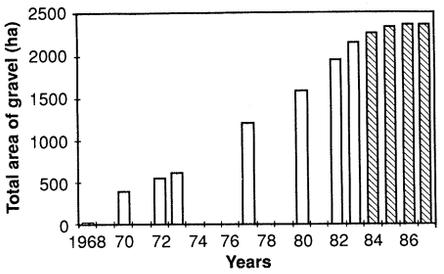

Fig. 2. Total area of gravel placement (pads and roads) in the Prudhoe Bay Oil Field through 1987. Amounts for the last 4 years were calculated by adding the yearly increments to the 1983 value of Walker *et al.* (*1*). The industry estimate for the total gravel area through 1987 is 1910 ha (*8*).

The authors' description of development in the Arctic oil fields requires some modification and updating. The Prudhoe Bay Unit extends beyond the Kuparuk and Sagavanirktok Rivers to the west and east and includes an area of more than 950 km^2. Estimates of gravel coverage in the unit total 19 km^2 (2% of the unit) through winter 1987 (*8*). Gravel coverage in the Kuparuk Unit is less than 1%, which reflects evolution in oil field development design. The pace of development is no longer proceeding at a nearly constant rate, but has abated sharply in the 4 years since the data of Walker *et al.* were collected (Fig. 2). Current drilling technology allows close spacing of many wells on a pad without enlarging the pad. While most of the Prudhoe Bay field now has eight wells per square mile [80-acre (32-hectare) spacing], the gravel drill-pads are approximately 2 miles (3.2 km) apart. The subsurface target areas are reached by directional drilling. Increases in gravel on the tundra are usually a function of developing new areas of the reservoir, not increases in well density.

After several years of study, the U.S Fish and Wildlife Service and the Alaska Department of Fish and Game have concluded that floodplains may be ideal sources of gravel with beneficial secondary utility (*9*). Spent mines that have been rehabilitated by flooding from the adjacent stream can provide excellent overwintering habitat for freshwater and anadromous fish.

Once a decision to proceed with a development is made, concern over aesthetics becomes somewhat moot: an oil field will not look like pristine, untouched wilderness. Most (>98%) of the field will remain as open space, however, and the appropriate concern is whether or not wildlife will continue to use it. Of the many functional values attributed to wetlands, most are absent or have limited presence in permafrost-based wetlands. One important attribute that does remain is that of bird habitat (*10*). Habitat does not appear to be a limiting factor controlling bird densities on the North Slope. Other wetland areas in Alaska are orders of magnitude more productive for waterfowl (*11*). While positive and negative distributional changes have been noted next to roads and pads, oil field operations do not generally result in disturbance effects that displace birds from normal habitats (*12*). Nor has "fragmentation" of habitat by the roads resulted in decreased bird use (*5*). Regarding wildlife corridors and calving grounds, data from the Kuparuk oil field, which, unlike Prudhoe Bay, is a historically high-use area for caribou, show that, while there have been some distributional changes in the vicinity of facilities, caribou have continued to use traditional calving grounds and insect relief areas within the oil field. Further, this caribou herd has tripled in size during development of this oil field, demonstrating that environmentally conscientious oil development can coexist with wildlife (*13*).

I agree with the authors' opinion that development in new areas should be preceded by comprehensive regional planning that includes an evaluation of cumulative impacts. However, I strongly disagree that large impacts "are likely to occur on the coastal plain in the next few years." Current design, construction, and operation techniques will keep indirect impacts to the landscape at negligible amounts and allow continued wildlife use of the area with little detrimental impact.

In summary, development of other Arctic regions is not likely to induce changes similar to those described in these worst-case areas of Prudhoe Bay.

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Response: Robertson's defense of the environmental record of the oil industry in northern Alaska points out many steps the industry has taken to minimize impacts, but it largely misses the point of our article. The cumulative effects of the existing oil fields need to be assessed before new developments can be planned. Our studies were a first step which chronicled the history and extent of direct terrain alterations that can be mapped from a historical series of aerial photographs. Our 1:24,000 scale maps accurately portrayed for the great majority of the field the timing and acreages of direct impacts (those where the areas affected are planned, such as gravel roads and pads). At the 1:6000 scale, we were able to map many indirect impacts (those that are unplanned, such as flooding, dust, and thermokarst). At that scale, we focused on areas of intensive development because these were most interesting from the standpoint of cumulative impact and because we did not have the resources to map the entire field. We did not intend to imply that our 1:6000 scale data were representative of the entire field. They are representative only of the more intensively developed areas. Even so, the total mapped area covered about 63 square kilometers and included 31% of the total roads, 25% of the gravel pads, and 27% of the permanently flooded areas within the Prudhoe Bay Oil Field. We did not map the actual "worst case" of development in the oil field. This occurred in the area near the main airport at Deadhorse, where oil field contractors, hotel operators, tourist facilities, and retail merchants have been attracted by

the presence of the oil field. These ancillary impacts may be as great of a concern as the actual oil field facilities. The changes that we recorded are only a part of the total cumulative effects. Other effects that are more difficult to assess include changes to water and air quality (*1*), wildlife habitat (*2*), aboriginal land use values, and the changes that follow once access to the public has been established by a system of roads and transportation corridors.

