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GUIDELINES FOR THE PLANNING AND DESIGN OF LAKE-ORIENTED SEASONAL HOME DEVELOPMENT IN MANITOBA

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GUIDELINES FOR THE PLANNING AND DESIGN OF LAKE-ORIENTED SEASONAL HOME DEVELOPMENT IN MANITOBA

This practicum is submitted to the Faculty of Graduate Studies of the University of Manitoba in partial fulfillment of the requirements for the degree of

MASTER OF LANDSCAPE ARCHITECTURE

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1. Introduction

Problem Statement

The Province of Manitoba has been richly endowed with an abundance of lakes. Manitobans value this resource highly, particularly for the opportunities provided for outdoor recreation. Swimming, boating, and fishing are pastimes which are avidly enjoyed throughout the province. A phenomenon of this love for water-oriented recreation is the summer cottage, a popular institution in Manitoba since its introduction in the early 1900's. Today in all parts of the province, lakes with cottages can be found which are alive with recreational activity during the summer months.

The immense popularity of water-oriented recreation and seasonal homes has led to intensive development of much of the accessible shoreland. Crowded conditions are not uncommon and conflicts have arisen between the different user groups who compete for the resource. The intensity of use has also led to deterioration of the natural environment in the form of reduced water quality, destruction of scenery and loss of wildlife.

Future growth in lake use will increase the stress on the natural environment and the probability of resource conflict. Already there are calls to "open-up" new lakes to relieve pressures on developed waters and satisfy the demand for outdoor recreation. While the lakes in the province number in the thousands, only a relative few are in proximity to the majority of Manitobans. Hence, the resource, which at first appears unfathomable, is in reality quite limited.

The need to manage the resource wisely is therefore critical. There is a danger that indiscriminate development of new lakes will not relieve present problems but simply extend them further afield.

Historically, seasonal home development in Manitoba has occurred in a rather piecemeal fashion. Lakes were opened and cottages built without understanding the limits of the resource or the impacts of development. The absence of a comprehensive planned approach has resulted in a squandering of a valuable resource and conflicts between users.

Clearly, action is required to remedy current problems and prevent their occurrence in the future. Developed lakes require rehabilitation and management to reverse the trend of environmental deterioration and resolve resource conflict. New development must be planned to protect natural systems, preserve aesthetic values and respond to the presence of other resource activity.

The Parks Branch, within the Manitoba Department of Natural Resources is the agency which is principally responsible for the planning and development of cottages on Crown Land in the province. The Branch is keenly interested in defining a comprehensive approach to lake planning and management which will assist in meeting the future demand for cottages while ensuring the long term viability of the resource and maintenance of a spectrum of water-oriented recreational activity. These guidelines are written to meet this objectives.

Use of the Guidelines

The guidelines are written primarily for the use of planning and design professionals within Manitoba's Parks Branch. They are applicable to both the planning of new development and the rehabilitation of developed lakes. The guidelines should also be useful for broader resource planning such as the Crown Land planning process.

Other personnel in the Parks Branch, other government agencies, private developers and the general public may also have an interest in the guidelines. They may be of value in the formulation of policy and the preparation of a public information package.

Because the primary users of the guidelines are assumed to have training and experience in planning and design, the guidelines are written to permit flexibility. Users are encouraged to exercise their professional judgement and alter the guidelines to respond to the situation and circumstances of each lake.

An effort has also been made to outline the concepts and principles upon which the guidelines are based, as well as providing the methods and techniques. It is intended that the guidelines be more than simply a "cookbook" from which a lake plan is concocted. The selected approach permits users to understand the rationale behind the guidelines and their limitations so that the validity of the methods may be judged.

Scope of the Guidelines

The guidelines are directed towards the planning of cottage development on Manitoba's "inland lakes" (i.e. not the province's large lakes: Lake Winnipeg, Manitoba and Winnipegosis). The task of planning and managing the larger lakes is beyond the capabilities of such a generalized study. However, parts of the guidelines will also be applicable to planning cottage development on these lakes as well.

The guidelines are written to be applicable throughout the province. As a result, the guidelines may be too general in some areas. Where this occurs, users are encouraged to modify the guidelines to conform to regional circumstances.

While the guidelines outline a comprehensive approach to cottage development which acknowledges other lake use, basically they are concerned with one resource (lakes) and one resource use (cottaging). It is important to recognize that effective management of a region's resources requires that lake planning fits into broader regional plans which deal with all resources and all uses.

Throughout the guidelines the terms "cottage" and "seasonal home" are used interchangeably. These terms are defined in a broad sense, to encompass a wide spectrum of dwelling and experience types, from the primitive, single family detached cabin to the attached, time-share condominium.

Today in Manitoba, examples from the entire spectrum can be found and it is likely that new types of seasonal homes will appear in the future. While use of a term such as "temporary recreational residence" might be more accurate, it was discarded in favour of more commonly used labels. It is important that the guidelines recognize the entire spectrum of seasonal home development, as each type has different implications for planning and design.

The Approach

The process of planning cottage development is more than subdivision design. It is a comprehensive process which involves three scales of planning and design, starting at the region or watershed, progressing to the lake basin and ending with the development site. Only through this broad approach will the long term conservation of the resource and quality of recreational experience be ensured.

THE REGION

Cottage planning begins at the regional scale because it is here that the process of identifying lakes for development occurs. The decision to develop a lake for cottages is possibly the most important in the lake planning process. Committing a lake to cottage development may make the lake unsuitable for many other uses and, in practical terms, irreversably alter its character. By taking care at this stage to select the most appropriate lakes for development, future problems will be avoided.

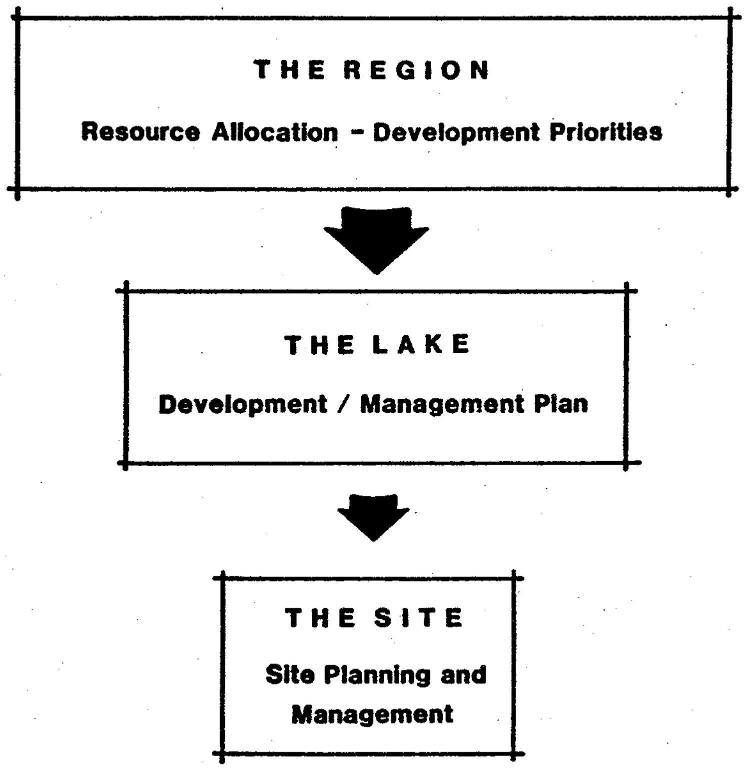
At the regional scale lakes may be examined in the context of surrounding biophysical, social, economic and administrative patterns. This permits the planner a better picture of the development potential of each lake and the entire region. By taking a broader view potential resource conflicts may be avoided and better use of the total resource achieved.

THE LAKE

Once a lake has been identified as a candidate for cottaging a plan is required to guide new development. This plan must not only locate and lay out cottage subdivisions it must outline a comprehensive stragegy for the development and management of the entire lake basin for all uses. Cottaging encompasses much more than the cottage site as the whole lake and shoreland area provide the setting for the recreation experience. The types, quantities and locations of use occurring on and around the lake (including new cottage development) will affect the quality of the experience. Further, the environmental impact of cottage development is not restricted to the cottage site and the effects will be felt throughout the lake basin. The plan must therefore acknowledge the lake as both an experience setting and an integrated biophysical system.

THE SITE

Site planning and design constitute the third level of cottage planning. The way in which a site is developed and managed can have a significant influence on the environmental impact of an individual cottage. Insensitive site development can negate the efforts expended at the regional and lake levels. On the other hand, good site design and management can enhance the attractiveness of a development and the quality of the total lake experience.



Guideline Principles

The guidelines are based on four fundamental principles:

1. THE LAKE/WATERSHED IS A BIOPHYSICAL SYSTEM

When planning lakes it is important to realize that the entire watershed and not just the lake, or the lake and its shoreline, is the basic ecosystem unit. The terrestrial and aquatic portions of any watershed are inherently linked by the "downhill" movement of minerals and water. The implications of this for lake planning is that any change of land use within the watershed, whether on the immediate lake-shore or upstream will have an impact on the lake. Similarly any change on the lake will have an effect downstream. Cottage development may also have "uphill" impacts by disrupting the biological transport of material through the food chain.

These linkages must be recognized to avoid conflicts between users of the system. For example, agricultural activity can have an effect on downstream water quality through inputs of chemicals, fertilizers and eroded soil. Alternately poorly constructed stream crossings, providing access to cottage development can disrupt fish migration.

Within the watershed, each lake is an integrated community of plants and animals which has developed in response to a particular chemical and thermal regime. While natural population fluctuations occur in response to seasonal and diurnal cycles of energy and nutrients, a state of equilibrium has likely been reached. Lakeshore development tends to disrupt the cycles, altering the chemical and biotic balance of the lake. When disruption is severe enough alterations can occur, such as changes of water quality and fish populations which reduce the quality of the lake for recreation. Lake planning must respond to the physical, chemical and biological characteristics of the lake to ensure that the impacts of development do not lead to undesirable effects.

2. RESOURCE CAPABILITY

Lakes do not all have the same capability to attract and sustain recreation development and use. The intensity and types of use a lake can support vary according to the characteristics of the water body and surrounding shoreland. When the capability of the resource is exceeded environmental deterioration and user conflicts can ensue, leading to an overall reduction in the quality of the recreation experience. Lake planning must ensure that cottage development does not exceed the capability of the resource.

3. DISCRIMINATORY RESOURCE ALLOCATION

While there are many potential users of a waterbody, it is important to realize that they should not all necessarily be accommodated. To attempt to provide for all parties can lead to difficult management problems, and lower quality experiences for everyone. Relatively few lakes have the capacity to support multiple use and satisfy all participants. A discriminatory approach to resource allocation can result in more satisfactory experiences and fewer management problems.

4. THE SPECTRUM OF SEASONAL HOME DEVELOPMENT

The guidelines recognize that cottaging is comprised of a range of experiences, from the highly serviced "urban" to the primitive "wilderness." The type of experience that is appropriate for a particular lake depends on the physical character of the lake, the type of other uses present and market factors. Each experience type has implications for the planning process in terms of: the form of development, site and service requirements, environmental and social impact. By acknowledging more than one cottaging model, the lake planning process will succeed in providing better quality recreation experiences by satisfying the diverse demands of the public and more closely matching these to the resource base.

Structure of the Guidelines

The guidelines are organized into two major sections. The section which follows is concerned with lake planning at the regional scale: the regional lake planning process is outlined and guidelines pertain to the implementation of the process. The other section defines the process for planning an individual lake and contains guidelines for lake planning and site design.

These sections are further organized into subsections each dealing with a separate component of the lake planning process. The subsections share a similar structure: initially there is a discussion describing the component subject and its relevance to the process, followed by recommended actions and procedures, ending with a list of pertinent information sources.

The purpose of regional lake planning is to determine the potential of a region's lakes for seasonal home development through an analysis of the resource base and resource use. This assessment is used to establish development priorities and to define a program for planning at the lake scale.

2. The Region

Introduction

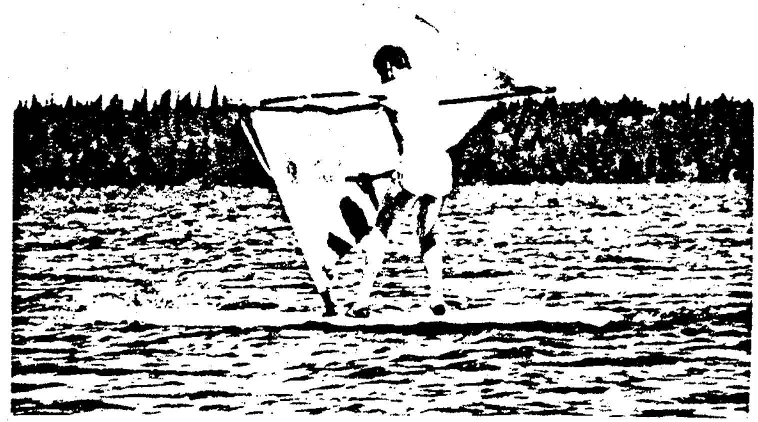
The Task

The task of regional lake planning is, essentially, to identify lakes which should be developed for seasonal home use. This task is at least as important as the one which follows: formulation of a lake management plan. The effort expended at this stage will reduce the potential for future problems arising from resource conflict and overdevelopment.

Development Potential

The development potential of a lake is determined, in the first instance, by the lake's biophysical characteristics. The characteristics of the shoreland and water determine the types of uses which can be accommodated. Some lakes have high capability for recreation and can support many types of activity including cottaging. Other lakes may have low capability for seasonal homes but are ideal for some other types of use. Regional planning is initially directed towards assessing the capability of lakes, and determining their best use.

It is not simply the natural capability of a lake which determines the suitability of a lake for cottage development, however. Suitability is also determined by the presence or absence of other activities, geographic context, access and other factors. A lake with high natural capability for cottaging could be unsuitable for development if occupied by some incompatible use or difficult to access. Alternately,



a lake with moderate capability may be very suitable given the right location and complementary uses. Regional planning is also concerned with lake suitability for development and examines each lake in terms of its geographic, social and economic context.

Discriminatory Resource Allocation

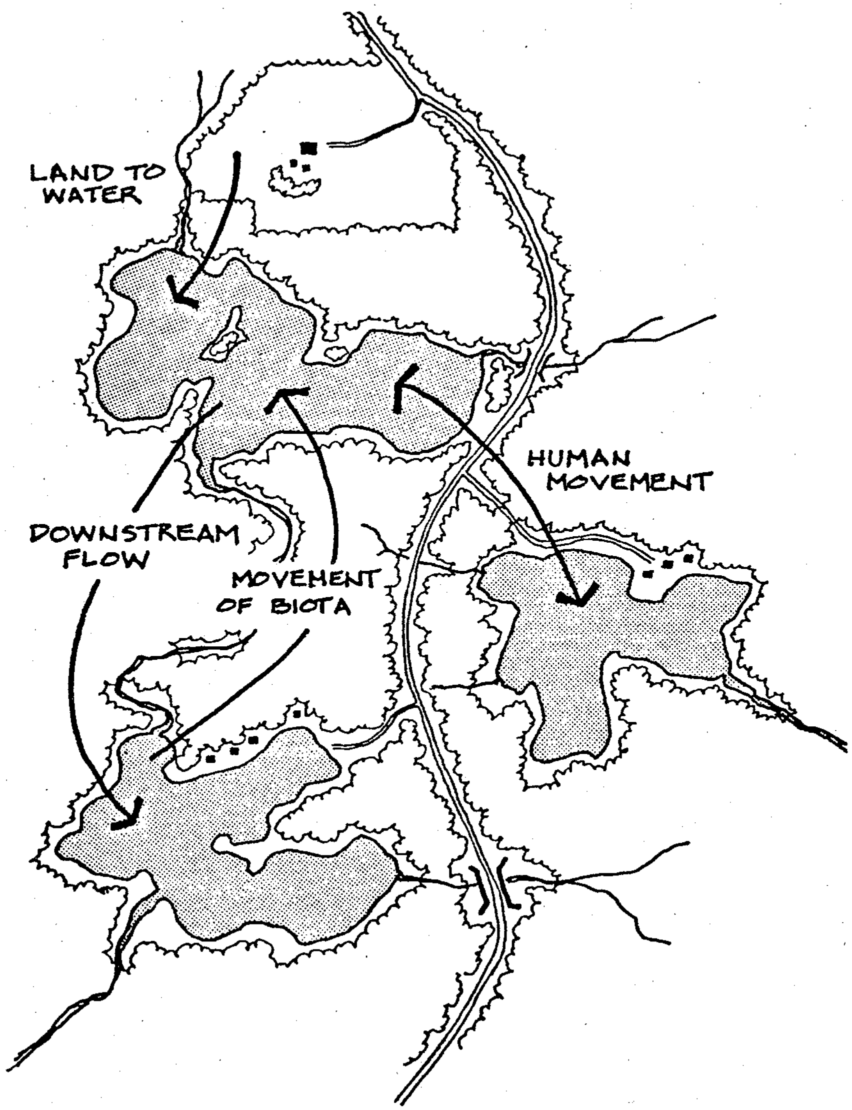
A lake which has potential for seasonal home development is quite likely to have potential for other uses as well. But it is not always feasible or desirable that all of these uses be permitted to use the lake. While some lakes are able to support multiple use, generally the compromise which results from the attempt to accommodate all possible users fails to satisfy any of them and can lead to conflict. A more logical approach to the management of lake resources is discriminatory allocation, with some lakes being developed for cottaging, others for commercial sports fishing and still others for day use and primitive camping. This requires that the lake resource of a particular region be planned and managed as a whole. Failure to adopt such an approach will result in the piecemeal development of the resource with consequent underutilization and management problems. Each lake must be examined not simply for its potential for seasonal home development but for other uses as well.

Regional Linkages

While each lake is unique with individual characteristics which must be recognized, it is important also to remember that lakes are part of larger biophysical systems. Lakes are linked by the terrestrial and aquatic portions of the drainage complex. Land use changes on the lake will have effects elsewhere in the system. Similarly, activities in the lake's watershed will have effects on the lake. The existence of these linkages requires that lake planning go beyond the shores of the lake and examine the entire system.

Any lake will also be influenced by human linkages: roads, portages, etc. The influence of lake development can spread to adjacent areas by the movements of humans, not only along waterways, but across watersheds into adjacent waterbodies. This kind of linkage can present opportunities for seasonal home use by utilizing groups of lakes to provide a variety of recreational experiences for one development. By examining each lake is context of its surroundings, regional planning can identify such opportunities.

Regional lake planning is in fact more than simply identifying lakes for seasonal home use. It is a resource allocation process: a systematic approach to the allocation of lakes for various uses. The impetus to the process is seasonal home development but more than just cottage lakes and cottage use are involved. The planner is concerned with all the lakes in a region, the lands in between and all resource uses occuring in that region.



Planning Context

Ideally lake planning for cottage development should occur within the context of a more comprehensive regional plan, for example a Provincial Park Master Plan. Such a plan provides a policy and administrative framework to guide the development of individual lakes. Where this framework is lacking the need for a systematic approach to regional lake management is even more important.

The need for dialogue with resource managers and resource users is obvious. Each branch will have its own plans, policies and programs which should influence lake development. Users will have differing opinions and priorities affecting lake development.

The Process

The regional lake planning process is structured as a sequential analysis which assesses the potential of lakes for seasonal home development in terms of a "list" of relevant criteria. A group of lakes (ie. all lakes in a particular region) are submitted to a series of "tests", lakes are assessed individually for each factor and their development potential rated relative to the other lakes in the group. An overall picture of the development potential of each lake is obtained by listing the "test" results in a summary table. The results of the assessment are used to set development priorities and develop a program for the initiation of individual lake plans.

