come into the same phase, or act in concert. (These figures refer to the wave height above the undisturbed ocean level and not the tidal range, the difference between the high and low tides).

"The interplay of these forces is responsible for the tides throughout the world," says Dr. Duff, "but the reasons for the extremely high tides in Fundy are to be found in the physical characteristics of the Bay itself. It shallows in a gradual manner, and converges progressively to its headwaters, both factors tending to convert a long wave into a steeper and shorter crest of greater height. Because Fundy is fairly steep-sided with a flat bottom, very little energy is lost on the sides of the Bay. In sum, the shape of the Bay has the effect of focussing the energy of the incoming wave. Another energy conserving factor is in the favorable bottom topography of the Gulf of Maine. On its arrival from the deep Atlantic, the wave must make a right-hand turn in the Gulf to enter Fundy, and it so happens that the shape of the bottom is favorable to this process. The wave is able to march or refract around the turn with a minimum loss of energy. Also, the wave may be said to "take to" the right-hand turn because of the so-called Coriolis force resulting from the Earth's rotation. If the map were reversed and the wave had to make a left hand turn it would be quite a different situation."

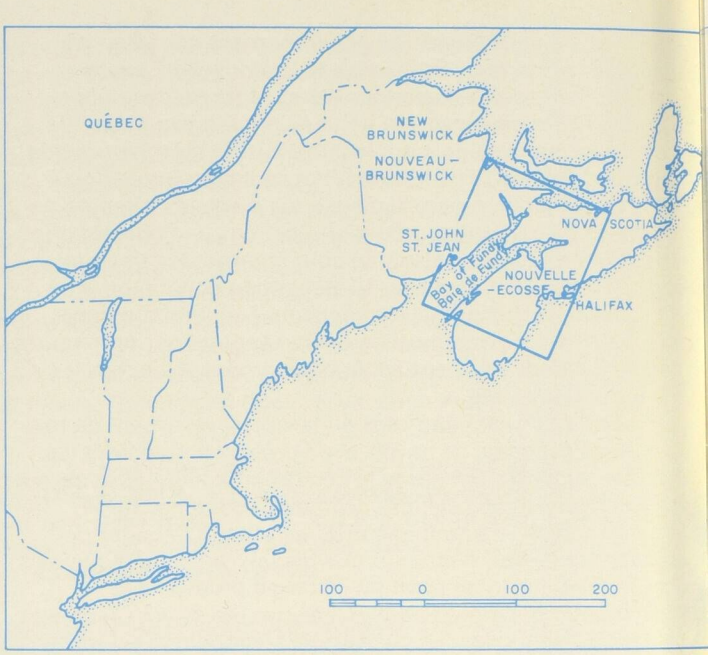
Dr. Duff took all the information available on the area between the continental shelf and the headwaters of the Bay of Fundy, the geographic and oceanographic dimensions, and embodied them in a mathematical model that described the surface wave characteristics of the waters. The results showed that a factor that was unusually strong in the system was resonance, a concept best understood by considering the example of a child on a swing. If an adult pushes the child at the top of each swing, the amplitude or height of the swing increases. The push has a period or interval very close to that of the swing, and the two are said to be in resonance.

"Like the swing, each body of water has its own natural period of oscillation," says Dr. Duff, "and the mathematical model demonstrated that the waters in the Fundy system out to the continental shelf have a natural period very close to that of the lunar tides. In other words the lunar "push" on the oscillating aquatic system occurs at precisely the right time or in just the proper phase to result in a resonating system. Resonance therefore makes a significant contribution to the high tidal wave that characterizes the system."

Dr. Duff explains that detailed numerical calculations were also done on the effects of erecting tidal barriers at sites that were considered in the ATPPB feasibility study. It appears that the barrier proposed for Economy Point will not make much difference to the tidal regime, but he feels that more definitive results require a much larger model, of the sort that he is presently devising. There has been some suggestion that the regime, or amplitude of the tide, would actually be increased by a barrier at Economy Point, but Dr. Duff feels that no one model can yet be said to accurately reflect the real system and as such it is still too early to make a conclusive statement.

"The tantalizing part of this whole problem is the question of what is the correct region to consider," he says. "If the body of water chosen is too small, say just Fundy itself, then the scope is not sufficient and it doesn't tell you very much. It may be just as difficult if it is too large, since you cannot calculate as accurately for a very large body of water.

"The place where the energy enters the ocean is largely the



Map of the Atlantic coast showing the Bay of Fundy and its two main headwaters, Chignecto Bay and the Minas Basin, separated by Cape Chignecto. Economy Point, shown on the western side of the Minas Basin, is considered one of the best sites for construction of a tidal power plant. • La baie de Fundy se prolongeant, à l'intérieur des terres, par la baie de Chignecto et le bassin Minas séparés l'un de l'autre par le cap Chignecto. L'un des meilleurs sites pour une usine marémotrice semble être à Economy Point sur la côte ouest du bassin Minas.

North Atlantic itself, and I've come to the opinion that you have to include a great part of the ocean in any realistic model. The question of how high the tides are is determined by a process of adjustment between how much energy enters the system, and how much goes out. It's a kind of contest between the "linear" motion imparted to the oceans by the moon's gravitational field, and the "non-linear" dissipative frictional forces of the tides against the coasts. How these balance or adjust themselves determines the amplitude of the tidal regime, and the adjustment process occurs in the oceanic as well as the coastal waters. The behavior of the waters in the deep ocean is therefore important and has been more adequately portrayed in the latest mathematical model."

As to the extensive studies that have been done on the tidal power plants in the Bay of Fundy, Dr. Duff does not think they have been a waste of time. The ATPPB concluded that the project was not economical but that was before the steep rises in the cost of energy and the discovery that the power output from the plants may in fact be larger than that calculated in the report. Whether or not they will ever be built depends upon the availability of other forms of energy. Breakthroughs in the technology of nuclear fusion or solar energy with their promise of unlimited amounts of energy would very likely relegate tidal power to the drawing board indefinitely. For the present, it represents a good contingency plan, a ready-made, evaluated scheme waiting in the wings should technological advance not live up to expectations. □

Wayne Campbell