled diesel "family") is now available that would substantially increase power. This would be very desirable in negotiating slopes or in heavy wind conditions; however, this is a "good to have option" and not essential. The craft with the V-8 option is known as the "1500 Super."

It is recommended that service personnel be provided as described (i.e., two operators, a mechanic, and a general helper) and that a container, used to ship the machine, be equipped to perform daily operational maintenance and act as a base of operations at the tide crack. The vehicle operators and other personnel should be hired and trained only for full year operations. The manufacturer's representative should be retained for the first seasons partial year operations in January-February 1988. It is strongly recommended, however, that thought be given to flying the ACV to McMurdo. This would afford an entire season for shakedown and for gaining operational experience before the critical period for its use from Scott Base Transition to Williams Field.

Table: Characteristics of Griffon-Hake
1500 TD Air Cushion Vehicle Engine:
Deutz BF6L913C 190 hp Air
Cooled Diesel

Length (ft)	33.3
Width (ft)	12.5
Width side bodies removed (ft)	7.3
Height off cushion (ft)	8.8
Cabin length (ft)	16.4
Cabin width (ft)	5.9
Payload (lb)	3307
Empty weight (lb)	5071
Maximum speed (mph)	38
Cruise speed (mph)	31
Passengers	17
Crew	[illegible]
Vertical obstacle clearance (in)	15
Maximum wind (mph)	29
Maximum wave height (in)	39

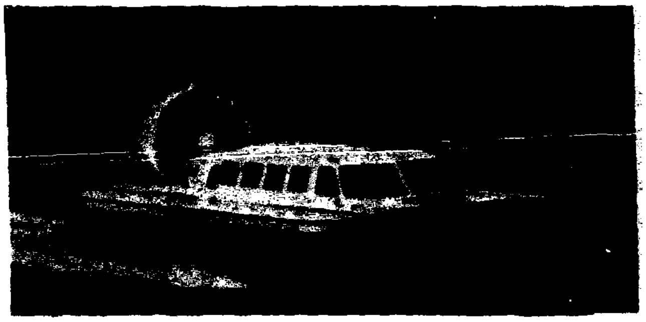

Figure 1. Griffon 1500
Operating Over Water

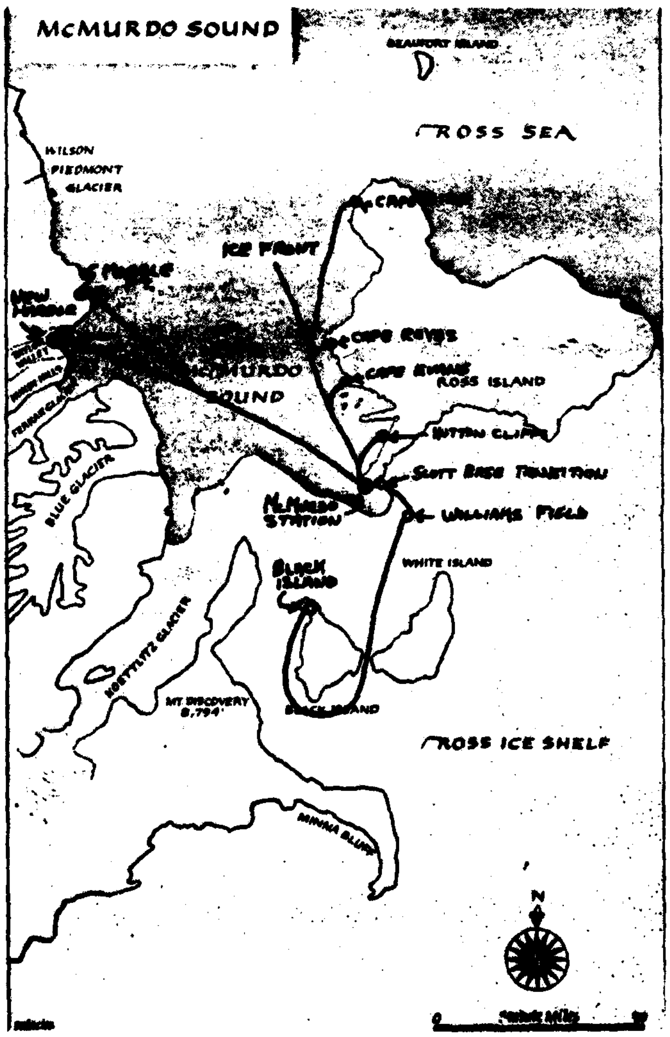

Figure 2. Map Illustrating Proposed
Routes for Air Cushion Vehicle

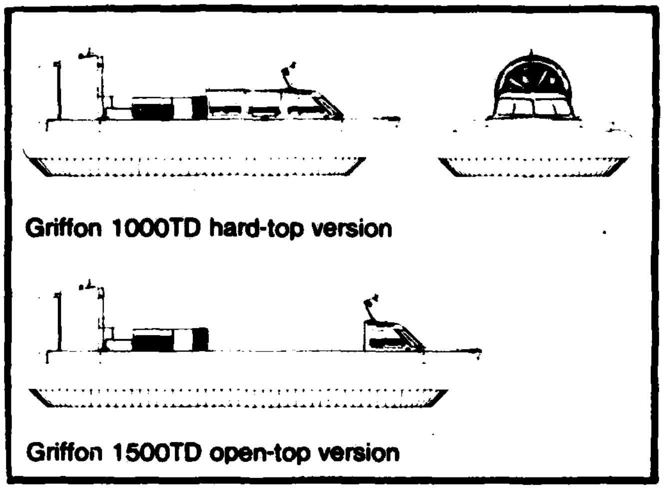

Figure 3. Drawing of the Hake-Griffon 1000 and 1500 Air Cushion Vehicle

Figure 4. Maryland Natural Resources Police Griffon 1000 Over Beach Area. NOTE: Spray suppression skirt on right side