The factors which determine development potential include the inherent capability of the land and water resource, other existing and potential use, pertinent policy and legislation and economic feasibility.

DEMAND ANALYSIS

The lake planning process will usually be initiated in response to an unsatisfied demand for seasonal homes. It is important, therefore, that the first task undertaken consist of a comprehensive analysis of this demand which will determine the types and quantities of seasonal homes desired; if in fact, the demand cannot be satisfied by existing supplies; price implications and other market factors. The nature and strength of the cottage demand has implications at all latter stages of the process including resource capability, development cost, and judging the relative priorities of cottages and other uses.

DEFINING THE PLANNING REGION

The second task is to define the planning region. The area will need to reflect both biophysical and human linkages as well as administrative and political boundaries and the distribution of population.

SHORELAND CAPABILITY

Lake shorelands are important to seasonal home development because they are the location of structures, services and building sites. Some shorelands will be more appropriate for cottage development due to their superior ability to withstand stress and meet physical requirements. By identifying and ranking these lands, the lakes with the best capability for use can be found and comparisons can be made between lakes in the region.

WATER CAPABILITY

The characteristics of the aquatic portion of a lake are equally important. Water is the raison d'etre for lake-oriented cottage development. However, not all lakes are equally desirable for water-oriented recreation and use as some are more sensitive and cannot tolerate developmental impact. The regional process identifies lakes with the best capability.

OTHER USE

Other existing and potential uses of a lake and watershed influence the suitability for cottage development. An aim of the regional process is to avoid conflict by managing lakes to meet the needs of all users. Lakes with conflicting use present or those which are more suited for other uses than cottaging are not good candidates for development.

POLICIES, PLANS, REGULATIONS

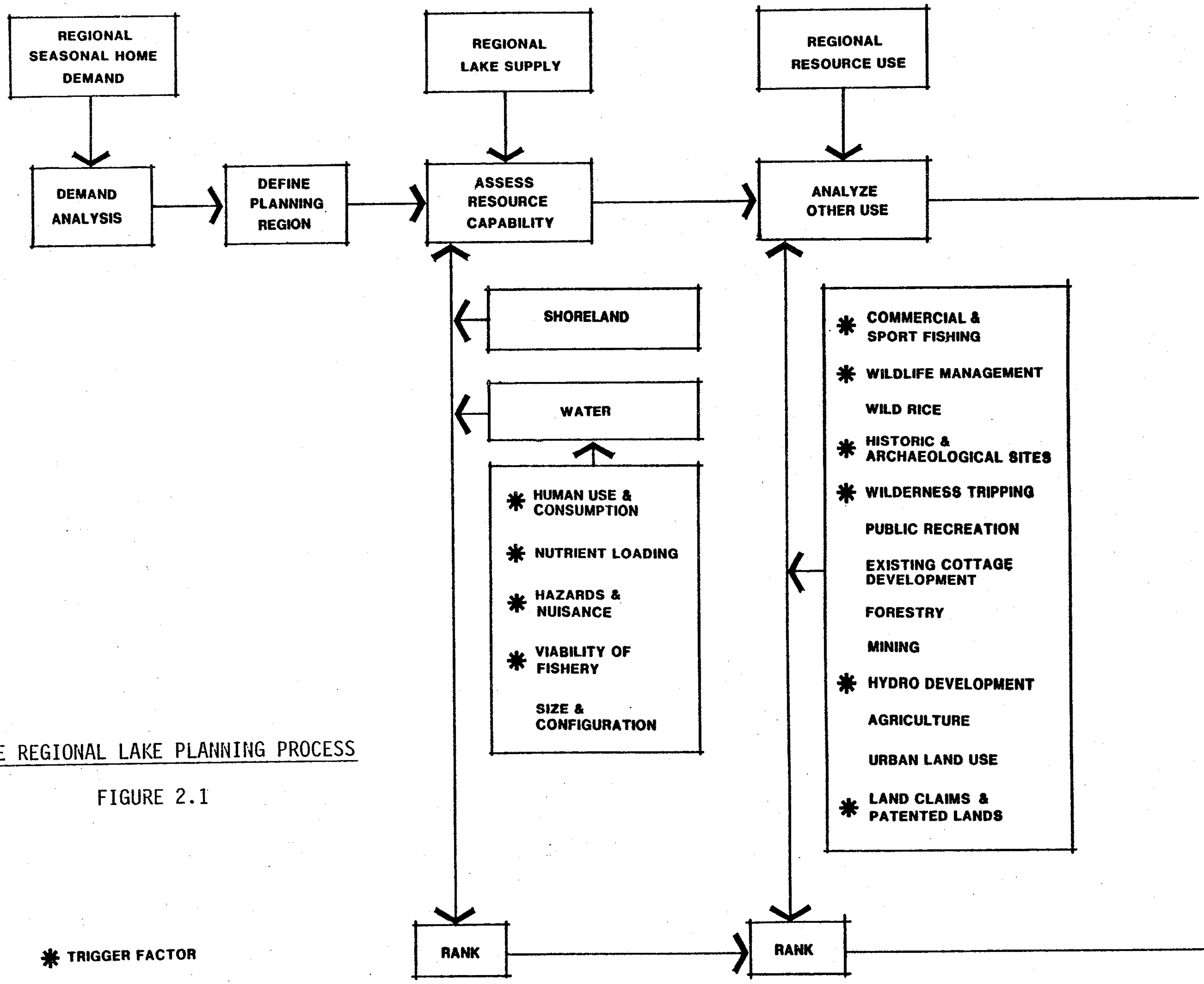
If a regional plan is in effect, this step may be the first undertaken as it may restrict cottage development from some areas and thus eliminate the need to do the preceding steps. Otherwise, there may be local regulations or plans which may affect development. The regional process is designed to identify those lakes where such regulations might impose on seasonal home development and use.

DEVELOPMENT COSTS

The costs of developing a lake can be a major determinant of suitability. Costs are not only the initial costs to the developer (eg. provincial government) but costs of ongoing management and costs incurred by the future cottage owner as well. Thus, those lakes which are less expensive in the short and long term will be more desirable.

RANKING SYSTEM

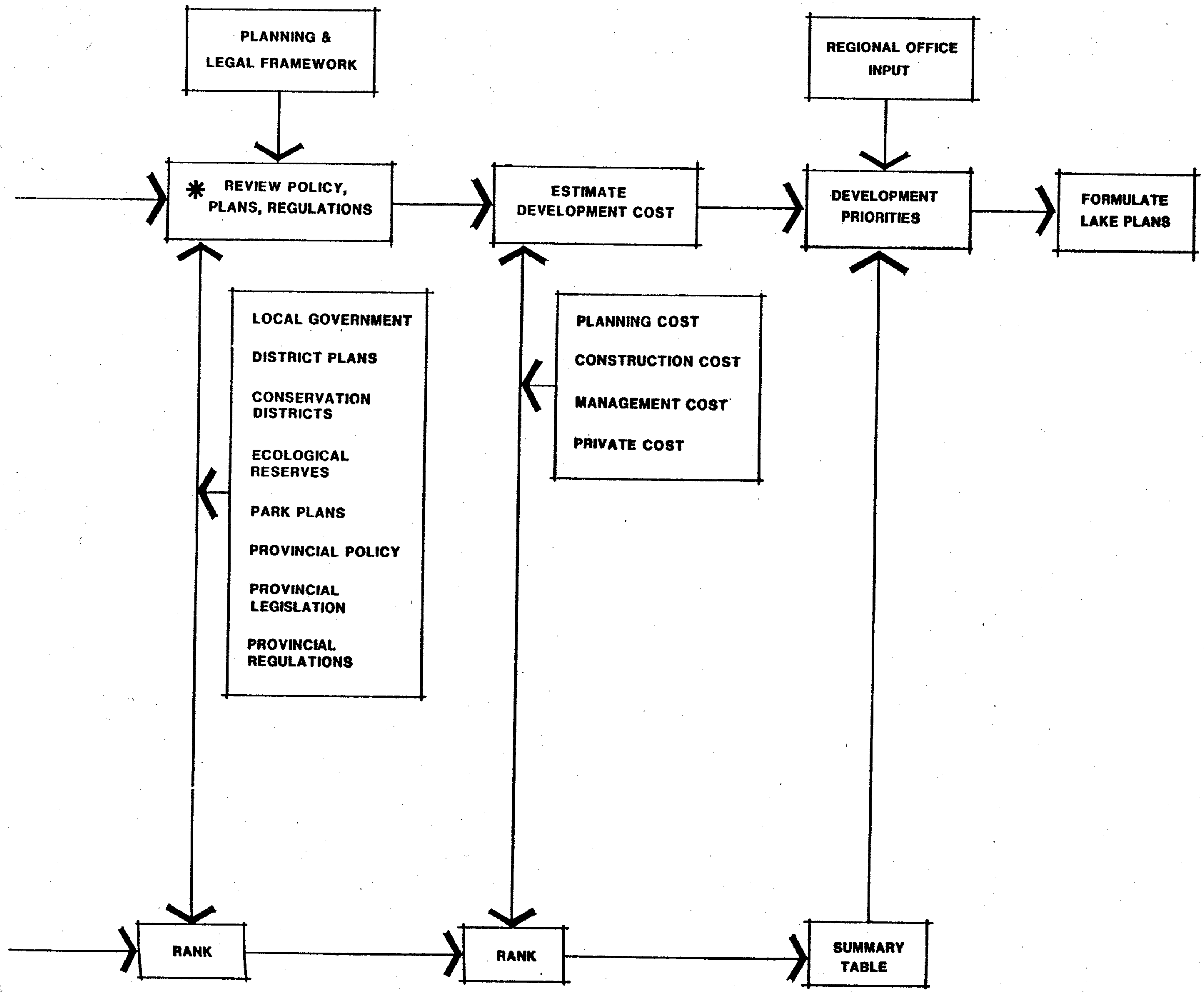
The system used to rate and rank lakes is flexible and can be as rigorous as desired by the planner. For some criteria (eg. angling capacity) the method of assessment produces a reasonably objective rating for each lake. In other cases (eg. viewing potential) ratings may be quite subjective and are based on the best judgement of the lake planner. Rating methods are proposed in these guidelines for each development criterion but may be altered or ignored as neces-



THE REGIONAL LAKE PLANNING PROCESS

FIGURE 2.1

✱ TRIGGER FACTOR


PLANNING &
LEGAL FRAMEWORK
REGIONAL OFFICE
INPUT
* REVIEW POLICY,
PLANS, REGULATIONS
ESTIMATE
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LAKE PLANS
LOCAL GOVERNMENT
DISTRICT PLANS
CONSERVATION
DISTRICTS
ECOLOGICAL
RESERVES
PARK PLANS
PROVINCIAL POLICY
PROVINCIAL
LEGISLATION
PROVINCIAL
REGULATIONS
PLANNING COST
CONSTRUCTION COST
MANAGEMENT COST
PRIVATE COST
RANK
RANK
SUMMARY
TABLE

sary. The planner decides on the relative weights to apply to the selection criteria based on the character of each region and the circumstances of each planning exercise. Certain factors, however, will usually have greater influence in the regional planning process. These are known as "trigger factors".

TRIGGER FACTORS

Trigger factors are factors which are given precedence in the process because of their overriding significance to lake selection and lake planning. They are highlighted because they may lengthen the process by requiring additional steps and more detailed analysis to be undertaken or they may "short-circuit" the process, causing a lake to be rejected from further consideration for seasonal home development. Trigger factors are of two kinds: a) those which are related to the characteristics of proposed development and b) those related to the characteristics of the lake.

Two trigger factors of the first type are identified:

i) The use of sewage treatment systems which permit treated wastes to reach the water body (eg. septic tank/tile field, pit privy, sewage lagoon, sewage ejector). These systems have special land capability requirements and can impact on water quality. When such systems are proposed a water quality survey and impact assessment will be required.

ii) When angling is considered an integral part of the cottaging experience an assessment of the viability of the sport fishery will be required.

Trigger factors of the second type are as follows:

i) Water quality which does not satisfy the minimum provincial standards for human use and consumption.

ii) Bodies of water qualifying as "high quality" as described in the general water quality objectives, appendix D, annex 1 in the Provisional Objectives of Surface Water Quality of the Province of Manitoba.

iii) Dangerous waters (eg. fast current) which pose a threat to public safety.

iv) Sport fisheries of national or provincial significance.

v) Wildlife habitat, wildlife populations of national or provincial significance.

vi) Historic and archaeological sites of national or provincial significance.

vii) Wilderness routes of national or provincial significance.

viii) Extreme water level fluctuations caused by hydro development.

ix) Lakes which are influenced by unsettled native land claims.

x) Lakes where seasonal home development is not permitted by policy or legislation.

PLANNING/DEVELOPMENT PRIORITIES

The final step in the regional process is the establishment of priorities for lake scale planning and development. Regional administrators determine lake priorities based on the development potential rankings derived from regional analysis and other factors related to the regional geographic and administrative context. With the establishment of lake priorities a program for lake-scale planning can be initiated.

Shoreland Capability

Discussion

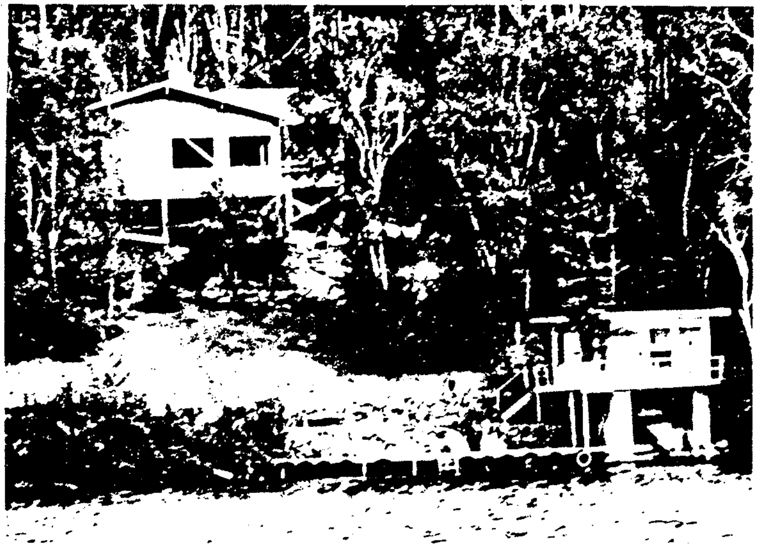
Shoreland capability is a measurement of the raw or natural capability of a lake's land base to attract and sustain seasonal home development and use. It embodies two concepts: the ability of the land to satisfy the physical requirements of cottage development; and the ability of the land to withstand the stresses caused by construction and use.

PHYSICAL REQUIREMENTS

The physical requirements of seasonal home development depend on the need for stable foundations, waste disposal, access and circulation, visual privacy, land and shoreline recreation. The form of a particular development and the types of activity associated with it will determine the specific site conditions required. Development form in this sense includes such factors as density, location, access, building type and servicing.

DEVELOPMENT STRESS

The development of land for seasonal home use will result in the removal of vegetation, disturbance of the soil structure and alterations to local drainage patterns. These changes may cause erosion, additional loss of plant cover and reduced soil fertility. The characteristics of a site: soil, slope, vegetative cover and other factors influence its ability to tolerate and recover from the alterations caused by development.



Higher capability lands are those which present fewer constraints to development and provide a greater degree of environmental protection. In general, they can support a greater intensity of use and a wider variety of uses. Although lower capability lands can be developed, the intensity of development and number of uses, which can occur without expensive site manipulation are less. Site limitations can possibly be overcome, however, through careful design and intensive management.

An important objective of lake planning is to identify and direct development to the higher capability shorelands. Favouring these areas will tend to reduce the environmental and economic costs of development and ensure a higher quality recreation experience.

Guidelines

The capability of shoreland for cottaging is a composite of the capabilities of land and shore areas for a number of specific uses.

The land area is the zone of habitation: where structures and services are located, circulation and land-based recreation occur. Development capability is a product of capabilities for road and building foundations, waste disposal (tile fields, lagoons, piped services), vehicular and pedestrian movement and visual screening. Capability is also determined by the susceptibility of vegetation to windthrow and site sensitivity to physical alterations caused by development.

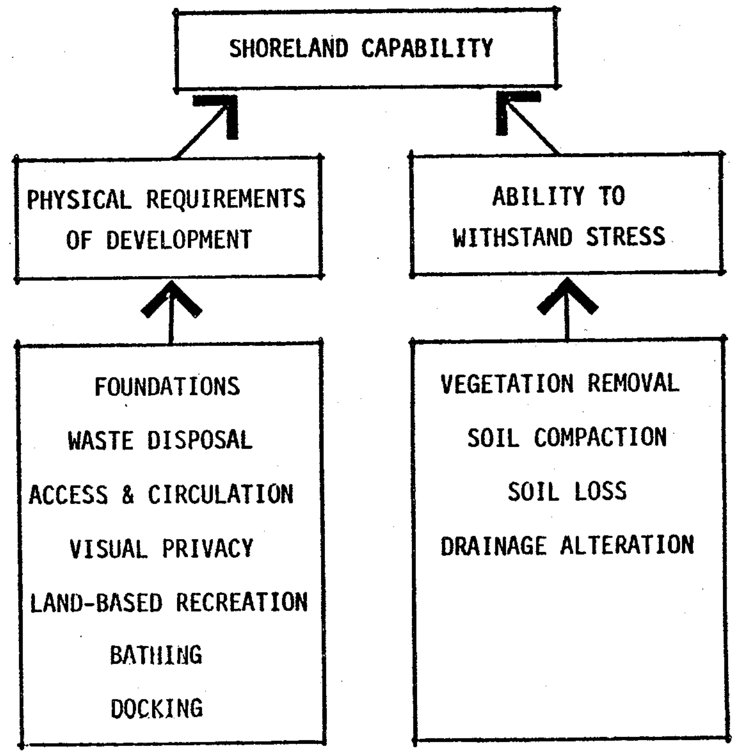


FIGURE 2.2

The actual area of land to be assessed depends on the potential form of development. For example, "ribbon" type, lakeshore subdivisions occupy the first 100 metres or so of shoreland. On the other hand, backland, cluster development with lagoon sewage treatment and a recreation trail system might require assessment of land capability up to 1 kilometre or more from shore.

The shore area is the location or base for all water-oriented activity, ie bathing, boating, fishing. The "dry beach" is the part of the shore lying between the high water and low water marks. It is important for riparian activity such as sunbathing and as the transition zone from water to land. The "wet beach", extending from the low water mark to the 1.5 metre depth, is the location for shallow water bathing and boat docking.* Development capability is determined by accessibility to water (slope, bank height), beach slope and beach material.

Both shore and land areas are important in the assessment of development capability. It is not always a requirement, however, that quality land and shore areas occur immediately adjacent to one another. Suitable shoreline within walking distance of backland development can be acceptable.

