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THE ENVIRONMENTAL EVALUATION WORK GROUP FY 1979 STUDIES
OF THE
WINTER NAVIGATION DEMONSTRATION PROGRAM

COMPARATIVE STUDIES OF THE ST. MARYS AND
ST. LAWRENCE RIVERS SHOWING BIOLOGICAL AND PHYSICAL
SIMILARITIES IN PROJECT AREAS

J. H. JUDD

Great Lakes and Marine Waters Center
University of Michigan
Ann Arbor, Michigan

July 31, 1979

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Project Officer

David A. Gregorka
Great Lakes Basin Commission
3475 Plymouth Road
Ann Arbor, Michigan 48106

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ABSTRACT

Data were collected from the existing literature to attempt to determine specific sites along the St. Marys and St. Lawrence River that could be considered environmentally similar. An Environmental Likeness index (ELI) was developed to qualitatively evaluate the data. From the existing data, similarity was found when comparison was made of sites between rivers. Three sets of sites along the St. Lawrence River were found to be potentially environmentally similar. Lack of sufficient data on specific sites along the St. Marys river precluded developing Environmental Likeness indices for that region.

SUMMARY

1. The study was designed to determine if there were sites or regions along the St. Marys and St. Lawrence Rivers that were similar in their physical, chemical and biological makeup.
2. All information was obtained from the existing literature.
3. An Environmental Likeness Index (ELI) was developed to quantitatively evaluate the existing published environmental data in terms of its similarity between specific sites either between the two rivers or within a single river.
4. Although a great deal of data was found, there was not sufficient amounts of data on a single site in most instances to permit comparison among similar sites.
5. When comparisons were made between rivers, no environmentally similar sites were found.
6. A number of sites along the St. Lawrence River were evaluated for environmental likeness. Three pairs of comparative sites were found that produced Environmental Likeness Indices greater than 0.70 (considered potentially ecologically similar): Chimney Point and Galop Island and Iroquois Dam regions. The regions of Bradford Hill Islands and Croiland Long Islands produced the highest Ecological Likeness Index.
7. There was insufficient data found to justify comparison of individual sites along the St. Mary's River.

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INTRODUCTION:

The St. Marys and St. Lawrence Rivers are major links in the Great Lakes Seaway system. Both are critical regions in determining the possible environmental effects of an extension of the shipping season. In order to fully assess the impacts of season extension, conditions and changes must be evaluated in specific terms as to the extent and environmental importance of these impacts.

Control sites have been delineated within each river system to provide baseline information on possible environmental effects. If the results of this information could be extrapolated to other sites along these rivers or between rivers, a better picture could be drawn of the possible effects season extension would have on a larger portion of the system. It could be assumed that areas of the rivers that are environmentally similar would react in a somewhat the same fashion to winter extension activities such as ice breaking, vessel transits and ice boom modifications. Actions such as ice jamming, ice scouring, propeller wash, surge waves and drawdown would probably effect environmentally similar areas in a comparative fashion.

OBJECTIVES

The objectives of this study were threefold. First, to develop a method to determine environmentally similar sites along the two rivers. Second, to bring together all available pertinent literature on the connecting channels of the St. Marys and St. Lawrence Rivers and, using the above method, identify and describe comparable sites within each river and, if possible, between rivers. Third, these would include, where possible, sites representing specific areas of concern and specific environmental areas (shore, inshore, littoral and benthic sensitive areas).

METHODS

Ecological Likeness Index

An Index was developed that would give a qualitative evaluation of site similarity. Physical, chemical and biological parameters were compared for two potentially similar sites. Each pair of parameters was compared subjectively and given a value on a graduated scale from 0 to 5. A numerical ranking of 0 indicated no similarity between sites for that parameter, while a value of 5 represented a parameter value at each site that was identical. Mean monthly values were used when available; otherwise yearly means were used. The biological parameters were evaluated at two levels, depending on the data available. Community diversity, density and overall community composition were used in a first level evaluation. If sites proved to be quite similar, species composition by month and numbers per species were evaluated.

Numerical rankings for each parameter were then totaled and an Environmental Likeness index (ELI) was developed for each given site comparison as follows:

$$EL = \frac{\sum N}{\sum N(5)}$$

where N is the numerical value of each parameter and N(5) is the theoretical maximum. Thus, the closer the index value is to 1.00, the greater the environmental similarity between sites.