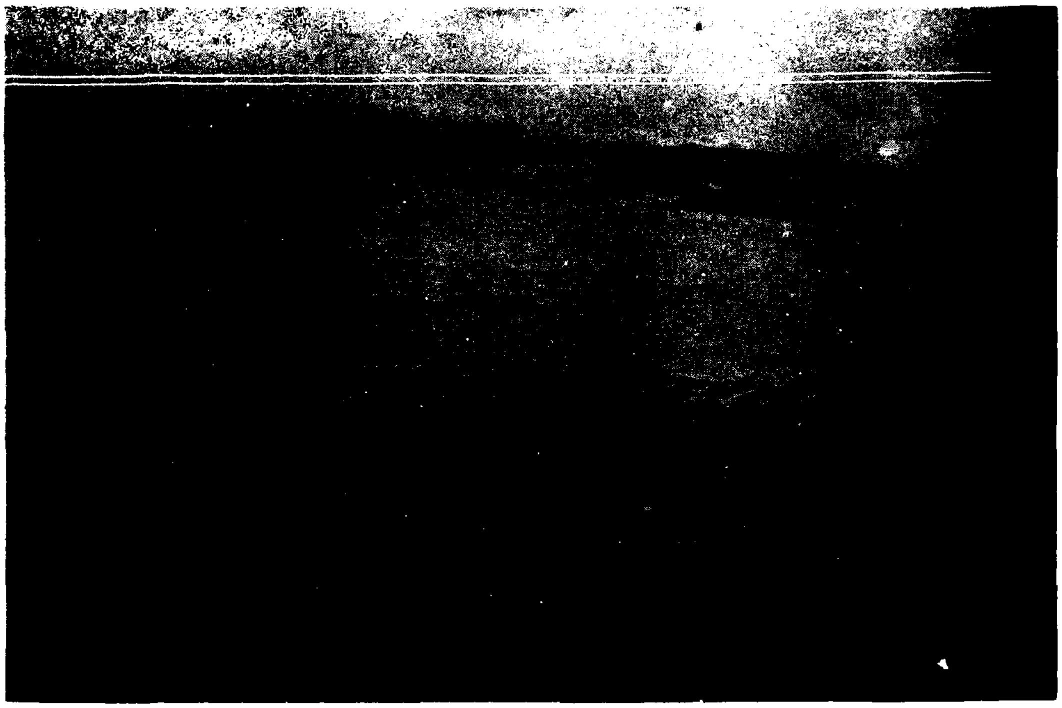

Figure 5. Typical Ridge in Sea Ice Near Cape Royds. Two seals are near ridge in center. NOTE: Drift to right of seals would allow air cushion vehicle to cross.

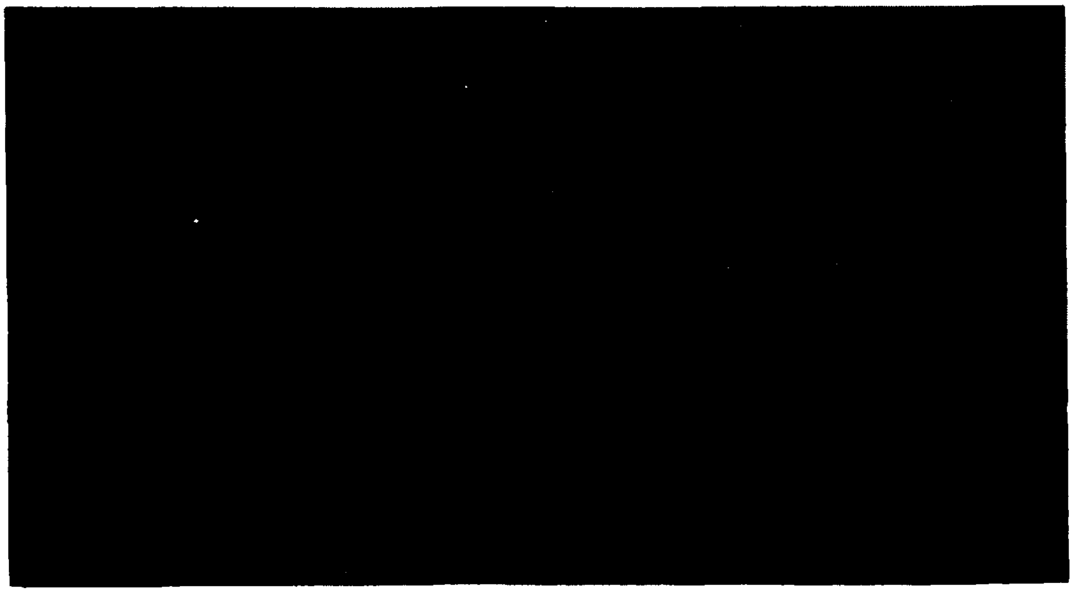

Figure 6. Jumble of Ice at Tide Crack, Cape Evans

Figure 7. Waters Edge at Cape Bird. Weddell seal is approximately 7 feet long.

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