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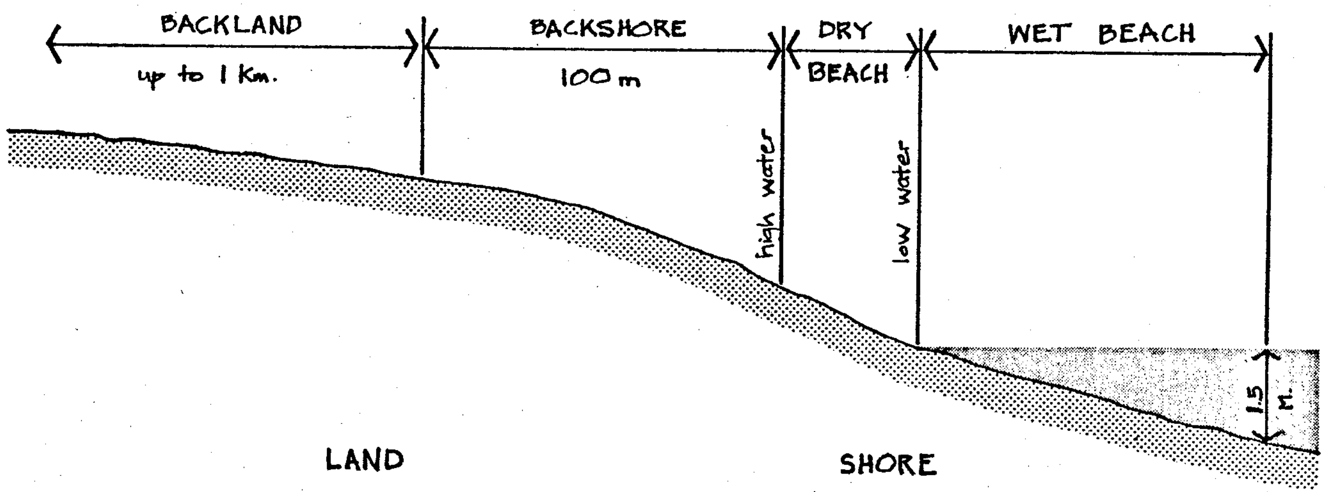
* see section 3 for more complete discussion



SHORELAND ZONES

FIG. 2.3

The capability of shorelands for cottage development is derived from analysis of soil type, soil depth, drainage, topography, vegetation, and shoreline characteristics for each site. Accurate assessments of these factors are a prerequisite for development. Section 3 describes in detail the importance of each factor to the development process and the methods by which they may be measured. Such assessments, which require detailed study and field work, are not always feasible or desirable at the regional scale due to the time and cost involved. It is preferable to use existing data sources where they are available, for the initial capability review.

In Manitoba, there are three major sources of land capability information for use at the regional scale: the Forest Inventory, the Canada-Manitoba Soil Survey and the Canada Land Inventory recreation capability mapping. None of these sources provide all of the information required to determine land capability for seasonal home development but when used together and confirmed through air photo interpretation they can give a reasonably accurate picture of site conditions.

Manitoba Forest Inventory

The Manitoba Forest Inventory covers most of the area of commercial forest in the Province. Township maps with accompanying legends are available at two scales: 1:15,840 (4" to 1 mile) and 1:63,360 (1" to 1 mile). Data on tree species composition, moisture regime, timber age and crown density are provided for each stand.

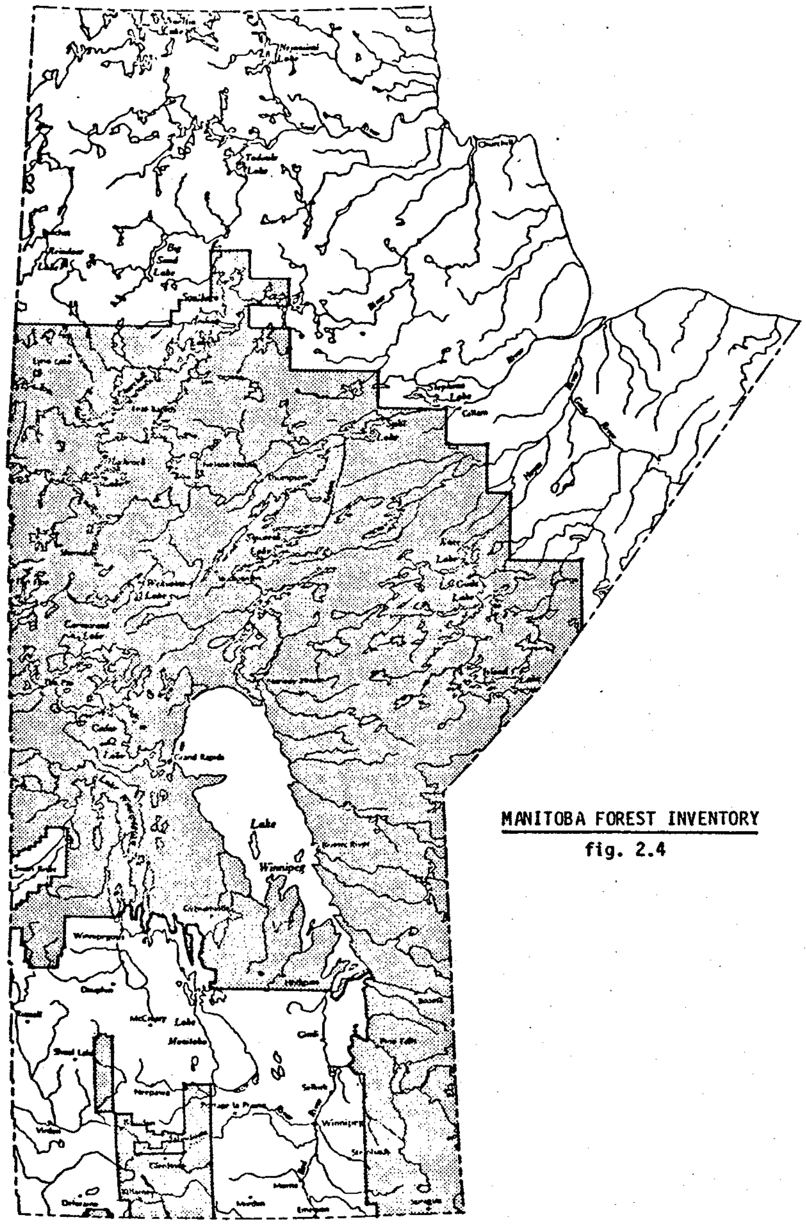
Land capability can be interpreted from the species mix of a stand, and a knowledge of the growing conditions preferred by different species. The capability rating can be defined further from the site type, cutting class and crown density data.

D.H.Mazur (1979) describes a method for using the Forest Inventory to interpret land capability in the precambrian shield region of the Province. His description is a good introduction to using the Inventory in this way but his actual method is not accurate for non-shield areas and the northern parts of the province.

ADVANTAGES:

data availability - coverage by the Forest Inventory is extensive, data is relatively current, the scale of information is reasonably detailed.

ease of application - given a knowledge of the relationship between tree species and site type on the part of the user, the technique is easy to learn and fast to execute.



MANITOBA FOREST INVENTORY
fig. 2.4

DISADVANTAGES:

reliability - the reliability of the data, particularly age and site classification, is dependent on the skill of the air photo interpreter, the inventory is not confirmed by operational cruise in most areas.

Mazur's method - some of Mazur's assumptions ie the wind firm properties of certain species and the significance of crown density are questionable.

shoreline conditions - the Inventory does not indicate shoreline vegetation conditions.

SOURCES:

Maps and legends can be obtained from the Manitoba Forest Inventory, 300 - 530 Kenaston Blvd., Winnipeg.

Mazur, D.H. 1979. A Method of Land Analysis and Classification for the Canadian Shield Portion of Manitoba. MA Thesis. Univ. of Manitoba.

Canada-Manitoba Soil Survey

The soil survey is the most comprehensive source of land capability information in the southern part of the province. Most of the south and west of the province has been covered by Reconnaissance Survey (scale 1:125,000). Selected areas have been the subject of detailed studies and surveys (scale 1:20,000). Large areas of the north and eastern parts of the province have been surveyed by the Biophysical Land Classification program (scale 1:125,000) or Exploratory Survey.

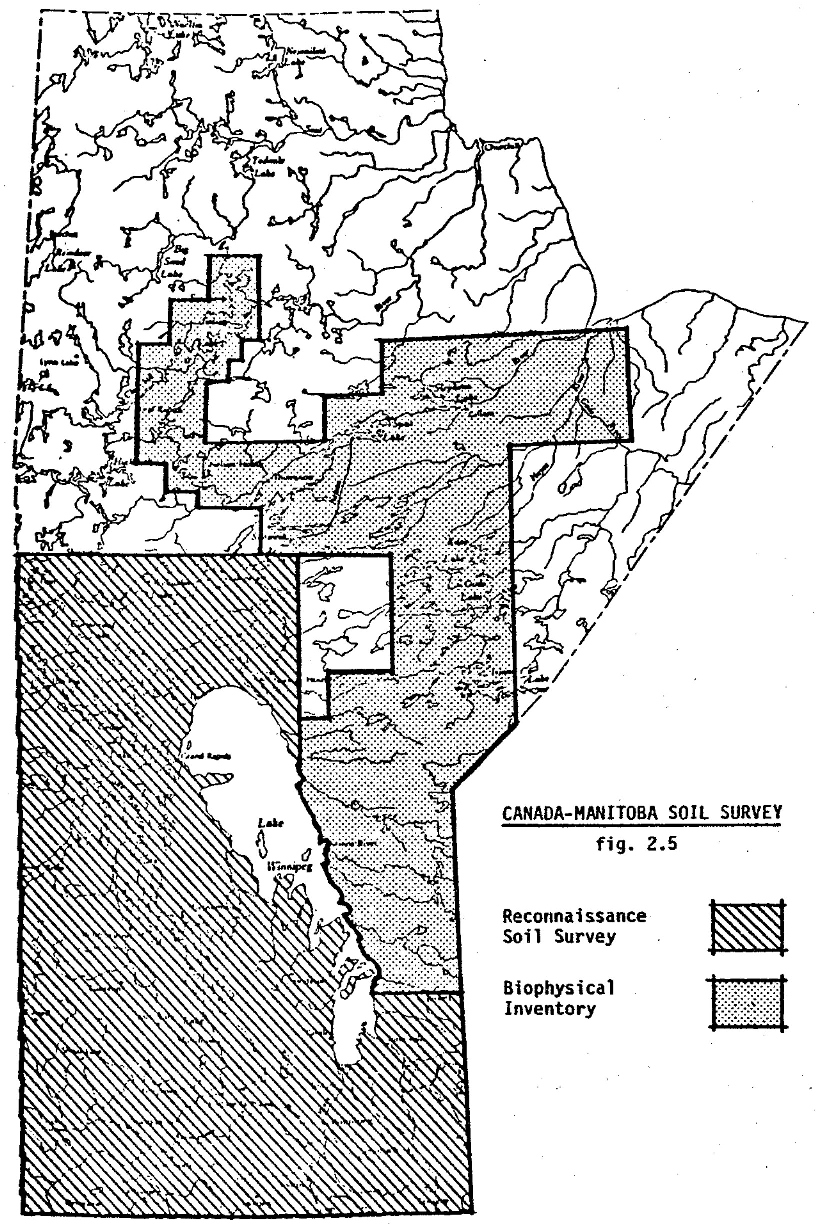
The soil survey reports contain data on soil type and texture, depth and drainage. Some reports include information on vegetative cover and relief. The larger scale surveys (Detailed and Reconnaissance) classify soils by agricultural capability. The more recent surveys also include interpretations for recreation and engineering capability.

ADVANTAGES

Reconnaissance scale information is available for most of the south and west of the province where Forest Inventory data is lacking.

Reconnaissance Survey reports which include interpretations for recreation and engineering capability enable quick comparisons at the regional scale.

Soil mapping is based on air photo interpretation and ground truthing. Reconnaissance scale surveys are reliable for decision making at the regional scale. Detailed surveys are accurate at the site scale.



CANADA-MANITOBA SOIL SURVEY

fig. 2.5

Biophysical and Exploratory surveys are a good cross-reference for Forest Inventory mapping.

DISADVANTAGES:

Where recreation and engineering capability interpretations are not given, time and effort are required to extract this information.

Detailed Survey coverage is patchy. Reports usually are concerned with specific locations rather than regions.

The detail of biophysical and exploratory surveys restrict their value as primary data sources.

SOURCES:

Canada-Manitoba Soil Survey, 1982, An Index to Soil Maps and Reports, Canada Agriculture, Manitoba Agriculture, University of Manitoba.

Published and interim reports and maps (Detailed and Reconnaissance Surveys) are available from: Publications Branch, Manitoba Department of Agriculture, 200 Vaughan Street, Winnipeg.

Biophysical Land Classification maps and reports are available from: Surveys and Mapping Branch, 989 Century Plaza, Winnipeg.

Preliminary maps and other field data are available from: Canada- Manitoba Soil Survey Office, University of Manitoba, Winnipeg.

Canada Land Inventory

Canada Land Inventory coverage is available for the south and west parts of the province. The inventory uses National Topographic Survey maps at 1:250,000 scale to rank land and shoreland units for various recreational uses using a national classification system. Some of the province is mapped at a scale of 1:50,000 and are available in an unpublished form.

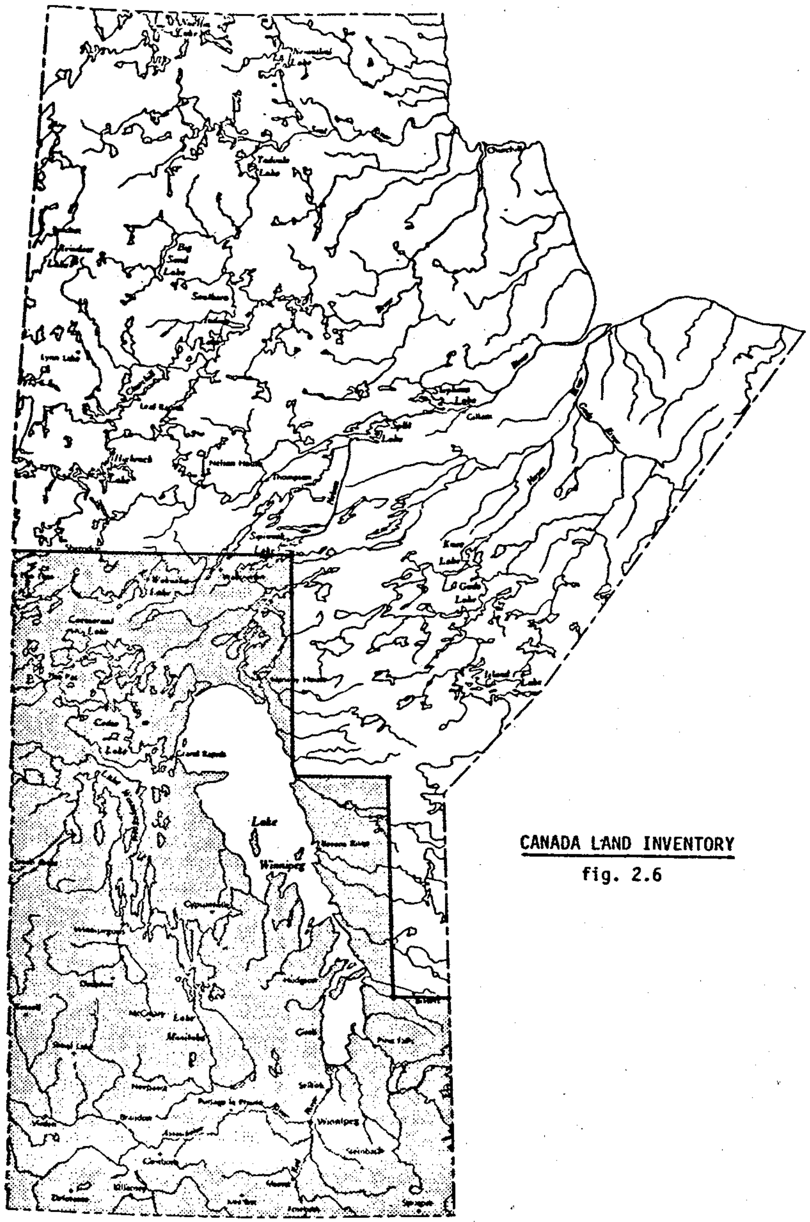
The Canada Land Inventory mapping includes interpretations of lake shorelands for lodging (cottages). Lodging may be a dominant feature of land units classed from 2 to 5, or a subordinate feature in units classed 1 to 5. Capability classifications for lodging units are based on the following standards (Canada, 1969):

Class 2 - Shoreland units with excellent attributes for cottaging, with capability for tiered lodging development.

Class 3 - Shoreland units with capability for a continuous row of lodging development (ie an average density of family units of one per 100-foot frontage throughout the unit).

Class 4 - Shoreland units with natural capability for 50% cottage development (ie the equivalent of one cottage every 200 feet).

Class 5 - Shoreland units with backshore capable of sparse cottage development (ie the equivalent of one cottage every 500 feet).



CANADA LAND INVENTORY
fig. 2.6

A quick estimate of the cottage capacity of a lake can be made using the following method (see figure 2.7):

1. Sum the length of shoreline in each capability class.
2. Calculate the number of cottages in each class by multiplying the length of shoreline by the development standard for that class.
3. Sum the amount of cottaging for each class to obtain the total capacity for the lake.

The development standard should be seen as a flexible value which is modified according to local conditions, and the form of the proposed development. For example, the Ontario Ministry of Natural Resources (1977) uses a standard of 150 ft. per unit in their manual.

ADVANTAGES:

Permits assessment and comparison of seasonal home capability with little time and effort.

Overlaps with area covered by soil survey.

DISADVANTAGES:

Capability classification assumes specific development forms (ie tier, ribbon) and services (ie tile fields). May not reflect capability for other forms.

Scale of mapping limits accuracy of information in terms of actual development units, field survey may reveal more or fewer building sites. However, total cottage capacity figures are still useful for regional comparisons between lakes (ie data is likely to be equally reliable for all lakes in the region).

SOURCES:

Canada, Department of Regional Economic Expansion. 1969. The Canada Land Inventory, Land Capability for Outdoor Recreation. rep. no. 6 Ottawa.

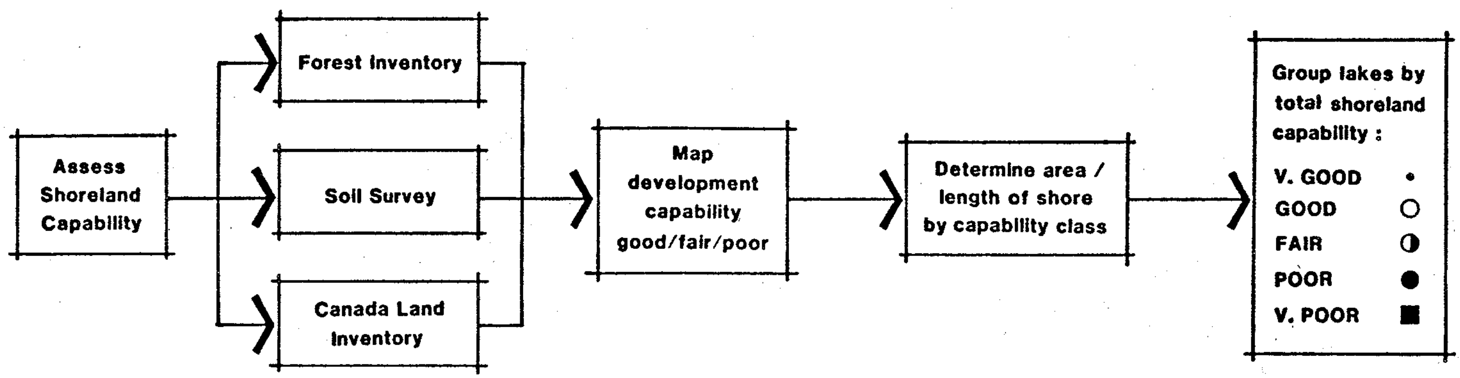
Canada Land Inventory maps are available from: Surveys and Mapping Branch, 989 Century Plaza, Winnipeg.

capability class*	development type	length	x	development standard			=	cottage capacity
1	backshore			2+units/100'	2u/30m	66u/km		
2	backshore			2+units/100'	2u/30m	66u/km		
3	100% ribbon			1 unit/100'	1u/30m	33u/km		
4	50% ribbon			1 unit/200'	1u/60m	16u/km		
5	20% ribbon			1 unit/500'	1u/150m	6.5u/km		
								total capacity

* only classes where lodging (subclass N) is dominate or subordinant feature.

fig. 2.7 A METHOD FOR DETERMINING SHORELAND CAPACITY USING CANADA LAND INVENTORY DATA

adapted from: Canada Department of Regional Economic Expansion. 1969. The Canada Land Inventory Report No. 6, Land Capability Classification for Outdoor Recreation. Ottawa.