Whenever data existed, the following parameters were compared:

1. River Hydrology
 - a. Water Depth
 - b. Flow Rates
 - c. Configuration
 - (1) channel
 - (2) shoals
 - (3) wetlands
 - (4) bottom sediment composition
2. Physical characteristics
 - a. Physico-chemical
 - (1) turbidity
 - (2) oxygen levels
 - (3) temperature
 - (4) pH
 - (5) transparency
 - (6) hardness
 - b. Ice Canopy Characteristics
 - (1) extent
 - (2) concentration
 - (3) duration
 - (4) thickness
 - (5) structure

- (6) features
 - hinge-line cracks
 - thermal cracks
 - thrusts
 - hanging dams
 - pools of open water
 - (7) stratigraphic features
 - (8) field relationships around island, shoals, bay-coves, wetlands
 - (9) included material
 - windblown inorganics and organics
 - bottom vegetation and microorganisms
 - (10) geochemistry
- c. Climate Conditions
 - d. Shoreline Classification
 - (1) summer
 - (2) winter
 - e. Sensitive areas potentially subject to drawdown and shipinduced waves. ice scour, tide cract activity, freeze-dam, and lifting of bottom sediments
 - f. Shoreline Development (Land Use Patterns)
3. Biological Characteristics (based on community diversity, density and overall community composition)
- a. Benthic Invertebrates
 - b. Zooplankton
 - c. Phytoplankton
 - d. Larval Fish
 - e. Juvenile and adult fish
 - f. Aquatic Macrophytes
 - g. Wildlife

Search was made for all available literature on the connecting channels of the St. Marys and St. Lawrence Rivers. Libraries and facilities of the following agencies and institutions were utilized:

The University of Michigan, including the Great Lakes library, Welch, Chandler and Smith Collections of the Great Lakes and Marine Waters Center and the main campus libraries.

The library of the Great Lakes Basin Commission (including all winter navigation studies) and the Great Lakes Regional Information Center (literature searches)

Great Lakes Fishery Laboratory library, U.S. Fish and Wildlife Service

Great Lakes Environmental Research Laboratory library, U.S. Department of Commerce

All literature was first evaluated as to the pertinent information it contained. If it referred to physical, chemical or biological parameters, these were listed along with such data as location of site or sites, amount of data, times data was taken and type of site, i.e. littoral, open channel. A quick comparison was then made of all the accumulated information to determine the sites by type that had comparable information. An Environmental Likeness index was then developed for these type sites.

RESULTS AND DISCUSSION

Environmental Likeness indices varied from 0 to 0.792. Comparisons between sites on the St. Marys and those on the St. Lawrence showed little or no similarity. Factors such as amount and types of ice cover, climate conditions, flow rates, water quality parameters, and a number of biological characteristics combined to produce ELI values too low to consider any comparative sites as being environmentally similar. For example, comparing the Lake of the Isles, Wellesley Island, Cape Vincent region to quiet water areas such as Lake Munuseong or Raber Bay produced ELI from 0.0909 to 0.0631. Insufficient data was found in the literature to fully compare any sites along the St. Marys River. In most cases, only a single, or at most, two or three parameters were available for a given site or site region.

Comparisons were made of a series of sites along the St. Lawrence River to determine possible environmental likeness. Not all parameters were measured in the exact same areas. Because of lack of more specific data, it was assumed that many of the chemical and biological conditions would be similar over short distances of the river. The presence of an out fall, rapids or other such feature between sites, of course, could make this assumption invalid. Sites evaluated were the regions around Chimney Point (Fig. 1), Galop Island (Fig. 2), Iroquois Dam (Fig. 3), Bradford Island and Wilson Hill Island (Fig. 4), and Croil and Long Island (Fig. 5).