An underlying concern of this debate is the future of the Arctic National Wildlife Refuge (ANWR). We can expect the issue of development in the Refuge to be revived once the furor over the Valdez oil spill subsides. Despite Robertson's implication that the negative impacts of Prudhoe Bay will not occur again, the history of development at Prudhoe Bay must be used as a model of potential impact from future development until we have a better model. The oil industry is now holding the Kuparuk oil field up as a standard for future developments, but although it is newer and neater, it affects an even larger area than the Prudhoe Bay field. Does even neat industry have a place in national wildlife refuges or wilderness areas? Robertson allows that, "[o]nce a decision to proceed with a development is made, concern over aesthetics becomes somewhat moot."

Robertson's statement that additional large impacts are unlikely to occur on the coastal plain in the next few years is a hollow refrain. How does the industry propose to develop the ANWR without large impacts if the scenario advocated by former Secretary of Interior Hodel is pursued? The environmental impact statement for this alternative envisions three major oil fields, removal of 40 to 50 million yards of gravel, construction of a 100-mile-long main pipeline, at least 280 miles of gravel road, two large marine salt water–treatment plants, seven large central production facilities, four airfields, and 50 to 60 permanent drilling pads (*3*).

Under such a scheme, within the proposed area of development, there is a potential loss of (i) 71% of the high-use, year-round musk-ox habitat, (ii) up to 37% of the concentrated caribou calving areas, (iii) the eastern part of the coastal area as denning habitat for polar bears, (iv) 162,000 acres of staging habitat preferred by the snow goose, (v) 5650 acres of coastal plain habitat covered by gravel roads and pads, and (vi) 7000 acres affected by indirect impacts, such as flooding and dust. These estimates are based on the best available information about the possible location and size of the prospects delineated by seismic surveys (*3*).

Oil exploration is occurring at numerous other sites on the Arctic Coastal Plain, including Harrison Bay, the Colville River Delta, Foggy Island Bay, and the Canning River Delta. A report by the Alaska Department of Fish and Game states that, if significant oil reservoirs are discovered in any of these coastal areas, an east-west pipeline and an associated road to connect these reserves to the Trans-Alaska Pipeline System are likely. If all the reservoirs are developed, there could be major transportation corridors across the coastal areas from Harrison Bay to Kaktovik, a distance of about 300 kilometers (*2*). With these prospects for the future, our statement regarding an extensive complex of oil fields, roads, pipelines, and service centers appears less speculative.

The environmental record of the oil industry in northern Alaska should not be used to promote development in *all* areas of the coastal plain, especially the ANWR. Even if the Prudhoe Bay experience were a complete environmental success story, should we even consider compromising the integrity of the ANWR, which is perhaps the finest example of a large, intact ecosystem that we have in the national refuge system? It seems to us that instead of focusing on resource extraction, in the case it would be wiser to insist on absolute protection.

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Cell Cycle: Progression from Interphase to Telophase

As presented in the report "Calpain II involvement in mitosis" by J. E. Schollmeyer (*1*), the possibility of a Ca^{2+}-regulated protease being involved in mitosis is definitely worth considering. While the discussion of this possibility is well presented in Schollmeyer's report, the quality of the evidence is difficult to judge because of some confusing statements and inaccuracies.

For example, the abstract states, "Injection of calpain II at late metaphase promoted a precocious disassembly of the mitotic spindle and the onset of anaphase." However, specific data on spindle structure are not presented in the report.

A confusion of the stages of mitosis is evident in the legend to figure 2. Figure 2a is referred to as a prophase cell, but it is more likely an interphase cell (and is referred to as such in the text). Figure 2h is referred to as a cell in late metaphase; but it is clearly a late anaphase cell, and thus it is no surprise that it should be in telophase 2 minutes later (*1*, figure 2i).

The inducement of a PtK cell to progress from interphase to late telophase in 15 minutes, as presented in figure 2, a through f (or 30 minutes according to the text), is remarkable when one considers that the normal duration of the mitotic stages in PtK_2 cells are as follows: prophase 30 to 60 minutes; prometaphase, 11 minutes; metaphase, 14 minutes; anaphase, 8 minutes; and furrowing, 5 minutes (*2*). The reported reduction in transition time to 15 minutes would require that the protease accelerates six distinct cellular processes (chromosome condensation, spindle formation, chromosome movement, cytokinesis, nuclear reformation, and separation of daughter cells), each requiring unique enzymes and structural proteins. This finding is so noteworthy that further explanation and better documentation are needed. Corresponding phase