SHORELAND CAPABILITY

Water Capability

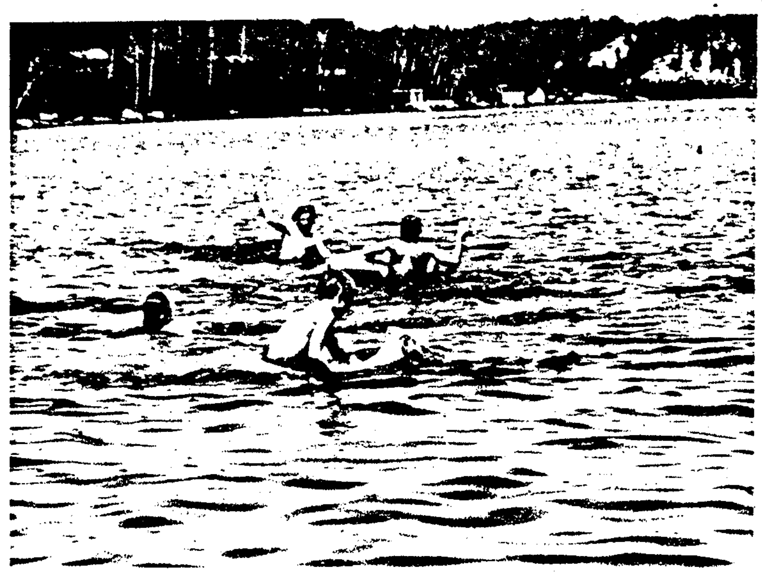
Discussion

The essence of lake-oriented seasonal home development predetermines that the aquatic resource is of fundamental importance. The lake is the arena for most, if not all, recreational activity: swimming; boating; angling. It is the focus for viewing and sight seeing. It may also be a transportation link, source of drinking water and waste disposal system.

While the lake's ability to satisfy these human needs is important, it must be recognized that the water body is part of a natural biophysical system. The function of this system strongly influences its suitability for recreation and other human use. Seasonal home development can disrupt or alter the system, causing a decline in recreation quality.

Water capability is the ability of the lake's aquatic resource to attract and sustain seasonal home development and use. It is assessed in terms of five variable categories:

- Suitability for human use and consumption
- Sensitivity to nutrient loading
- Hazards and nuisances which interfere with recreational activity
- Viability of the fishery
- Size and configuration of the lake



Human Use and Consumption

Concern here is with the quality of the water for contact recreation, drinking and domestic use.

HUMAN HEALTH - water should be free of disease-causing micro-organisms, toxic algal blooms, and unsafe levels of chemical pollutants. Poor water quality may cause stomach and intestinal illness, ear and throat infections, skin and eye irritations, and viral infections.

TASTE AND ODOUR - large algae populations can taint fish and drinking water. Algal blooms form surface scums which collect on leeward shores where they rot, producing malodorous conditions.

CLOGGING OF FILTERS - free floating planktonic algae can clog water intake filters.

TURBIDITY - turbid water is unattractive for swimming and creates hazardous conditions for boats and swimmers by hiding underwater obstacles. Turbidity can be caused by sediments held in suspension (eg. Lac du Bonnet) and free-floating algae (eg. Rock Lake).

LEECHES - leeches can be very disconcerting to bathers if found in abundance.

Guidelines

Waters to be used for domestic cottage consumption must meet the requirements of class 1A or 1B waters outlined in Manitoba's provisional water quality standards (Clean Environment Commission, 1979). The <u>minimum</u> requirements for a cottaging lake are those for class 2B waters.

Generally, lakes with water limitations for human use and consumption are the shallow, naturally productive lakes of the Prairie regions. Deeper, colder lakes with high flushing rates will tend to have high water quality.

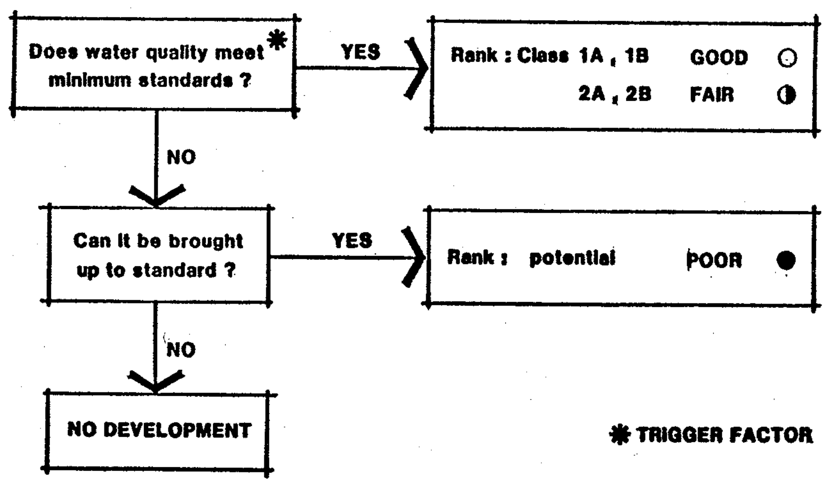
Pathogens and chemical pollutants are usually associated with existing urban, agricultural, industrial or large scale recreational land use.

Sources

Obtain information on water quality from Water Standards and Studies Section, Environmental Management Division, Winnipeg, Current data is available for relatively few lakes. Where data not available, consult with Water Standards and Studies biologists, Regional Public Health Inspectors, Regional Fisheries Manager and local residents to determine potential for water quality problems. <u>If potential exists water quality analysis will be required</u>.

Water quality standards are found in:

Clean Environment Commission. 1979. Report on a Proposal Concerning Surface Water Quality objectives and Stream Classification for the Province of Manitoba

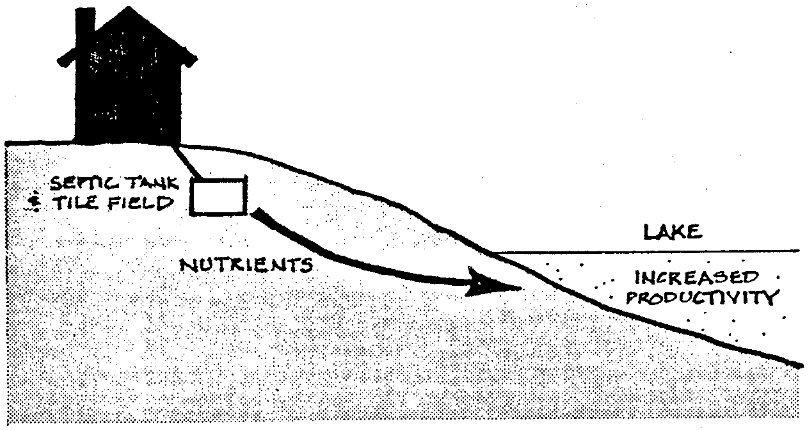


Nutrient Loading

A major issue associated with the rapid growth of seasonal home development over the last 25 or so years is the impact on lake systems of nutrient enrichment from human occupation. Nutrients contained in human and household wastes, when permitted access to a water body, upset the balance of productivity and accelerate the natural process of eutrophication or lake succession.*

Phosphorus is the nutrient of greatest concern, for it is the mineral which most often limits plant productivity in lakes. Laundry detergent was a major source of phosphorus prior to the passage, in 1973, of federal legislation restricting phosphate content. The main source of phosphorus from most households today is human waste; 0.8 kg per capita-year on average. Other possible sources of phosphorus from cottages are dishwashing detergent (very high phosphate content) and lawn fertilizers. Increased erosion from land clearing and disturbance of lake bottom sediments by motor boats in shallow water areas may also increase nutrient loads.

Septic tank/tile-field systems, pit privies or other waste disposal systems which release sewage to the soil for treatment are potential sources of nutrients. In Precambrian shield



* A more complete discussion of eutrophication and other limnological concepts is found in the appendix.

areas where soils are typically shallow and coarse-textured phosphorus retention by the soil is negligible. Clay or clay-loam soils provide some measure of protection but do not retain all nutrients. Sewage lagoon effluent is also a source of phosphorus upon its release in the spring or fall.

The increase in nutrient supply stimulates productivity in the aquatic system. In deep, clear unproductive lakes such as found on the precambrian shield the result is an increase in the levels of phytoplankton which may cause turbid conditions and a general decline in water quality for most recreational activity. Increased decomposition can lead to the depletion of dissolved oxygen in bottom waters creating conditions unfit for coldwater species. In shallow, naturally productive lakes increased nutrient-loading stresses an already productive environment. There may be an increase in the production and frequency of algal blooms and aquatic plants to the point where recreation activities such as swimming and boating are hindered. There may also be an increase in the frequency of the summerkill and winterkill of fish.

The most dramatic cases of cultural eutrophication have been associated with urban, industrial or agricultural land use. The impact of sparse population densities such as those of typical cottage development can be difficult to detect. However, steady cottage use over a period of 10 to 25 years may have a significant impact on a lake's trophic state.

Guidelines

The nutrients policy contained in the proposed provincial water quality objectives (Clean Environment Commission, 1979) states, as a goal, that all lakes and impoundments shall be protected from becoming more eutrophic. Therefore, where disposal systems which permit waste to reach a waterbody are proposed, scientific assessments of lake sensitivity must be undertaken. Similar assessments are also required, regardless of waste disposal system type, for waterbodies deemed to be of "high quality" as described in appendix D of the provincial water quality objectives (see appendix).

Lake systems have varying capabilities to absorb nutrient loading without showing signs of stress. Many factors determine a lake's sensitivity, including: size, shape and depth of the lake basin; trophic state; flushing rate; existing nutrient input; and geology of the watershed.

Although sensitivity to nutrient loading must be assessed on an individual basis, a number of generalizations about lake sensitivity may be stated. These are presented to help explain the concept of lake sensitivity and are not to be used alone as criteria for selecting recreational lakes. There are many assumptions inherent in the guidelines and doubtless there are many lakes which are exceptions to them.

GENERAL LAKE SENSITIVITY GUIDELINES

1. UNPRODUCTIVE, OLIGOTROPHIC LAKES ARE MORE SENSITIVE TO NUTRIENT LOADING THAN NATURALLY ENRICHED EUTROPHIC LAKES.

   The effect of a given increase in nutrient loading will be more easily detected in an oligotrophic lake than a eutrophic lake. A relatively small increase in productivity will have a more dramatic effect on water clarity in clear, unproductive, oligotrophic lakes than eutrophic lakes.

2. HIGHLY EUTROPHIC LAKES ARE SENSITIVE TO NUTRIENT LOADING.

   Highly eutrophic lakes, particularly those not well-exposed to the wind have a propensity to summerkill and winterkill. Development can increase the possibilities of such occurences.

3. COLDWATER FISHERIES ARE MORE SENSITIVE TO NUTRIENT LOADING THAN WARMWATER FISHERIES.

   Salmonoid species require deep waters rich in dissolved oxygen. Development can cause oxygen depletion in the bottom waters.

4. LAKES WITH HIGHER FLOW ARE LESS SENSITIVE.

   Higher flow usually means greater dilution of nutrient input and less water stagnation.

5. SHALLOW LAKES ARE MORE SENSITIVE TO NUTRIENT LOADING.

   Shallow waters (ie. less than 2-3 metres) are prone to summerkill and winterkill.

ASSESSING SENSITIVITY

Estimates of lake sensitivity and predictions of development impact can be made by experienced limnologists and fisheries biologists from an analysis of the lake's physical, chemical and biological characteristics. A model which can be used to estimate lake carrying capacity based on nutrient loading is described in the carrying capacity section of this report.

As water quality data is not available for most lakes in the province a lake survey will likely be necessary. The data which will be required includes:

CLIMATIC CHARACTERISTICS

precipitation
ice-free period

WATERSHED CHARACTERISTICS

land use
geology and soils
vegetative cover

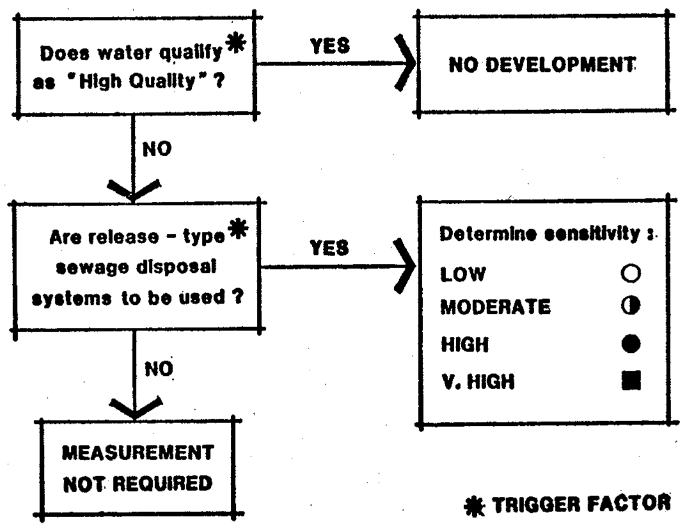
LAKE CHARACTERISTICS

flushing rate
depth; volume, form of lake basin
thermal regime
oxygen distribution
trophic status: chlorophyll a; secchi disc; total phosphorus

Sources

Clean Environment Commission, 1979. Report on a Proposal Concerning Surface Water Quality Objectives and Stream Classification for the Province of Manitoba.

Water Standards and Studies Section, Environmental Services Branch - water quality data for select Manitoba lakes stored on computer.



Hazards and Nuisance

Certain lake characteristics may present serious hazards to recreational use, other characteristics, while not hazardous, may significantly reduce the quality of recreational experience.

WATER LEVEL FLUCTUATION - may cause flooding; excessive draw down hinders access to water, boat docking and exposes unsightly mud flats.

AQUATIC VEGETATION - extensive growth hinders bathing and boating; cutting of aquatic vegetation by boat motors and for beach improvement increases decomposition and can create malodorous conditions when the debris collects on the shore (eg. Lake Metigoshe).

DANGEROUS WATER - water with fast and unpredictable currents and extensive shoals present hazards to boating and bathing activities

WAVE ACTION- large or choppy waves can hinder boating and create hazards for small craft.

DANGEROUS ICE CONDITIONS - dangerous winter ice restricts lake suitability for water use.

Guidelines

WATER LEVEL FLUCTUATIONS

Annual water level fluctuations in excess of 1.5 metres will require detailed analysis of the lake to determine potential problems.

Information regarding fluctuations on lakes with control structures should be obtained from the Water Resources Branch, 1577 Dublin Ave., Winnipeg.

Fluctuations on some uncontrolled lakes are monitored by the Water Resources Branch. For other lakes, inquire of local residents and regional office personnel.

AQUATIC VEGETATION

Lakes with extensive growths of aquatic vegetation along much of the shore or with vegetation near the surface in areas of "open water" have lower capability for cottage development.

What constitutes excessive "weed growth" varies by region. For example, in the prairie region a certain amount of aquatic vegetation is taken for granted.

Obtain information on aquatic vegetation conditions from Canada Land Inventory recreation capability and waterfowl capability maps. Additional information may be obtained from air photos, the Regional Fisheries Manager, local residents, and Ducks Unlimited.

DANGEROUS WATER

Lakes with numerous or serious hazards which are dangerous for navigation and/or on-water recreation are less capable for cottage development.

Hazardous water will have a local reputation. Obtain information from Conservation Officers or other local residents.

Shoals will appear on air photos. Major shoals appear on topographic maps.

WAVE ACTION

Lakes with fetches oriented in the direction of the prevailing wind will have rougher water conditions. The effective fetch of a lake is longer when shoreland areas are low and void of vegetation.

Shallow lakes tend to have choppier wave conditions.

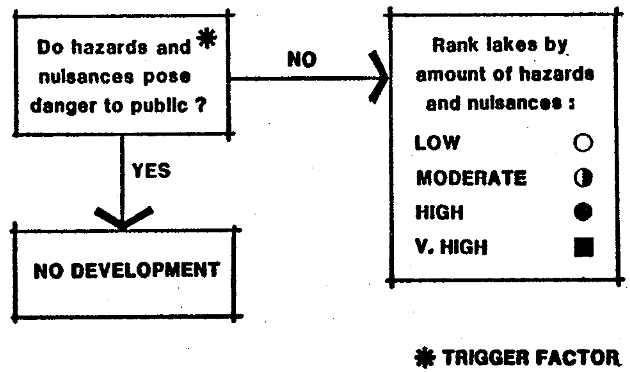
Lakes which tend to "blow-up" easily have a lower capability for cottage development.

Determine potential for hazardous wave conditions by referring to topographic maps, climatic data, lake depth information and consulting with Conservation Officers or other local residents.

DANGEROUS ICE CONDITIONS

Dangerous ice conditions will reduce the suitability of a lake for cottage developments where winter use is planned.

Obtain information on ice conditions from Conservation Officers or other local residents.



Viability of Fishery

Sport fishing is often an important element of the cottaging experience. Cottage development which occurs on a lake incapable of satisfying angling demand or maintaining viable fish populations has increased the need for long-term fisheries management.

Lakes do not all have the same capability to produce and maintain viable fish populations. Deep, oligotrophic lakes are poor in nutrients and support relatively low populations of coldwater species. Shallower, more eutrophic lakes support greater populations of warmwater species. Lakes at advanced stages of eutrophication are less capable of maintaining fish populations due to the occurrences of fish "kills": drastic oxygen depletion caused by decomposition of large algae populations.

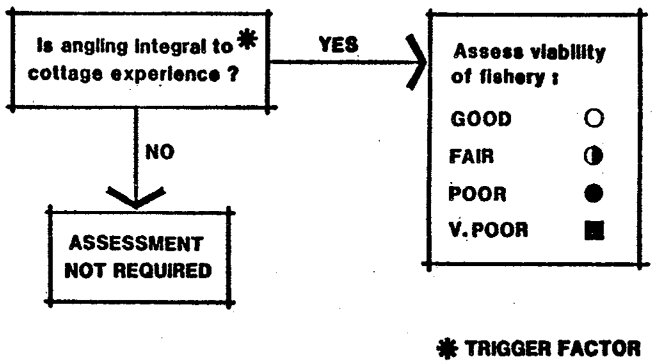
Guidelines

- Coldwater (trout) fisheries are more easily depleted by angling than warmwater fisheries due to the low productivity of oligotrophic lakes. Lakes which support coldwater species have a lower capability for cottage development.

- Shallow, eutrophic lakes have a greater susceptibility to summerkill and winterkill. These lakes have a lower capability for cottage development.