Values for the ELI ranged from 0.4962 to 0.792 (Table 1). Those producing a value of 0.70 or greater were considered to be potentially environmentally similar. They can only be considered potentially similar because, as pointed out above, not all parameters were sampled at the exact same location. The region of Bradford and Wilson Hill Islands and that of Croil and Long Islands

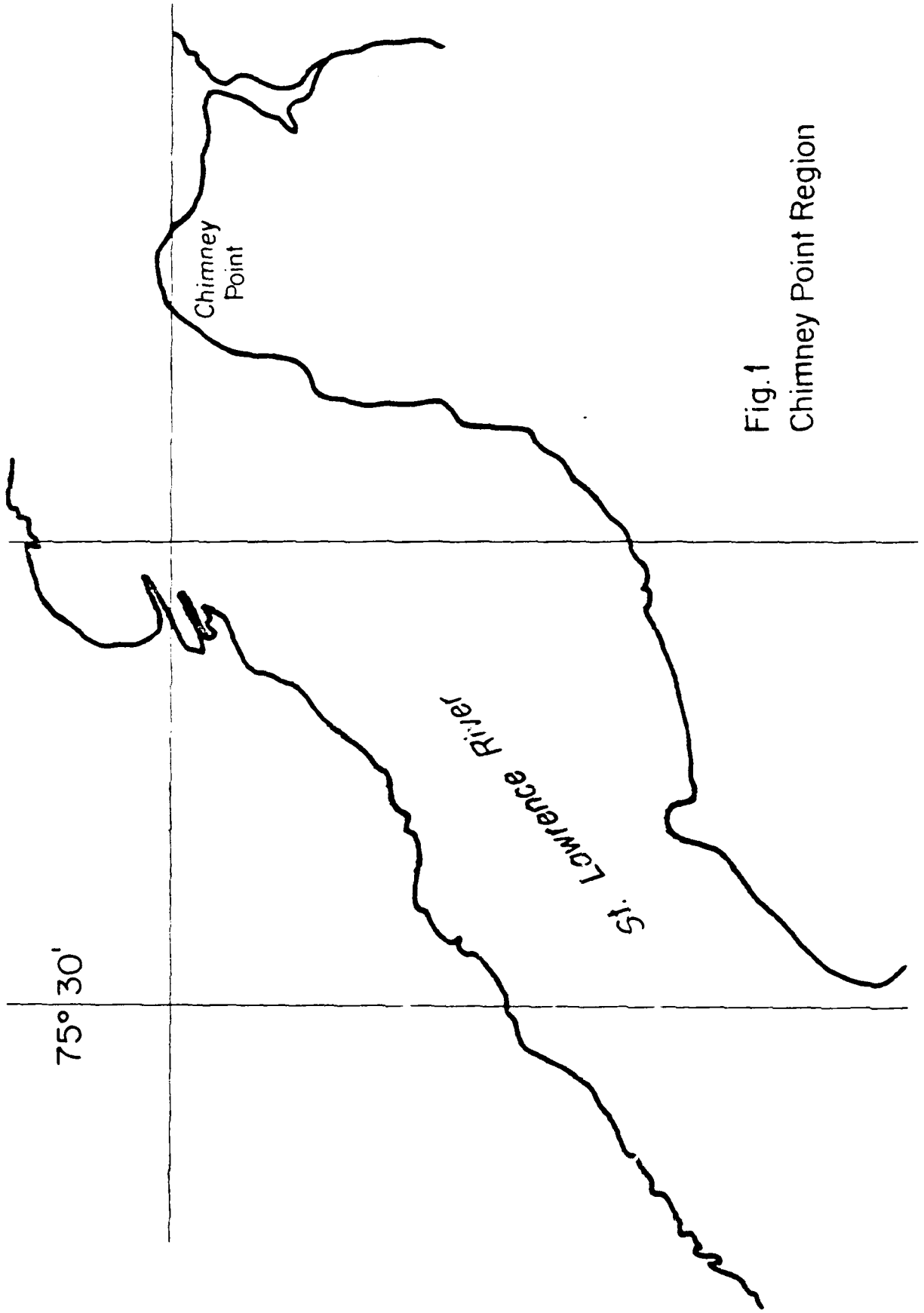


Fig.1
Chimney Point Region

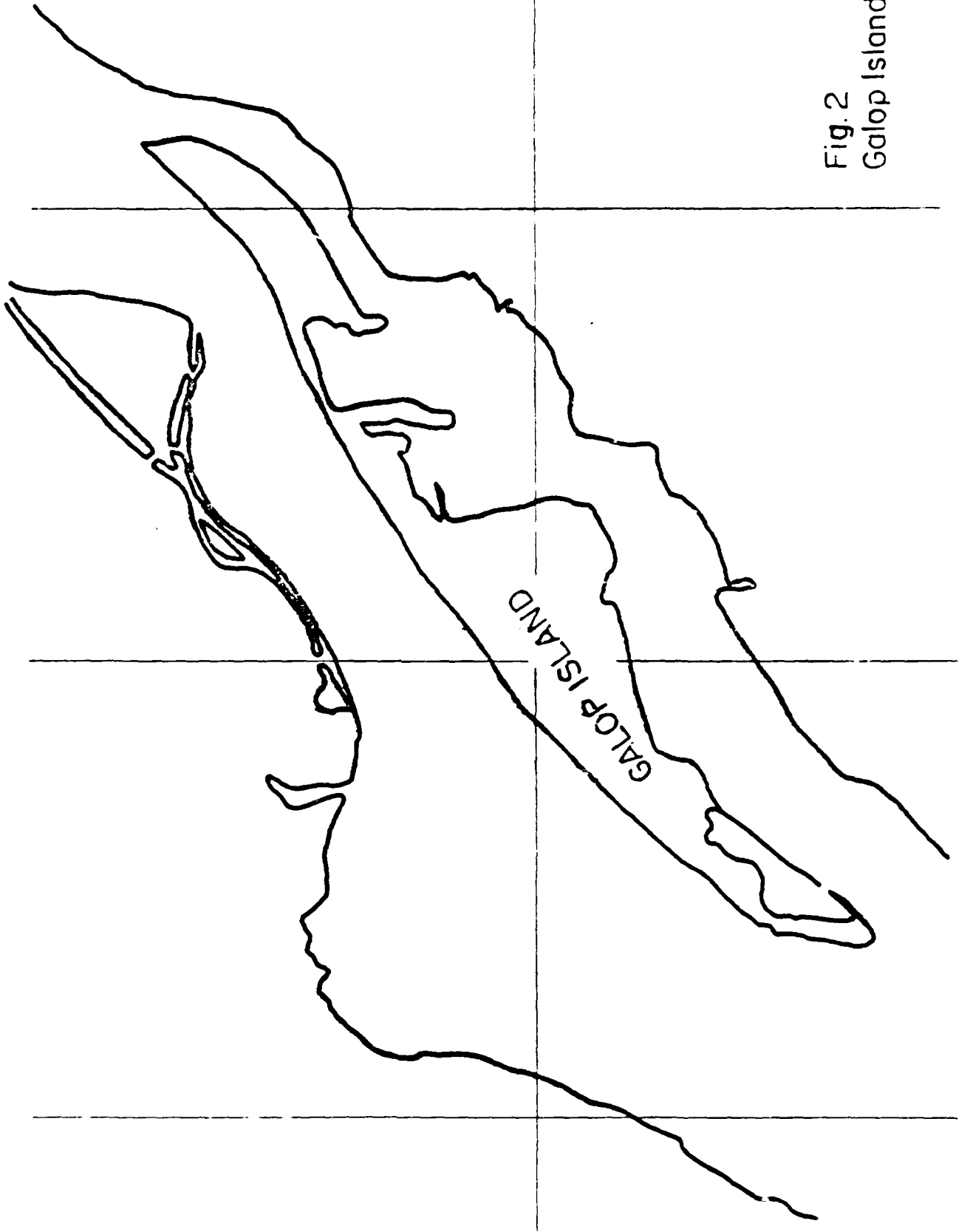


Fig. 2
Galop Island Region