Where angling is anticipated as an essential part of proposed cottage development an assessment of the fishery will be required. This study, undertaken by fisheries biologists, will involve sampling of fish populations, analysis of lake trophic state and determination of the lake's angling capacity. Contact the Regional Fisheries Manager.

General information on lake capability for sport fishing may be obtained from Canada Land Inventory recreation series maps.

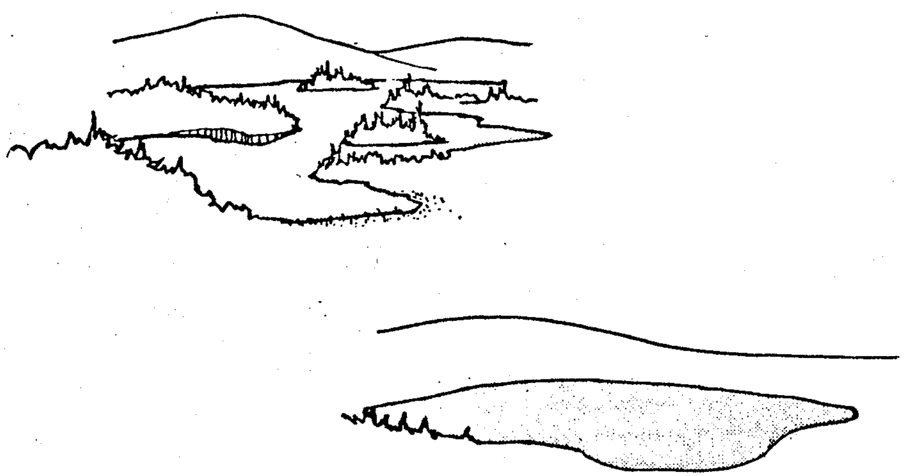


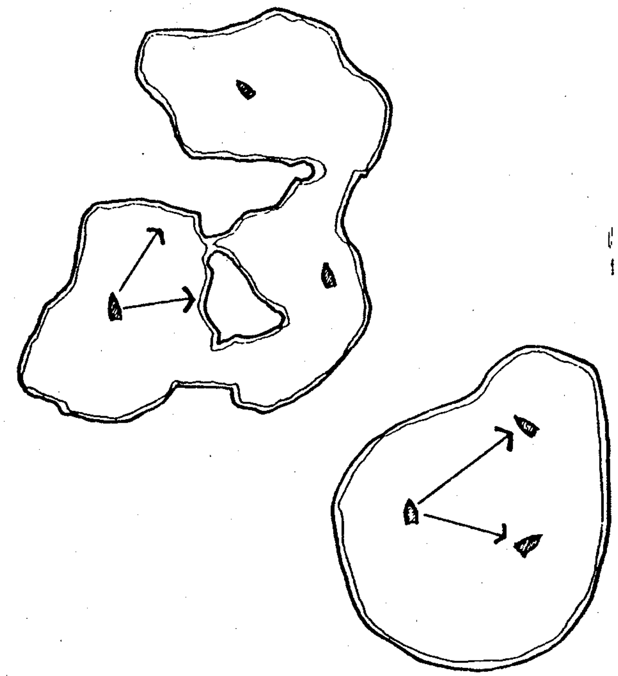
Size and Configuration

The size and configuration of a lake have implications for visual attractiveness, perceptional and spatial carrying capacity. Spatial carrying capacity is determined by the surface area requirements for safe and unimpeded on-water activity. Perceptional carrying capacity is a reflection of the spatial needs of on-water activities as perceived by users.

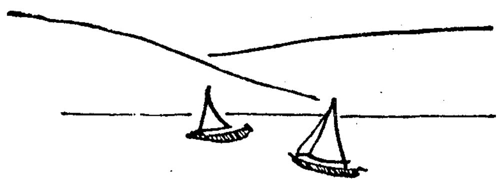
Guidelines

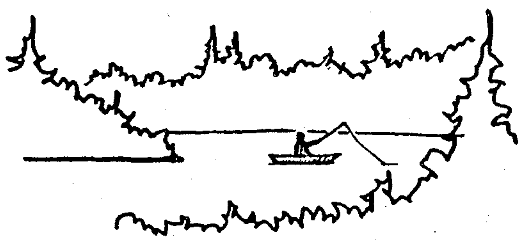
1. A lake which has many bays and islands and a variety of shoreland types is more visually complex and generally more attractive.





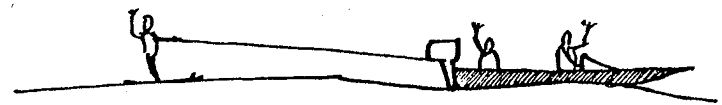
2. A lake with a more complex configuration increases opportunities to segregate activities and reduce the visual impact of development.





3. A lake with protected bays and channels as well as open water areas has potential for a greater variety of boating activities and on-water experiences. (eg. isolated bays for quiet canoeing; open water for sailing.)

4. A lake with a large water surface and few boating hazards has a higher carrying capacity for power boats than a smaller lake or one with extensive shallow water areas and aquatic vegetation.



Assess the irregularity of lake shoreline and brokeness of shoreland silhouette using topographic maps and air photos. Where available, refer to CLI recreation capability maps for interpretations of shorelands with significant scenic quality

Assess boating capacity using method outlined in the carrying capacity section of this report. If time does not permit calculation of capacity assess boating capability using surface area, mean depth and fetch exposure (see

Assess viewing potential:			Assess boating potential:		
	GOOD	○		GOOD	○
	FAIR	◑		FAIR	◑
	POOR	●		POOR	●
				V. POOR	■

FIGURE 2.8

A METHOD TO RANK WATERBODIES FOR BOATING AND VIEWING

	BOATING			VIEWING*	
Limitation	Waterbody Area	Mean Depth	Fetch Exposure of Most of Shore	Irregularity of Shoreline	Shore Silhouette
0	Large 40 + km^2	Moderate or Deep >3 m	< 6 km	irregular	moderately or strongly broken
1	Medium 10-40 km^2	Shallow 1.5-3 m	6 - 12 km	moderate	flat or weakly broken
2	Small 2.5-10 km^2		>12 km	open	
4	Very Small <250 ha	Very Shallow <1.5 m			
6	Extremely Small < 65 ha				

* 1. Very irregular shoreline may cancel flat silhouette limitation.
2. Strongly broken silhouette may partly cancel open limitation.
3. Aquatic nuisances and reefs may be further limitations.

NOTE: Ranking system for viewing is most appropriate in precambrian shield areas. The visual quality of prairie lakes is determinad by more subtle landform characteristics.

Adapted from Ontario Ministry of Natural Resources (1971).

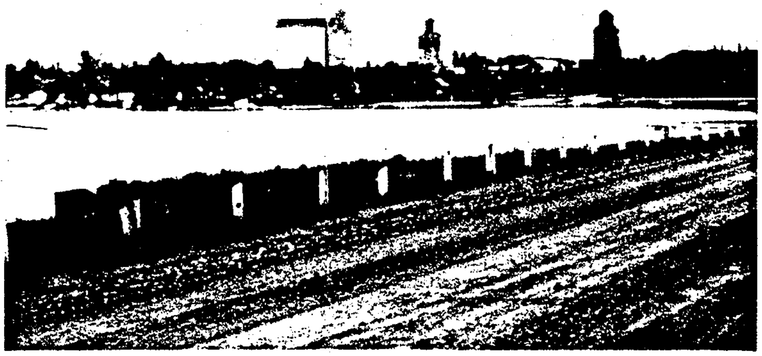
Other Resource Use

Discussion

The suitability of a lake for cottage development is strongly influenced by the presence of other uses, both on the lake and in its watershed. Some uses are, by their nature, incompatible with seasonal home development. In such cases it is inadvisable to permit both uses to occur. Other uses may have potential for conflict, requiring careful planning and management to prevent problems. Still other uses can be compatible with cottaging and present opportunities which will benefit both.

It is important that not only the uses which presently exist be considered but potential uses must be examined as well. Failure to do this may result in future resource conflict or missed development opportunities. Acknowledging other uses and providing for their needs is fundamental to the regional process.

Lakes with potentially conflicting uses will pose restrictions for cottage development and will increase long term management needs. Such lakes are therefore less suitable for development. Lakes with uses that complement cottage development have greater suitablilty.



Commercial and Sport Fishing

Cottage development impacts on fisheries in two ways:

a) increased angling pressure - "opening-up" a previously inaccessible lake; introducing a resident population of anglers.

b) alterations of fish habitat - changes in lake trophic state; destruction of fish spawning, nursery and feeding grounds.

The former type of impact can have a dramatic effect on fish populations but the latter can be much more damaging in the long term. A fish population is rarely extirpated by angling pressure however the quality of the fishery for recreation or commercial purposes can be severely reduced. Alterations of fish habitat can render the waters unfit for certain species.

On the other hand, a lake with a productive sport fishery can be very attractive for cottage development.

Guidelines

In general the following types of lakes have greater potential for conflict:

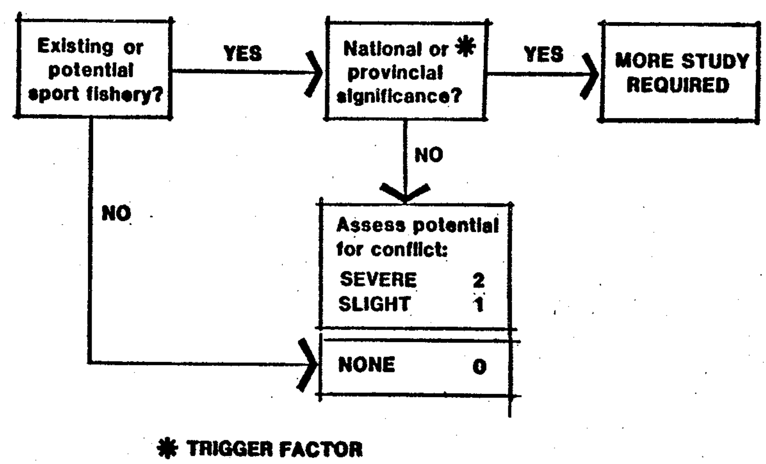
a) lakes which support commercial fisheries and commercial sport fisheries.

b) lakes with fisheries of district, regional or provincial significance.

c) lakes capable of supporting coldwater species - due to the sensitivity of such species to angling pressure and changes in trophic state.

d) headwater lakes which are important for fish spawning.

Consult with Regional Fisheries Manager to assess lakes with least potential for conflict.



Wildlife Management

Cottage development impacts on wildlife in two ways:

a) destruction or alteration of habitat.

b) improved access to previously inaccessible areas - leads to increased hunting pressure and disturbance from increased human presence.

The presence of wildlife represent recreational opportunities for cottagers in the form of viewing and hunting.

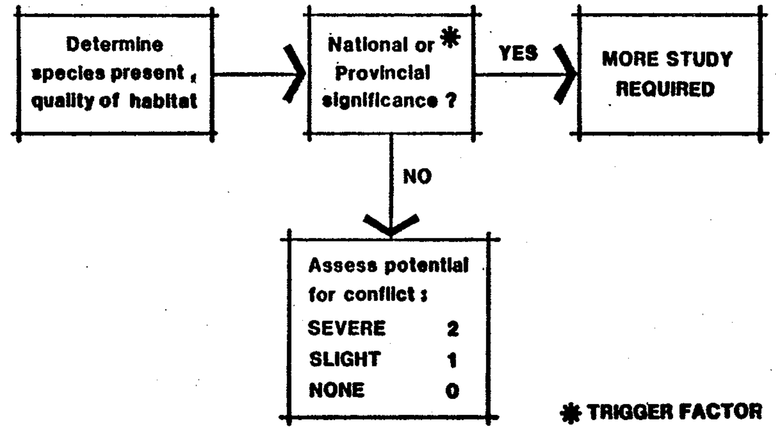
Guidelines

Destruction and alteration of some habitat can be reduced through careful design at the lake and site scales. However certain areas need to be identified at the regional scale and avoided where possible. These include:

- high quality ungulate, furbearer and waterfowl habitat
- colonial nesting sites
- raptor nesting sites
- other rare or unique species habitat

Contact Regional Wildlife Manager to obtain information about important wildlife habitat, wildlife management programs and the potential for conflict with commercial fur harvesting, sports hunting and wildlife conservation.

Refer to Canada Land Inventory Land Capability for Wildlife (waterfowl and ungulates) map series to locate important habitat.



Wild Rice

Conflicts can occur between wild rice management and cottage development over the issue of water level control and disturbance of licenced stands by recreationists.

Guidelines

While conflicts can sometimes be prevented through design and management at the lake level, areas of significant wild rice potential should be avoided if possible.

Wild rice grows in the south and south-eastern parts of the province. Obtain and map information on stands and leases source: Crown Lands Branch, 1495 St. James Street, Winnipeg.

Assess potential for conflict:

SEVERE	**2**
SLIGHT	**1**
NONE	**0**

Historic and Archaeological Sites

Cottage development and the activity it generates can damage historic or archaeological sites if steps are not taken to protect them. On the other hand, such sites present opportunities for interpretation.

Almost all lakes will have sites of historic and/or archaeological significance, most of which remain undiscovered. There are, however, known sites of importance which should influence the process of resource allocation.

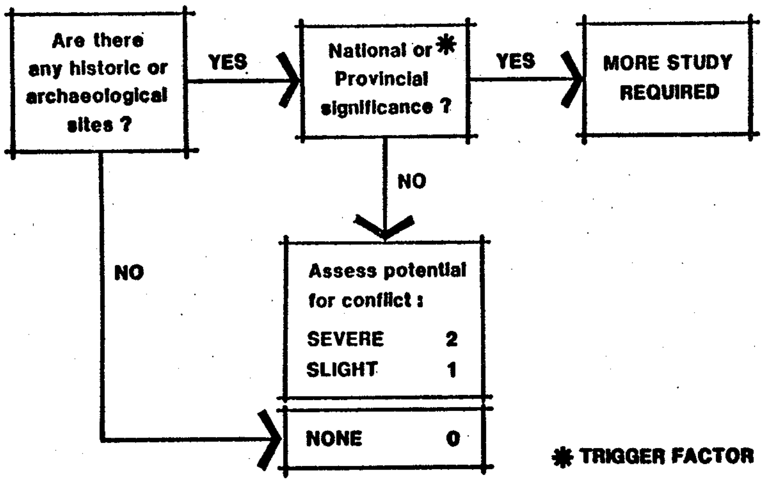
Guidelines

Historic Resources Branch personnel will be able to advise as to the severity of conflict which might occur as a result of seasonal home development on various lakes. Lakes where there is potential for conflict are less suitable for development.

Obtain information about known sites of historic significance from the Historic Resources Branch 200 Vaughan St., Winnipeg.

Obtain information about registered archeological sites by applying to the Provincial Archeologist, Historic Resources Branch.

Obtain additional information from local historical societies, regional Department of Natural Resources personnel and local residents.



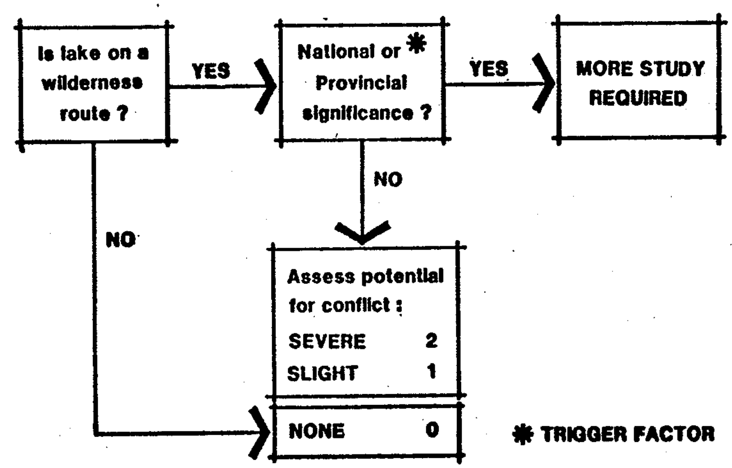
Wilderness Tripping

The existence of even one cabin or motorboat on a wilderness canoe or hiking route can be offensive to a wilderness user. On the other hand, such routes increase recreation opportunities if accessible from a cottage developpment.

Guidelines

While the impact on wilderness users can be reduced somewhat through careful design, cottage development should occur where conflicts will be avoided.

Obtain and map locations of canoe routes, hiking and cross-country ski trails, source: Parks Branch, 280 Smith Street, Winnipeg.



Public Recreation

Seasonal home development can reduce the quality of a water body for public recreation: camping, day use by altering the character of the lake and increasing the number of people using it. Furthermore, cottage development may alienate shorelands from the general public.

Where both cottaging and public recreation can be accommodated opportunities exist for cost-savings in the provision of services and facilities.

Guidelines

Lakes which are used for public recreation require more detailed analysis to determine the potential for conflict. Lakes of regional significance for public recreation are less suitable for cottage development.

Lakes with significant potential for public recreation (eg. with high quality beaches, potential campground or park sites) may be less suitable for cottage development.

Identify and map lakes presently used for public recreation sources: regional office personnel, local residents.

Identify and map lakes with significant potential for public recreation sources: CLI recreation capability, air photos, regional office personnel.

Assess potential for conflict:

SEVERE	**2**
SLIGHT	**1**
NONE	**0**

Existing Cottage Development

The presence of existing cottage development on a lake can be significant deterrent to new development. Established lake users have a tendency to regard the water body as their own and may resist changes which they believe will affect the quality of their own recreation experience.

On the other hand, new cottage development will be able to take advantage of services and facilities already in place. Additional development may improve services already available.

Guidelines

Lakes with large numbers of existing cottages relative to area of water surface and length of shoreline may be less suitable for development.

Lakes with more irregular shoreline configurations will have greater potential for separating activities and will be more suitable for development.

Determine numbers of cottages and levels of use. sources: Crown Lands Branch, air photos, field inspection.

Estimate potential for on-water conflict by calculating boating capacity using the method described in the carrying capacity section.

Estimate potential for visually and physically separating new from existing development.

Assess potential for conflict :

SEVERE	**2**
SLIGHT	**1**
NONE	**0**

Forestry

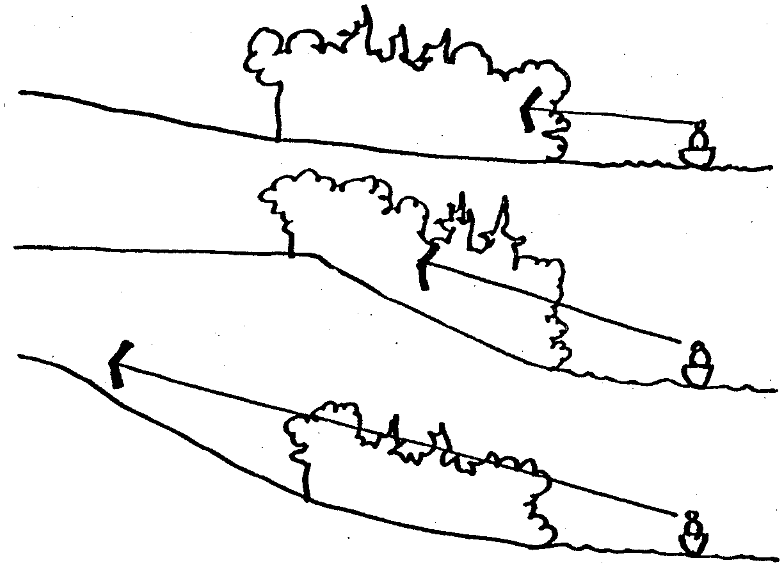
Forestry operations can affect recreational use of lakes in two ways:

a) Timber cutting can alter the visual appeal of surrounding shoreland.

b) Cutting operations can affect water quality by increasing sedimentation, nutrient loading and water temperature.