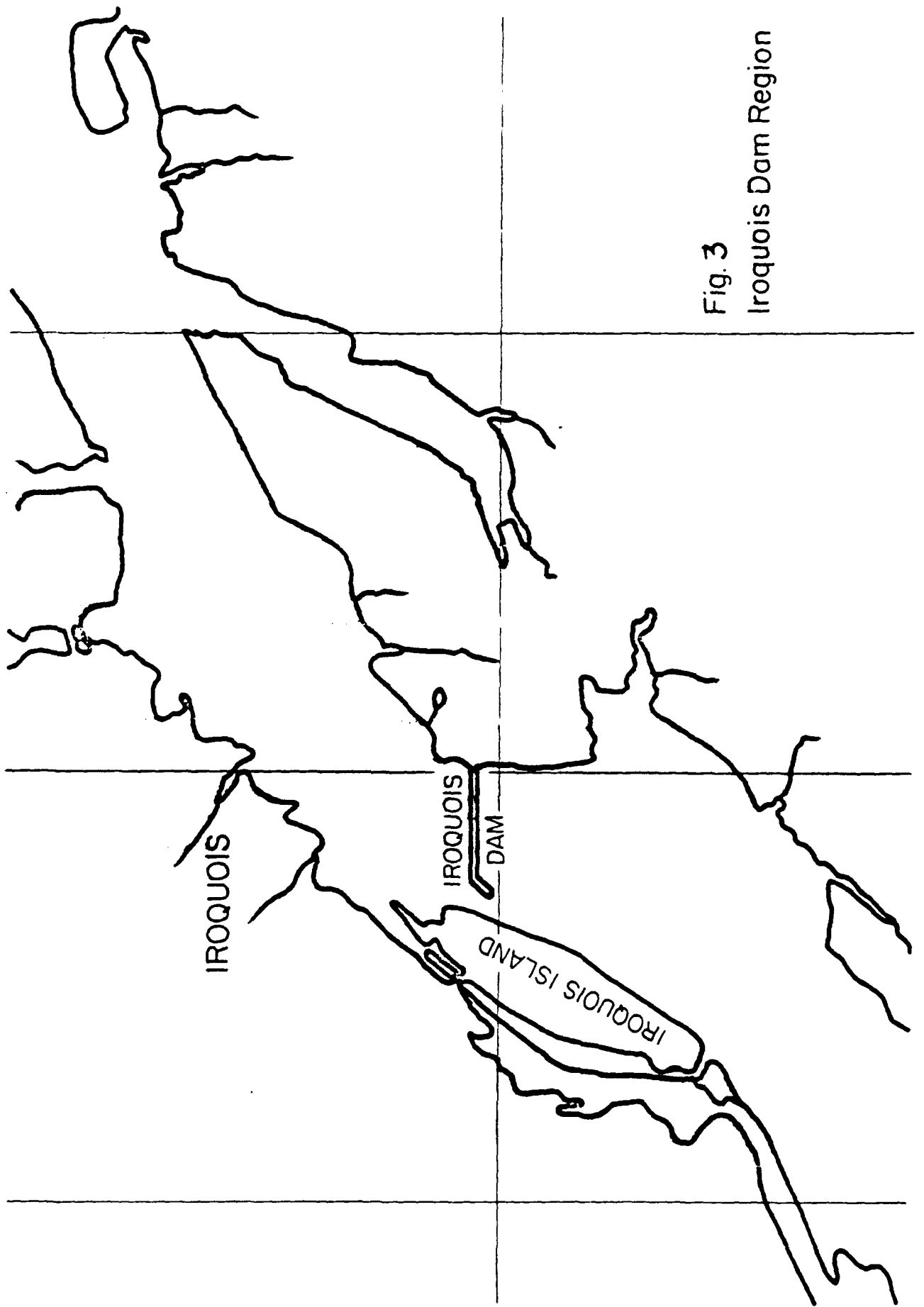


Fig. 3
Iroquois Dam Region

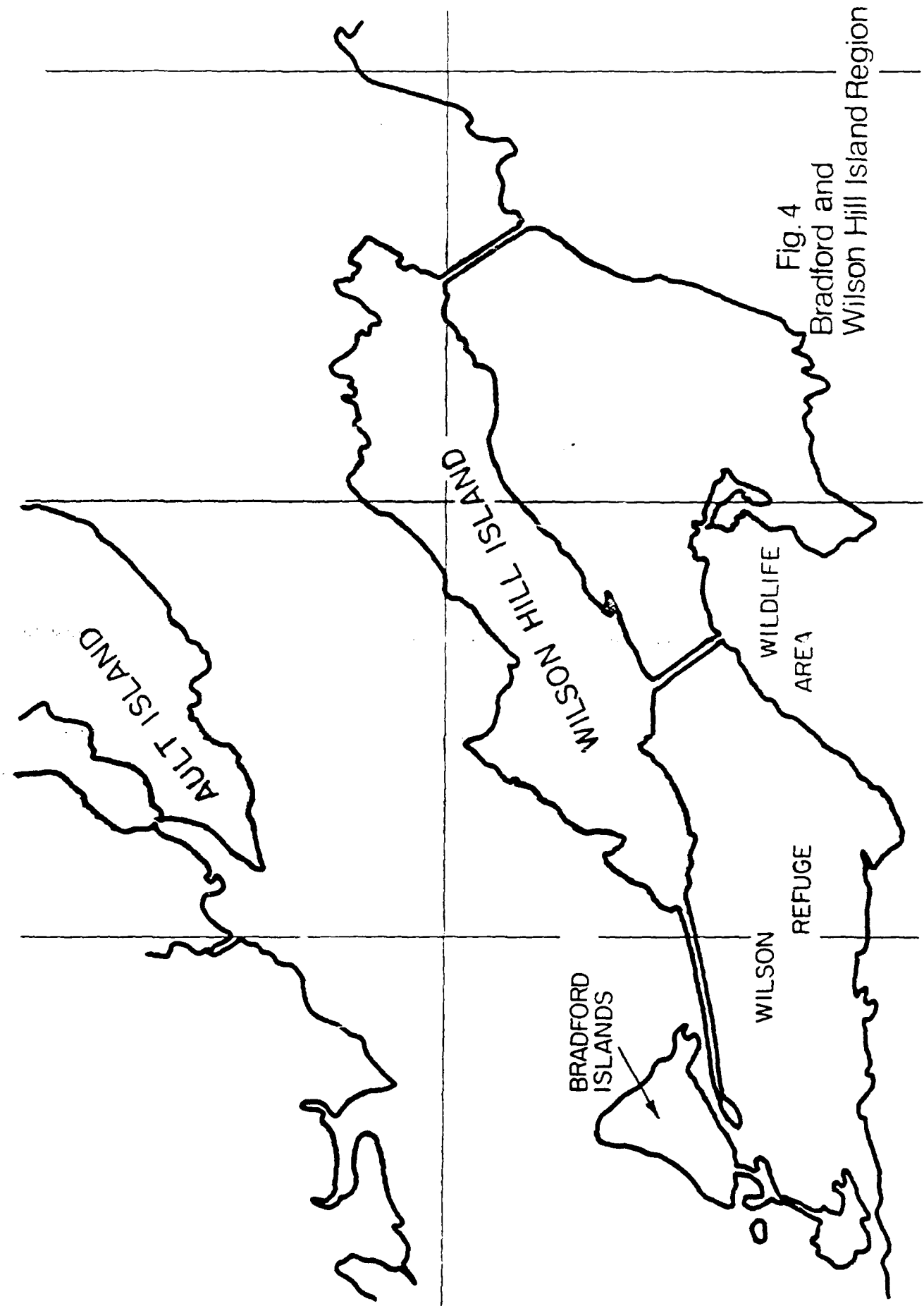


Fig. 4
Bradford and
Wilson Hill Island Region

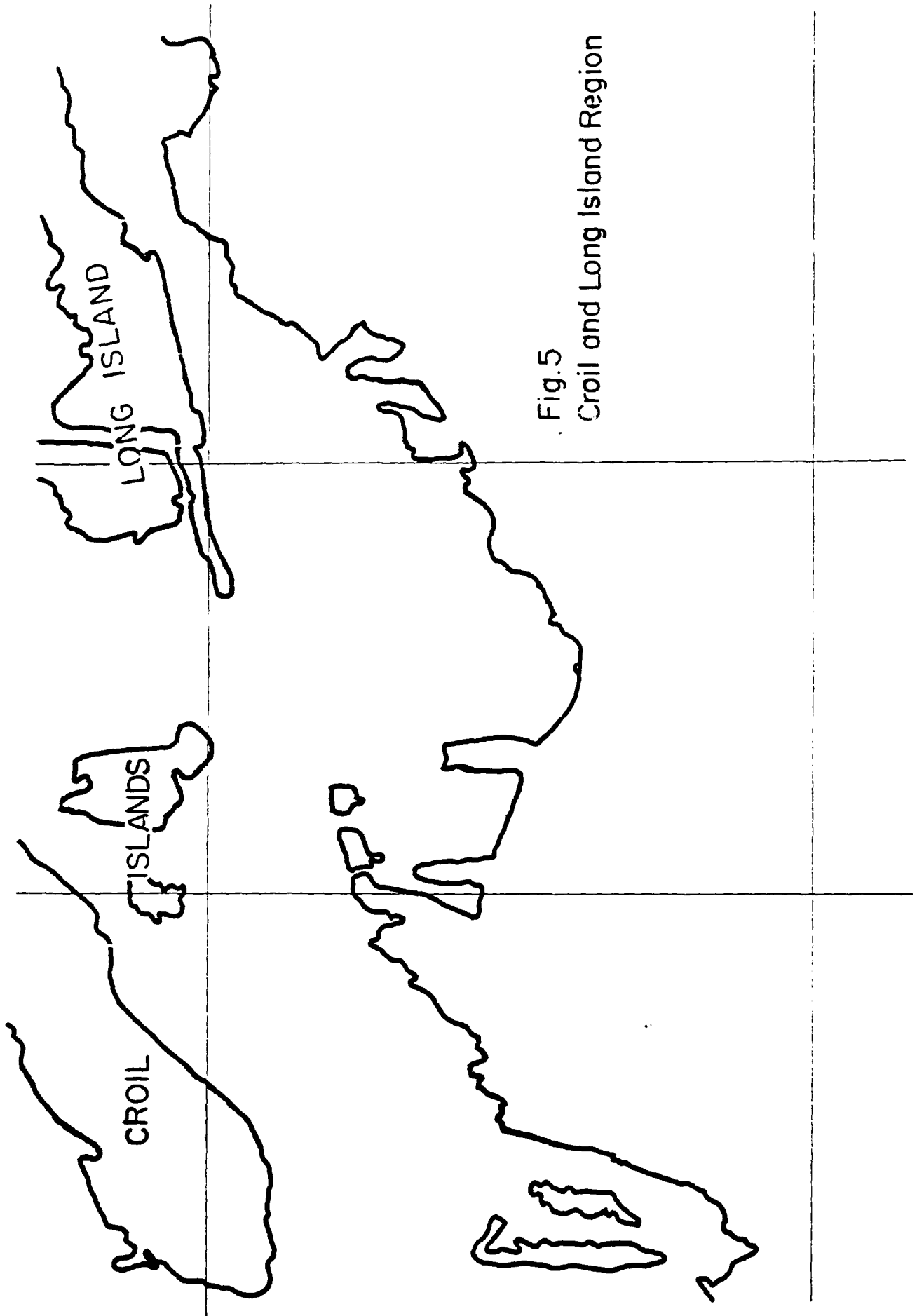


Fig.5
Croil and Long Island Region

TABLE 1: Environmental Likeness Indices for various paired sites on the St. Lawrence River

Paired Sites	ELI Value
Bradford and Wilson Hill Island Croil and Long Island	0.792
Chimney Point Galop Island	0.704
Galop Island Iroquois Dam	0.7043
Chimney Point Iroquois Dam	0.656

produced the highest ELI (0.792). The value was based on similarities in climate; chemical data: dissolved oxygen, pH, alkalinity, phosphorus (total, soluble and organic), nitrate, nitrite, calcium and chloride; physical data: water temperature and biological : fish species

Two other pair of sites had ELI above 0.70. Chimney Point and Galop Island (0.704) and Galop Island and Iroquois Dam (0.7043). The ELI values were based upon most of the same parameters as the Bradford and Wilson Hill Islands and Croil and Long Islands sites. A comparison for possible similarities between the Chimney Point and Iroquois Dam regions produced a lower value of 0.656.

In general data was available in the published literature on both the St. Marys and St. Lawrence river for almost any physical, chemical or biological parameter. The major drawback in attempting to determine sites of environmental likes was the lack of a large number of the same parameters for two given sites. Generally, if biological data was available at a given site or sites, there was little or no physical or chemical data. River flow data was available for specific locations, but data on other parameters was lacking. Only in a few cases was sufficient data available to make an evaluation of environmental likeness. Even these determinations lacked a wide breath of data. Based upon the amount of data available in the literature, it does not appear that a large number of sites can be sufficiently compared to fully determine if environmentally similar sites do actually exist on the St. Marys and St. Lawrence River.

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