Although the first type of impact can be controlled or reduced by the delineation of skyline reserves and cutting patterns which respond to landscape form these are not always practical or desirable. Impacts on water quality depend on cutting practices, slope and soil conditions.

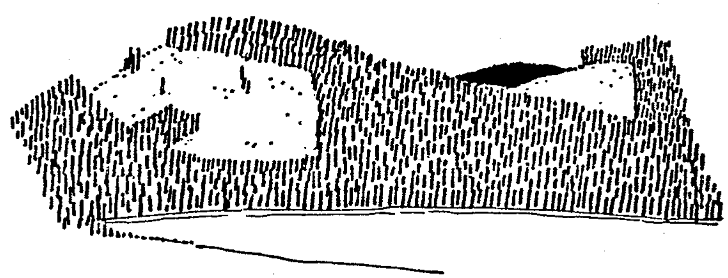
On the other hand, the existence of forest access roads can significantly reduce the cost of developing a lake.



Clearcut operations have potential for greater visual impact than other methods of timber extraction particularly where cutover areas form rectilinear patterns.

Guidelines

The angle and length of shoreland slope affects potential for visual conflict. Shorelands with gentle or bluff slopes are less susceptible to visual disruption if a minimum shoreline reserve is maintained.



The impact of timber cutting on water quality will be most pronounced when large areas of watershed are clearcut on a continuing basis over several years. Sedimentation and nutrient loading will be greatest where erosion potential is high ie. steeper slopes, moderately and highly erodible soils. The recreation quality of lake water is unlikely to be significantly altered except under these extreme conditions. The change in water quality can remain for some time after cessation of timber operations but eventually the lake will return to near-original condition as the forest becomes re-established.

Lakes, where there is significant potential for visual conflict or where extensive cutting of the watershed will occur, are less suitable for cottage development.

Estimate the potential for visual conflict by analyzing cutting plans and terrain conditions. Use topographic maps and air photos to assess terrain. Consult with Regional Forester to determine the potential for conflict.

Obtain Forest Inventory mapping to determine the potential for future timber extraction. source: Forest Inventory, 300-530 Kenaston Ave., Winnipeg.

Consult with Environmental Management Division where there are potential impacts on water quality.

Assess potential for conflict :

SEVERE	**2**
SLIGHT	**1**
NONE	**0**

Mining

Mining operations can conflict with recreation development through visual impact, pollution, and in extreme cases of open pit mining through the manipulation of lake levels.

Mineral claims and leases effectively alienate affected land from cottage development.

Assess potential for conflict:

SEVERE	**2**
SLIGHT	**1**
NONE	**0**

Guidelines

Lakes situated in areas of high mineral potential are less suitable for development.

Lakes situated downstream from a mining operation may have altered water quality. The water should be tested to assess impact on recreational and domestic use.

Contact Mineral Resources Division, 1007 Century Street, Winnipeg for information on mineral potential. Mineral capability mapping is available for some areas.

Obtain locations of mining dispositions from Mining Claim Maps available at the Mining Recording Office, 989 Century Street, Winnipeg and the Recording Office in The Pas.

Consult with Environmental Management Division where there are potential pollution problems.

Hydro Development

The use of lakes as hydro-electric reservoirs can create problems for recreational development. Water fluctuations can expose mud flats and erode shoreland, hindering access to the water and creating unsightly conditions. Flooding to create reservoirs can result in floating and submerged stumps and logs which create boating hazards.

The creation of a hydro reservoir can create recreational opportunities which did not previously exist.

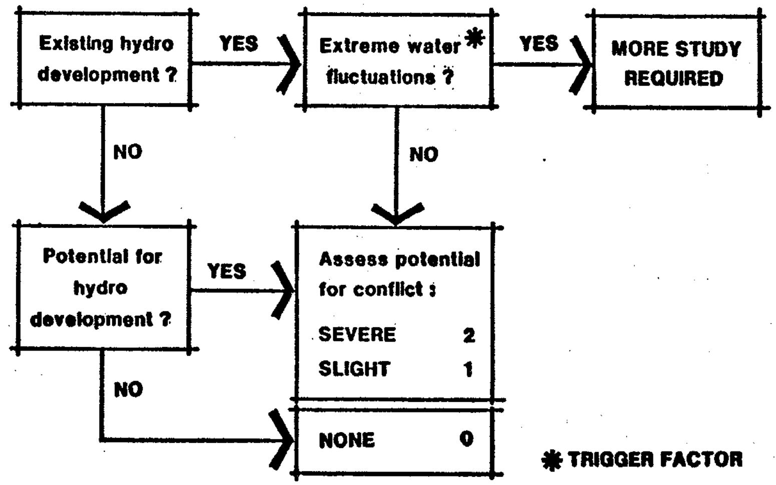
Guidelines

Waterbodies which function as hydro reservoirs require closer assessment to determine potential conflict. Ascertain water level fluctuations, shoreline conditions and the presence (if any) of boating hazards.

Waterbodies which may, potentially, be affected by hydro development are less suitable for development.

Determine shoreline conditions, boating hazards etc. by field analysis.

Contact the Water Management Service, Water Resources Branch, 1577 Dublin Avenue, Winnipeg to determine water level fluctuations, locations of hydro reserves and potential locations for hydro development.



Agriculture

Agricultural land use in a lake's watershed can have a dramatic effect on trophic status. Increased nutrient-loading results from increased erosion and sedimentation, fertilizer use and runoff from livestock operations.

Guidelines

Where agricultural activity occurs in a lake's watershed water quality should be tested to determine existing and future impact. Lakes which are experiencing a decline in the quality of water for recreation are less suitable for development.

Consult with Environmental Management Division to assess the potential impact on recreation quality.

Assess potential for conflict :

SEVERE	**2**
SLIGHT	**1**
NONE	**0**

Urban Land Use

The presence of urban land use in a lake's watershed can have a significant impact on water quality by altering natural runoff, increasing erosion and releasing treated or untreated sewage to the system.

Guidelines

Lakes which are experiencing a decline in water quality for recreation as a result of urban land use are less suitable for cottage development.

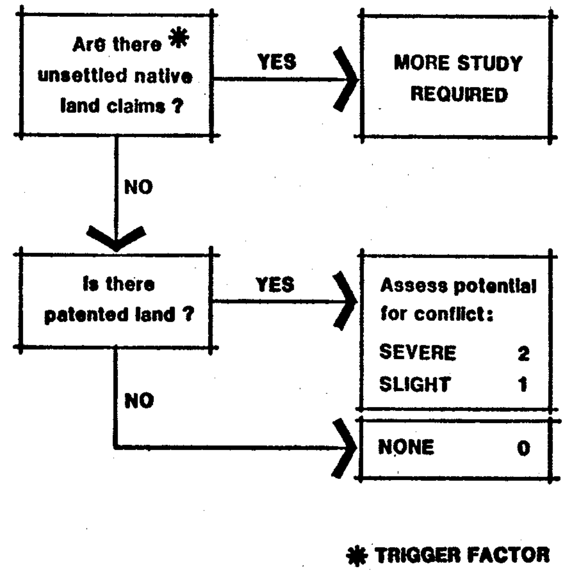
Determine if there are any urban centers in the lake's water shed which are contributing sewage to the system and the level of treatment. Where phosphorus removal is not occurring a lake survey may be required. Consult with Environmental Management Division to assess the potential for impact on recreation quality.

Assess potential for conflict :

SEVERE	**2**
SLIGHT	**1**
NONE	**0**

Land Claims and Patented Lands

Unsettled native land claims are a potential source of conflict with cottage development if boundaries overlap. Parks Branch is less able to control the form of development on patented lands and Indian Reserves. However, through co-operation compatible development may be achieved on all lands with costs shared between all land owners.



Guidelines

Areas where claims are not well-defined should be avoided until such time as boundaries are clarified.

Lakes with large amounts of undeveloped shoreland in private hands will require additional study to determine the intentions of land owners.

Obtain information on land claims from the Indian Land Claims Section, Crown Lands Branch, 1495 St. James Street, Winnipeg.

Refer to the Crown Lands Handbook for information on land disposition in Agro-Manitoba. For northern areas and for greater detail in the south reference must be made directly to Crown Lands Records, Winnipeg.

Compatibility Summary

Sum the conflict ratings assessed for each use category to derive a total compatibility score. Organize lakes into groups having similar compatibility scores as shown below. Note and isolate in a separate list lakes where trigger factors apply.

USE CATEGORY	LAKE A	B	C	D	E
COMMERCIAL AND SPORT FISHING	0	1	1	0	2
WILDLIFE MANAGEMENT	1	0	1	0	2
WILD RICE	1	0	0	0	0
HISTORIC AND ARCHAEOLOGICAL SITES	0	1	0	0	1
WILDERNESS TRIPPING	0	0	0	0	0
PUBLIC RECREATION	0	0	1	0	0
EXISTING COTTAGE DEVELOPMENT	0	0	0	0	0
FORESTRY	0	0	0	0	1
MINING	0	1	0	1	0
HYDRO DEVELOPMENT	0	0	0	2	0
AGRICULTURE	0	0	0	0	0
URBAN LANDUSE	0	0	0	0	0
LAND CLAIMS AND PATENTED LANDS	0	0	0	1	1
TOTAL SCORE	2	3	3	4	7

COMPATIBILITY RANK

0-3 GOOD ○ 7-9 POOR ●

4-6 FAIR ◑ 10+ VERY POOR ■

FIGURE 2.9

Policy, Plans, Regulations

Discussion

Prior to designating a lake for recreational development an analysis of existing plans, policies, regulations and legislation which may effect the proposed development should be undertaken. Such information is to be found at the local, regional and provincial levels.

Guidelines

LOCAL GOVERNMENT DISTRICTS

Department of Natural Resources policy stipulates that all cottage subdivisions conform to local regulations. Review local zoning by-laws and land use plans.

UNORGANIZED TERRITORY

Recreation development must conform to local regulations imposed by the Department of Natural Resources.

PLANNING DISTRICTS

Lake planning should address district plans where they are in effect.

CONSERVATION DISTRICTS

Where a lake is within the jurisdiction of a conservation district the district manager should be contacted to obtain information about conservation and development plans.

PARK PLANS

Cottage development within a provincial park must conform to any master plan, interim management guidelines and area development plans in effect.

PROVINCIAL LAND USE POLICIES

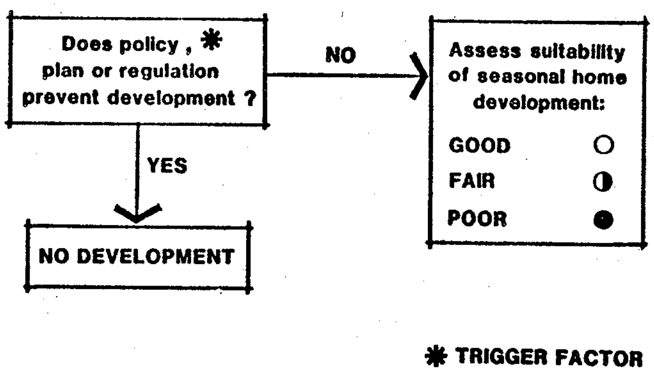
Cottage development should respond to Manitoba's Provincial Land Use Policies.

ECOLOGICAL RESERVES

Cottage development should not compromise the sanctity of designated ecological reserves. The location of ecological reserves and the regulations pertaining to them may be obtained from the Resource Allocation and Planning Branch.

ACTS

Crown Lands Act
Park Lands Act
Planning Act
Forest Act
Wildlife Act
Wildlife Management Areas Act
Mining Act
Historic Resources Act



Development Cost

Discussion

The cost of delivering seasonal home lots to the market can be one of the most important considerations in the resource allocation process. A lake with high capability for cottaging may not be suitable if the costs of developing it are prohibitive.

Cost comparisons should include not only the costs which are usually assessed against the price of a lot or levied on an annual basis such as survey, access, garbage collection, and road maintenance; the "hidden" costs of development such as planning, water quality surveys, and fisheries management should also be recognized.

The other types of costs to be considered are "private" costs: expenses borne by the cottager in addition to the purchase or lease price which also affect ability to pay.

Some costs pertain to the lake or site scale and will not be accurately known until the development is at the design stage. However rough estimates are required at this time to reflect the total cost of development.

CONCERNING DEVELOPMENT COSTS

Throughout these guidelines emphasis is placed on the need for basic planning and scientific study both prior to and following the development of a lake for cottaging. These studies provide essential data for the production and monitoring of environmental impact and the administration of fish and wildlife management

programs.

It is possible that the costs of such studies may be perceived, by Provincial officials, as prohibitive. It is argued here, however, that this work is fundamental to the effective management of lake resources and a normal part of the process of developing cottage lots. As such, the costs of these studies can legitimately be added to the cost of a cottage lot. These costs are then borne by the cottage owner in return for the privilege of a private dwelling adjacent to a prime public resource. When cottage owners realize that such work is in their own best interest they should be willing to contribute.

While it is unlikely that the additional costs would make the price of a lot unattainable to those who really desire one, the issue of affordability is raised. If the Province is seriously concerned with providing greater access to seasonal home use for Manitobans, there are other approaches to follow. One example, already in use by the Province, is the provision of cabins which can be rented on a weekly basis by those who cannot, or do not wish to build their own.

Guidelines

Development costs fall into four categories:

PLANNING COSTS

1. Planning and design, including field analysis.
2. Water quality survey.
3. Legal survey.
4. Administrative and legal.
5. Engineering design - roads.

CONSTRUCTION COSTS

1. Clearing for road access.
2. Construction of road (ditching, embankments, grading, compacting, gravel, etc.).
3. Signing (roads, trails, boat launch, etc.).
4. Communal potable water supply (wells, pumps, treatment).
5. Communal sewage disposal (lagoon).
6. Communal landfill
7. Boat launch, docking (parking for remote lots, boat pull-up areas, break-water.
8. Hydro and telephone service, including r.o.w. clearing.
9. Landscaping.
10. Communal recreation facilities (walking trails, play fields, tennis courts, etc.).

MANAGEMENT COSTS

1. Road maintenance, snow plowing.
2. Solid waste management
3. Sewage lagoon monitoring and control
4. Policing, including conservation officers.
5. Water monitoring.
6. Fisheries management.
7. General maintenance of communal facilities.

PRIVATE COSTS

1. Site preparation (brush clearing, leveling).
2. Cottage construction.
3. Waste disposal (on-site facilities and pump-outs).
4. Water supply.
5. Hydro and telephone service.
6. Travel

COST ESTIMATE

At this stage of the lake planning process, when the actual size and design of potential development has not been decided many costs will remain unknown. General cost estimates can be made, however, based on two factors: accessibility and service infrastructure requirements.

Accessibility affects costs related to travel (time, fuel, etc.). It influences all four categories of costs: eg. cost of getting to lake for surveys and construction, cost of extra distance for policing, travel costs of cottage owner. The further the lake is from population and administrative centers, the greater will be the costs involved.

Where such facilities as sewage lagoon, landfill, roads do not presently exist they will need to be provided. Costs will be significantly higher in areas where there is no existing service infrastructure.

Group lakes according to the potential cost of development:

LOW	○
MODERATE	◑
HIGH	●

Development Priorities

As previously defined, the purpose of the regional process is to determine the potential of a region's lakes for seasonal home use and establish priorities for planning and development. Development potential was determined by a systematic analysis of the resources and use of all lakes in the planning region. Each lake was assessed against a slate of pertinent criteria and rated on a relative scale.

An overall impression of development potential may be obtained for all lakes in the region by summarizing the individual "scores". Such a summary will facilitate the making of decisions when establishing priorities for planning and development at the lake scale.

SUMMARY TABLE

The method recommended here for summarizing the results of the regional analysis is to display the individual ratings for each lake in tabular form. An example of such a table is shown below. The use of a table permits quick comparisons between lakes for all development potential factors. Numerical values are not used, instead the purpose of the table and symbols is to give a visual impression of the relative potential of lakes. While it is likely that equal importance will not be given to all factors in the decision-making process, no attempt is made to give more weight to any one factor in the table. However, this does not prevent greater weight being applied to one or more factors once the table is completed.

SUMMARY TABLE

LAKE	SHORELAND CAPABILITY	HUMAN USE & CONSUMPTION	SENSITIVITY TO NUTRIENT LOADING	HAZARDS & NUISANCE	VIABILITY OF FISHERY	VIEWING	BOATING	OTHER USE	POLICY, PLANS & REGULATIONS	COST
A	•	○	○	○	◑	○	○	◑	◑	○
B	○	○	■	○	■	○	◑	●	○	○
C	●	◑	○	○	○	○	○	○	○	◑
D	○	●	◑	●	○	◑	◑	○	○	●
E	◑	○	◑	○	◑	○	○	○	●	○
F	■	◑	○	○	○	○	○	◑	○	○
G	○	○	○	◑	●	○	○	○	○	◑

CONSTRAINTS

• ○ ◑ ● ■

LEAST ⟶ MOST

SHORELAND CAPABILITY

VERY GOOD	•
GOOD	○
FAIR	◑
POOR	●
VERY POOR	■

HUMAN USE & CONSUMPTION

1A, 1B	GOOD	○
2A, 2B	FAIR	◑
potential	POOR	●

SENSITIVITY TO NUTRIENT LOADING

LOW	○
MODERATE	◑
HIGH	●
VERY HIGH	■

HAZARDS & NUISANCE

LOW	○
MODERATE	◑
HIGH	●
VERY HIGH	■

VIABILITY OF FISHERY

GOOD	○
FAIR	◑
POOR	●
VERY POOR	■

VIEWING

GOOD	○
FAIR	◑
POOR	●

BOATING

GOOD	○
FAIR	◑
POOR	●
VERY POOR	■

OTHER USE

GOOD	○
FAIR	◑
POOR	●
VERY POOR	■

POLICY, PLANS, REGULATIONS

GOOD	○
FAIR	◑
POOR	●

COSTS

LOW	○
MODERATE	◑
HIGH	●

FIGURE 2.10

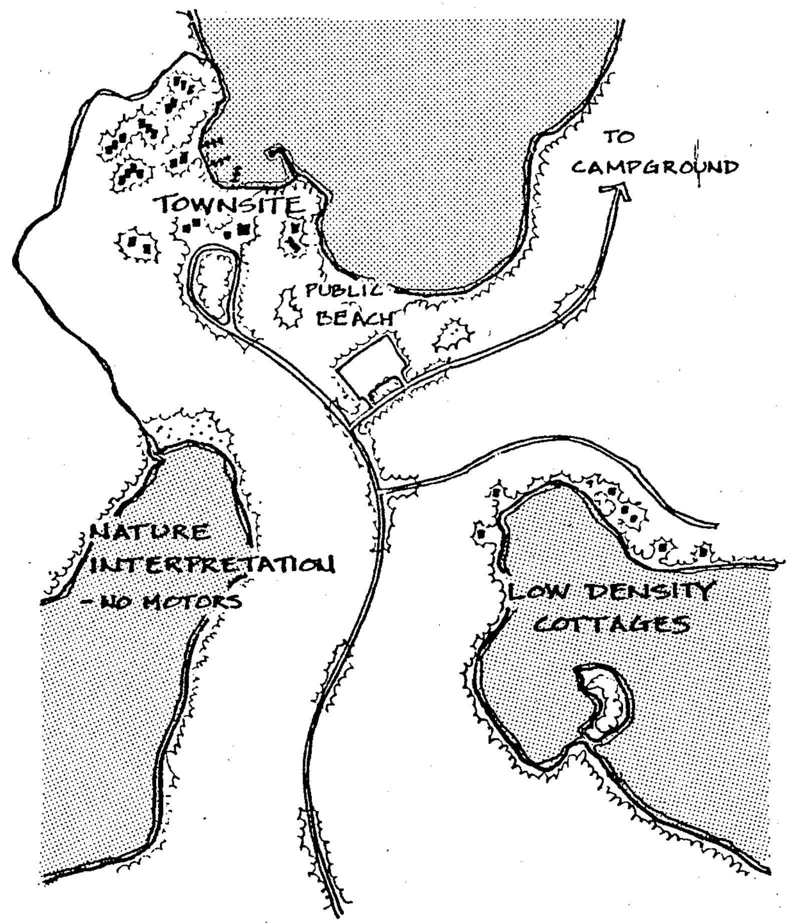
ESTABLISHING PRIORITIES

As stated at the outset, the selection of a lake for seasonal home development is, possibly, the most important decision in the entire lake planning process. The decision to develop a lake for seasonal home use may effectively exclude the lake from consideration for other use. Whether a lake is suitable for development is dependent on many factors, as has been shown. However, the decision needs to be based on more than just the results of the regional analysis as represented by the summary table. While the analysis and table produce a reasonably comprehensive image of development potential they do not show a complete picture. The establishment of development priorities must examine each lake in the context of its immediate surroundings (eg. adjacent use, potential linkages, etc.) and the regional setting.

For example, when lakes occur in natural clusters, opportunities are presented for the sharing of basic services and the provision of a variety of recreation experiences in one area. While all of the lakes in the cluster may not rate well in the analysis their value for development is increased due to the presence of their neighbours.

On the other hand, a lake which scores well in the analysis may not be desirable for seasonal home development if isolated or if there is a risk that development could have detrimental impacts downstream or on adjacent lands.

The principle of discriminatory resource allocation means that there must be a partitioning and sharing of the total resource. This means that even if all lakes in a region have potential for seasonal home development they should not all,



When lakes occur in natural clusters they may be developed for different uses necessarily, be developed for that use. When it comes to deciding how to allocate the resource there is a need to involve regional resource managers and the public to ensure that the interests of all potential users are considered.

Once development priorities have been established a program may be organized for lake scale planning.

The purpose of the lake plan is to outline the way the lake is to be developed and managed. It determines the types and quantities of use which will occur. It allocates shore and water areas for various uses, locates proposed development and gives it form. Finally it outlines how proposals are to be implemented.

3. The Lake

The Lake Plan

Once a lake has been identified as a suitable candidate for seasonal home development a lake plan must be formulated. The purpose of the plan is to define a program for the development and ongoing management of the lake which will satisfy human desires for recreation while maintaining environmental quality. The plan outlines the type, location and quantity of use which will occur on the lake. It outlines the implementation strategy including development phasing, regulations on use and resource management program requirements (eg. water quality monitoring).

While the fundamental objective of the plan is to provide sites for new seasonal home development the plan is concerned with more than just cottage use and cottage sites. The plan must address all uses on the lake, both existing and future, because they will all have an effect on one another and will influence the character of the developed lake.

The plan encompasses the entire lake, for it is the whole lake basin which serves as the setting for the cottage "experience". Changes occurring on one part of the lake will be felt elsewhere.

The lake plan must also consider areas and uses beyond the immediate lakeshore. The effects of new development may be transported through the drainage system or may spread into adjacent land areas. Resource activity occurring upstream or elsewhere in the vicinity may, in turn, have an effect on new development.

Introduction

Each lake has an individual character and presents both opportunities and constraints to seasonal home development. It is the goal of lake planning to formulate a strategy for lake development which takes advantage of opportunities, responds to constraints and enhances the quality of the lake environment. The plan process examines the lake character, defines an appropriate development concept and determines the method by which the concept is to be fulfilled.

The Plan Document

The process by which the plan was formulated, the results of analysis and development/management recommendations are brought together and described in the lake plan document. The purpose of the document is to provide information to others and to serve as a record of findings. The document outlines development recommendations in verbal and graphic form and explains the basis for development recommendations. The record of detailed resource data will be of assistance for future planning and management.

ROLE STATEMENT

The first step in the lake planning process is to define a "role" for the lake. The role statement describes the type of "experience" which is to be created on the lake, giving an indication of the types of use which will occur and their relative importance. The objectives of the plan are stated to provide direction to the remainder of the process. The role is defined based on information from the regional process, in consultation with regional resource managers and the public.

OTHER USE

Existing use of the lake is examined to determine how to account for the needs of these participants in the plan document. Potential uses of the lake (other than cottaging) are also examined to determine whether they can be accomodated in the plan and how this might be done.

RESOURCE INVENTORY

While some analysis of the resource base occurred during the regional process more detailed resource data is needed to guide site-specific decision-making and design. The resource inventory propgram will require the collection of primary information and field work.

DEVELOPMENT POTENTIAL

The findings of the site inventory and analysis are combined to assess the capability of potential sites for development. The results of this assessment will assist in locating new development.

CARRYING CAPACITY

Estimates of lake carrying capacity are made to provide an indication of the quantity of use which should be permitted on the lake.

ALTERNATIVE PLANS

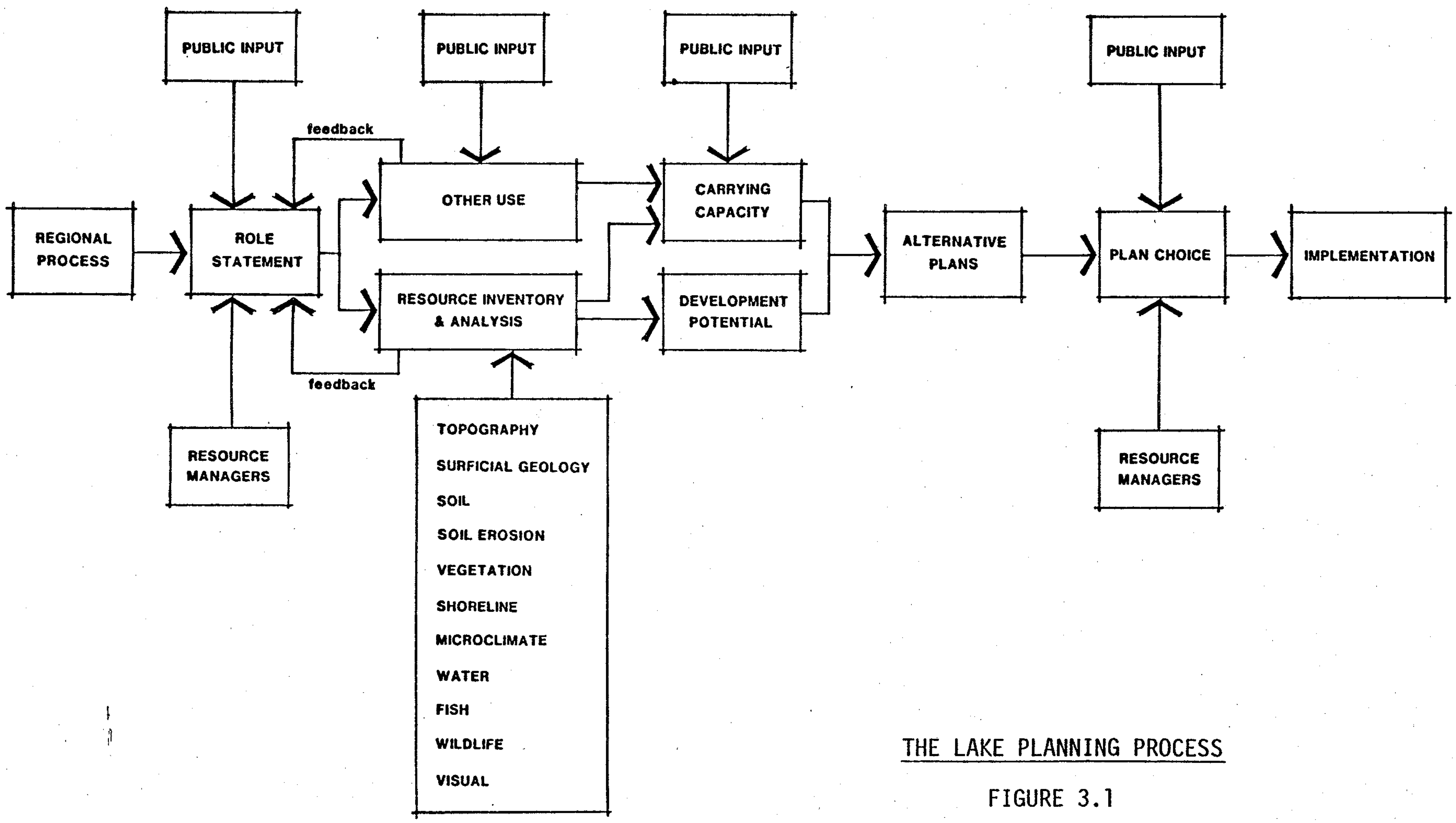
Alternative plans are formulated to show the different ways in which the role of the lake could be fulfilled. The relative advantages and disadvantages of each option are discussed.

PLAN CHOICE AND RECOMMENDATIONS

Following review of the alternative plans by regional resource managers and the public one plan or a combination of plans is chosen for implementation. The program by which the plan is to be implemented and the lake managed is outlined.

Structure of this Section

This section is divided into subsections which follow the steps in the planning process. A large part is devoted to the section on resource inventory and analysis, which includes guidelines applicable to site planning and design.



THE LAKE PLANNING PROCESS

FIGURE 3.1

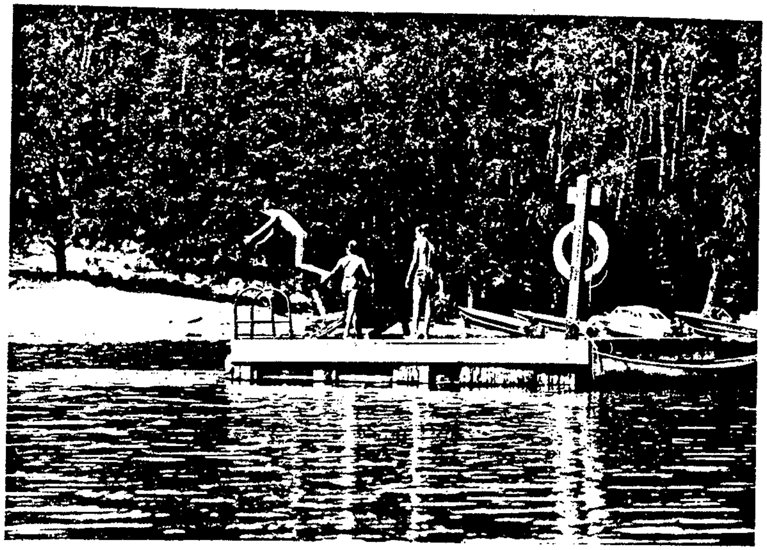
Role Statement

The first step in the formulation of a lake plan is the drafting of a role statement. The role statement describes the role the lake is to fulfill within the region and defines the type of "experience" to be created by the plan. It includes both general descriptions of the proposed future character of the lake and a list of objectives which state, in more specific terms, how the "experience" is to be achieved.

The purpose of the role statement is to provide direction to the planning process and a framework for decision-making. All of the remaining steps in the process, including resource analysis, carrying capacity calculations and drafting of alternative plans are influenced by the role statement. The statement indicates the relative value to be given to the various factors which influence the plan. For example, the importance of sport fishing within the context of the entire recreational experience is stated.

The statement outlines the future character of the lake by describing the types of development and activity which will occur, the level of servicing to be provided and standards of environmental quality to be maintained.

The role of the lake is defined based on the findings of the regional process and through discussions with resource managers and the general public. Once defined, the role statement is not "carved-in-stone". It may be revised in response to the findings of the more detailed resource analysis which follows. In fact, the role of the lake will not be finalized until final plan selection.



Other Lake Use

Discussion

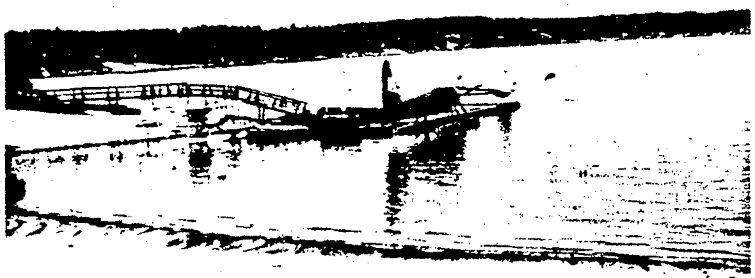
Other uses of a lake, both existing and potential, will influence the planning and design of new seasonal home development. Some uses of a water body may complement cottage development providing opportunities to share facilities and services (eg. sharing a road by a cottage development and a lodge facility). Other uses may be potentially incompatible and will require separation or regulation of use (eg. marina and public beach).

Existing and potential uses of a lake will initially be identified at the regional scale, during the lake selection process. Those lakes with uses which are incompatible with seasonal home development will normally have been rejected during this process. The task at the lake level is to plan and design new developments which take advantage of opportunities and respond to existing use patterns.

Guidelines

Prepare a map which shows existing and potential use of the lake which includes the following information:

1. Existing land tenure - Identify all encumbered and occupied land including patented land, leases, land-use permits,



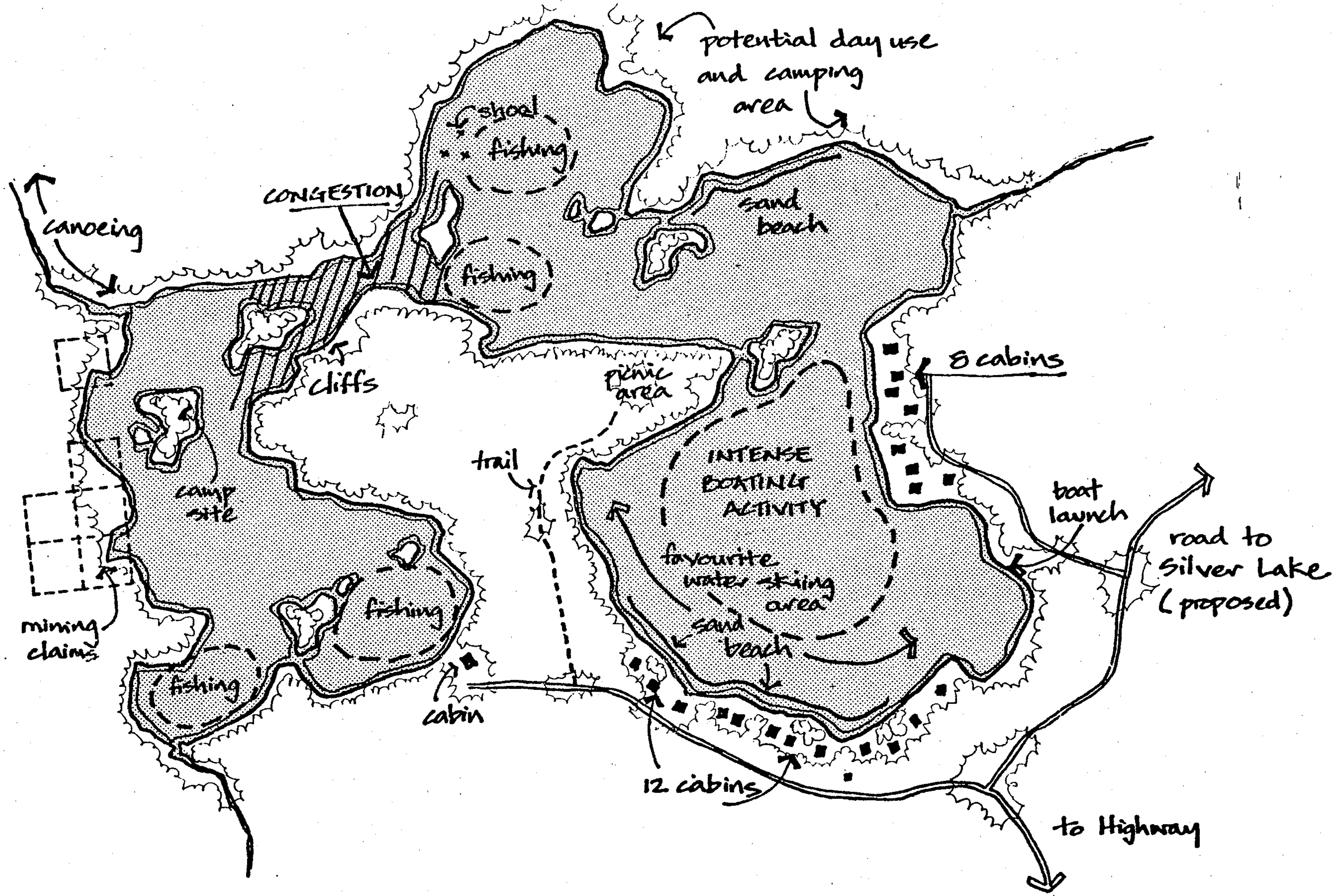
reserves, orders-in-council mining claims and federal lands. This information may be obtained from Crown Lands Records.

2. Known future use - Map the location of known future use (eg. future forest cutting area). This information will have been obtained during the regional process.

3. Existing use patterns - Prepare behaviour setting maps which chart the location and occurrence of lake and shore activity, by type. From observation and discussion with existing users determine the timing, frequency and duration of activity. Note areas of congestion and high contact.

4. Potential use - Map the location of potential uses, other than cottaging, which were initially identified at the regional scale. (eg. prime sand beach as potential day use area).

Estimate the quantity of existing use from observation, discussions with users and regional office personnel.



EXISTING AND POTENTIAL USE MAP

FIGURE 3.2

Assess the potential for use conflict resulting from new development, in order to determine the need for separation between uses. Examine the following five conflict types:

visual conflict - intrusion by one use into another's private space; disruption of views.

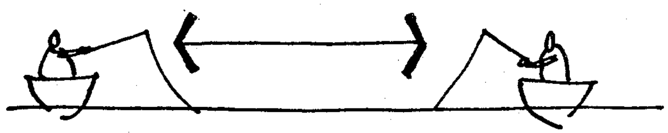
noise conflict - auditory disruptions of peace and quiet.

physical conflict - physical crowding of use where one activity interferes with the carrying-on of another (eg. boat wake disrupting still fishing).

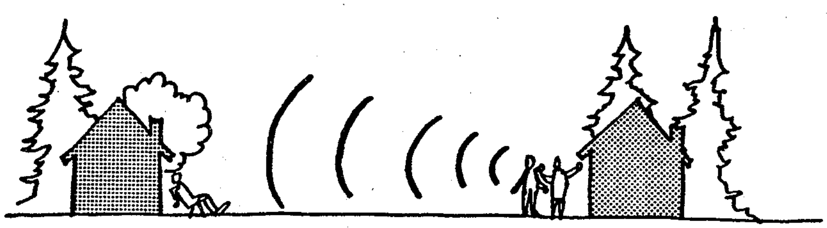
environmental conflict - when one activity causes a decline in environmental quality, which in turn affects other use (eg. pollution of water).

service conflict - when new use causes overloading of services and facilities (eg. overcrowding of parking).

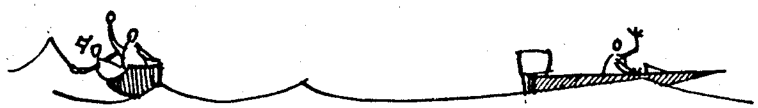
Uses with similar behaviour characteristics are less likely to conflict with one another than uses exhibiting varied characteristics eg. quiet, slow and "low technology" activities (such as canoeing, sailing) are more likely conflict with noisy, fast-high technology activities (water-skiing).



visual conflict

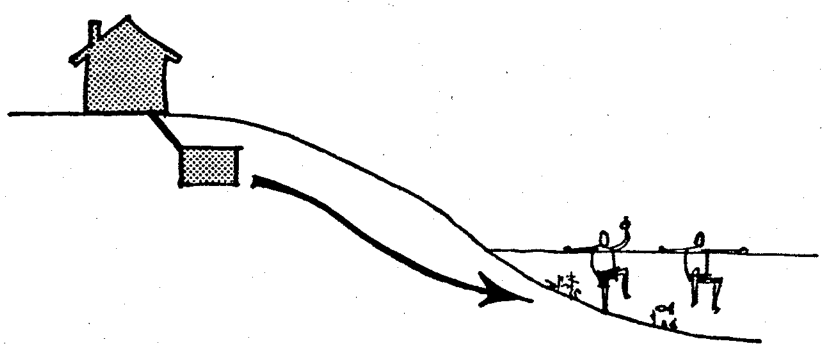


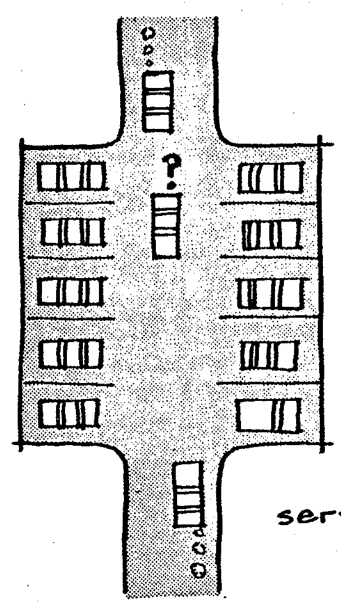
noise conflict



The potential for conflict between uses is very much dependent on the attitudes and perceptions of users. Activities which are perceived as undesirable by lake users will be likely to cause conflict no matter how well planned and designed. Linked to this is the reality that existing users of a lake are much more sensitive to alterations of the lake environment than future users. Often, any change is perceived by lake residents as bad, as it is believed to reduce the quality of their own recreation experience.

This emphasizes the need for public participation in the lake planning process. By explaining proposed development to lake users and responding to their concerns early in the process, conflict may be avoided.





Resource Inventory & Analysis

As a result of resource analysis undertaken during the regional process the character and limitations of the resource are already known in general terms. This information is unlikely to be of sufficient detail for planning and design at the lake and site scales. Detailed data is required for the delineation of sensitive areas (eg. spawning beds), the identification of special features (eg. scenic elements) and the determination of development potential.

While it is important to have specific and comprehensive resource information it is not necessary that the analysis include all of the data listed in the pages which follow. The inventory need include only the information which will influence the plan. Indeed, not all of the factors described in this section apply everywhere in the Province.

The collected data should be recorded on maps of the lake at the same scale. This will permit overlaying of information and the drafting of composite maps. The mapped resource data will be a useful record for future lake planning and management.

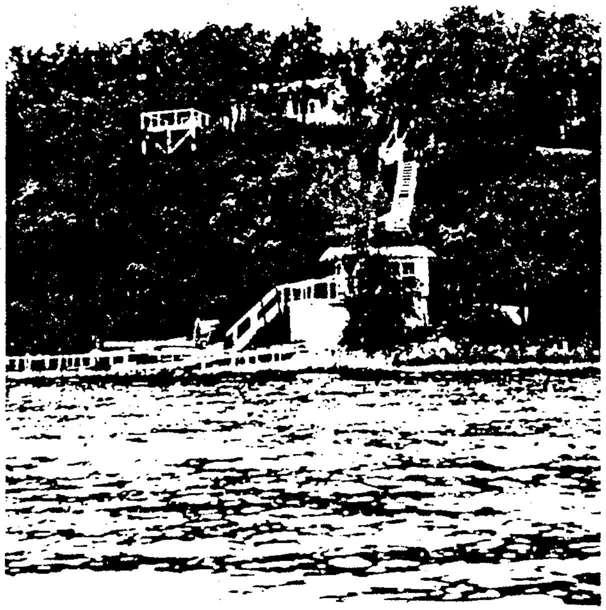
topography

Discussion

Slope and relief may present both opportunities and constraints to cottage development. Moderate and steep slopes improve backshore views to the lake and undulating terrain allows for more interesting siting of buildings. However, steep slopes and strongly broken terrain can severely restrict the potential of a site for cottage development by hindering access and circulation and increasing the costs of construction and servicing. Effluent from sullage pits and absorption fields can resurface on steep slopes creating malodorous conditions and wetness. Steep slopes are more susceptible to erosion and slippage, while gently sloping sites can experience drainage problems.

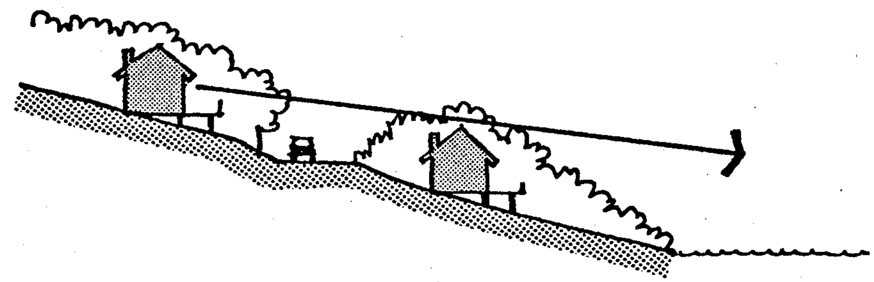
Guidelines

Map shoreland topography. Slopes should be classified as gentle, moderate or steep as described below. Indicate local relief which would restrict development such as high embankments, cliffs, and depressions.



GENTLE SLOPES < 8%

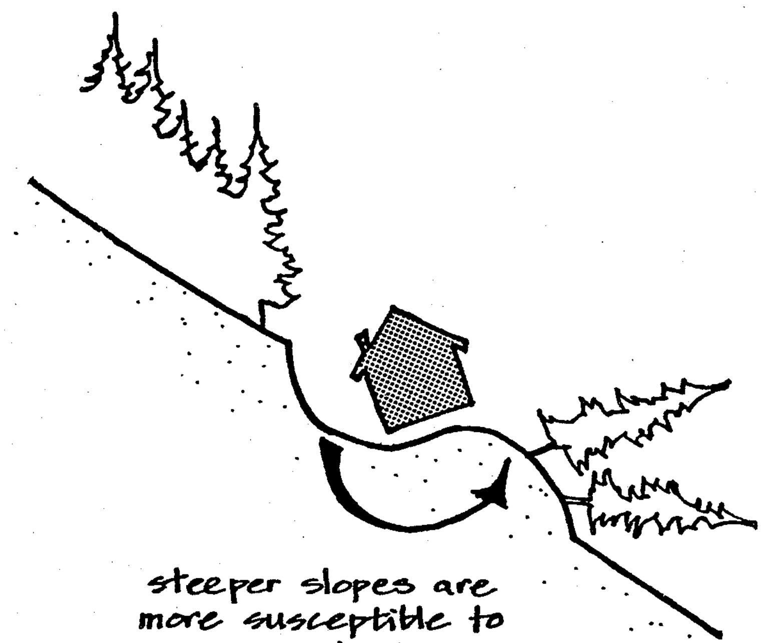
- slight or no limitations to cottage development
- adequate environmental protection with standard design and management practices
- gradient permits near round automobile access and informal pedestrian movement and activity
- low to moderately low erosion hazard
- slopes <3% may experience drainage problems and restrict backshore views to water
- slopes >5% may pose limitations for sewage lagoons
- ditches with gradients >5% may require rip-rap



steeper slopes improve backland viewing

MODERATE SLOPES 8 - 15%

- moderate limitations to cottage development
- above average design and management are required to ensure environmental protection
- gradient restricts automobile and pedestrian movement: winter access is difficult
- erosion hazard may be high on certain soils and when vegetative cover is disturbed
- heavily used pathways may require stabilization
- tile field and sullage pit effluent may resurface
- foundation construction and utility connections are more costly



steeper slopes are more susceptible to erosion and slippage

STEEP SLOPES >15%

- severe limitations to cottage development
- sensitive design and intensive management are required to ensure environmental protection
- automobile access is impractical, pedestrians may require steps
- heavily used pathways will require stabilization
- erosion hazard is severe with most soils and site conditions
- tile fields are impractical

The degree to which slope and relief conditions restrict development is related to the form and density of development and the level of servicing. As development density increases the area of disturbed ground and amount of impervious surfaces grow, causing an increase in the speed and volume of runoff and erosion. Multiple tier and cluster-type development will generally require flatter and more gently sloping sites than dispersed ribbon subdivisions.

Automobiles generally require gradients less than 10-15% for ease of circulation. Road accessibility can become a major site determinant if holding tanks are used for waste disposal. Other waste disposal systems are restricted by gradient.

Higher density development can be located on moderate or even steep slopes and still ensure adequate environmental protection. However, site design and management requirements increase

	GENTLE	MODERATE	STEEP
SLOPE	< 8%	8 - 15%	>15%
LIMITATIONS TO DEVELOPMENT	none to slight	moderate	severe
ENVIRONMENTAL PROTECTION	high	medium	low
QUALITY OF DESIGN / MANAGEMENT REQUIRED	standard	above average	highest

DEVELOPMENT CAPABILITY OF SLOPES

FIGURE 3.3

significantly. Steps will be required to control runoff and erosion, stabilize slopes and minimize disturbance to vegetation and soil. Such measures increase the cost of development significantly.

Where quality design and site management cannot be ensured, development should be located on gentle slopes as these provide the greatest degree of environmental protection.

Sources

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surficial geology

Discussion

Geological surface features may be used as indicators of local soil conditions and site capability. This is particularly valuable where soil survey data is lacking. Surficial geology can also provide clues to the location of sensitive areas and hazard lands.

An analysis of surficial geology is also advisable to identify potential deposits of aggregate. These deposits will be useful for the construction of proposed cottage development as well as a regional resource.

Guidelines

Map surficial geology using information obtained from reports and maps published by the Manitoba Mines Branch, the Geological Survey of Canada, and the Northern Resource Information Program (Manitoba Biophysical Inventory). Where such sources are not available, geological surface features may be mapped using air photography. This will require experience with air photo interpretation and a basic knowledge of earth science.

Once the surface features are identified, soil conditions and site capability may be estimated based on an understanding of the geomorphological processes which formed the features. The principal formation processes, composition and drainage commonly associated with geological surface features are given in fig. 3.4 as a general guide.

Sensitive and hazardous lands include ground water recharge areas, unstable soils, and flood-prone areas. Groundwater pollution can occur when sewage disposal systems (tile fields, lagoons) are installed in recharge areas. Groundwater recharge is often associated with outwash deposits formed by meltwater streams. Alluvial and eolian deposits can be very unstable.

The best aggregate materials for use in concrete or road construction are clean gravels and sands. Surface features where such materials are likely to be found include ice-contact, glacio-fluvial deposits (eskers, kames) and beach ridges.

Sources

Bloom, A.L. 1969. The Surface of the Earth Prentice-Hall.

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FIGURE 3.4 PROCESSES, COMPOSITION, AND DRAINAGE COMMONLY ASSOCIATED WITH GEOLOGICAL SURFACE FEATURES

Feature	Process	Composition	Drainage
Alluvial fan	stream deposition at base of slope	sand, silt, clay with fraction pebbles and cobbles; markedly stratified and highly heterogeneous; all in the form of semiconical-shaped fan	variable; upper portions may be well drained, lower portions may be very poor owing to groundwater seepage
Alluvium	river channel and floodplain deposition	mainly sand, silt, clay with organic fractions locally; stratified and heterogeneous	typically very poor owing to high water table and periodic flooding
Barrier beach	deposition by waves and currents	sand and pebbles	good, but water table often within several feet of surface
Beach	shoreline wave action with secondary effects of wind	variable; typically sand and pebbles but may also be clayey and silty or bedrock and rock rubble	good if sandy, but water table usually within several feet of surface
Beach ridge	deposition by waves and wind	mainly sand but pebbles common in lower portion	excellent, especially in those with high elevation
Bog	standing water and organic deposition	organic (muck, peat) with fraction mineral clay	very poor
Colluvium	integrated deposition from mass movement, runoff, streams	highly heterogeneous, may range from clay to boulders; stratified material mixed with undifferentiated material	highly variable, if situated near footslope, groundwater seepage may be present
Cusp or cuspate foreland	deposition by waves and currents	sand and pebbles	good, but water table often within several feet of surface
Delta	river deposition	usually clay, silt, and sand with local concentrations of organic material	very poor to poor
Drumlin	deposition and redistribution by glacial ice	clayey with admixture of coarser fractions as large as boulders; whale-shaped hilly form	good to poor

FIGURE 3.4 PROCESSES, COMPOSITION, AND DRAINAGE COMMONLY ASSOCIATED WITH GEOLOGICAL SURFACE FEATURES

Feature	Process	Composition	Drainage
Escarpment (see scarp)			
Esker	channel deposition by glacial meltwater stream	stratified sand and pebble mixture (gravelly) in the form of a sinous ridge	excellent
Floodplain	river deposition	see alluvium	see alluvium
Ground moraine	deposition from glacial ice	often sand, silt, clay admixture, but may be highly variable ranging from compacted clays to sand, pebbles, cobbles, boulders; usually gently rolling	good to poor
Kame	deposition by glacial meltwater stream	mainly stratified sand and gravel in the form of a conical shaped hill	excellent
Lake plain	wave and current action	clayey with local concentrations of beach and dune sand	poor to fair
Lake terrace	wave erosion and deposition	usually sand and pebbles but may be bedrock or clay and silt	excellent to good
Loess	wind deposition	silt, rather structureless	excellent and good
Marsh	standing water and organic deposition	organic (muck, peat) with fraction mineral clay	very poor
Moraine	deposition from glacial ice	often sand, silt, clay mixture, but may be highly variable ranging from compacted clays to sand, pebbles, cobbles, boulders; usually in form of irregular hilly terrain	good to poor

FIGURE 3.4 PROCESSES, COMPOSITION, AND DRAINAGE COMMONLY ASSOCIATED WITH GEOLOGICAL SURFACE FEATURES

Feature	Process	Composition	Drainage
Outwash plain	deposition over broad areas by glacial meltwater streams	sandy	usually excellent, but high water table in some locales
River terrace	river erosion and deposition	variable; stratified clays, silts, sand	excellent to fair
Sand dune	wind deposition	pure sand	excellent
Scarp	complex of weathering and erosion of the outcropping end of bedrock formation	bedrock often with partial coverage of thin soil and talus footslope	good, but groundwater seepage common along footslope
Scree	mass movement (rock falls, rock slides)	cobbles and pebbles in form of 30°-40° slope	excellent
Spit	deposition by waves and currents	sand and pebbles	good, but water table often within several feet of surface
Swamp	standing water and organic deposition	organic (muck, peat) with fraction mineral clay	very poor
Talus	mass movement (rock falls, rock slides)	boulders in form of 30°-40° slope	excellent
Till	deposition from glacial ice	often sand, silt, clay admixture, but may be highly variable ranging from compacted clays to sand, pebbles, cobbles, boulders	good to poor
Till plain	deposition from glacial ice	often sand, silt, clay admixture, but may be highly variable ranging from compacted clays to sand, pebbles, cobbles, boulders; usually gently rolling	good to poor

(from Marsh, 1978)

soil

Discussion

Soil is a critical determinant of the development capability of shoreland. A potential seasonal home site requires soils which are able to tolerate the physical pressures of construction and use, and satisfy the engineering requirements of proposed development. Soil conditions can be the single most important factor in the selection of development sites. Consequently, a survey of soil conditions is a fundamental component of lake planning.

ENGINEERING REQUIREMENTS

From an "engineering" perspective soil is important as a foundation and construction material and as a medium for waste disposal and underground servicing. Soils for road and building foundations require adequate load-bearing capacity, low compressibility and resistence to frost-heaving. Septic fields, lagoons and other sewage disposal systems have very specific requirements for soil permeability, depth and drainage. Underground services need to be located below the depth of frost penetration in stable soils for year-round use.

IMPACTS ON SOIL

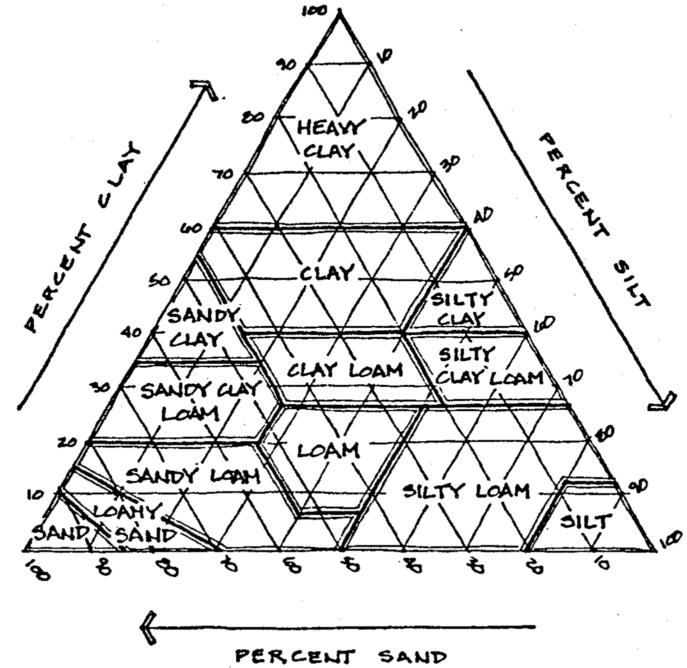
Seasonal home development can cause soil loss and deterioration. Clearing of vegetation, removal of forest litter, and exposure of the mineral soil increases erosion and reduces soil fertility. Pedestrian and vehicle movements can compact the soil, altering moisture regimes and

porosity. Trampling can remove ground vegetation and soil. Certain soil types and soil conditions are more sensitive to such pressures.

Soil conditions also affect the tolerance of vegetation to development pressures. Plants growing on deep, fertile, well-drained soils are better able to withstand development stresses than plants growing in impoverished conditions.

SOILS AND RECREATION

Soils which dry out slowly or cause surface ponding inhibit outdoor activity. Clay soils are sticky when wet, loose sandy or silty soils are subject to blowing when dry. Rocky and uneven surface conditions can restrict certain types of outdoor play.



SOIL TYPE/TEXTURE

Soil type is defined, firstly, by mechanical composition. Soils are organized into textural classes according to the relative proportions of sand, silt, and clay particles present. The textural classes are allocated to coarse, medium and fine textural groups. Soils which contain a significant content of fragments 2mm in size are further defined by such terms as gravelly, cobbly or stony eg. gravelly sand loam.

SOIL TEXTURAL CLASSES

Coarse	S	Sand
	LS	Loamy Sand
	SL	Sandy Loam
Medium	Si	Silt
	SiL	Silt Loam
	SiCL	Silty Clay Loam
	L	Loam
	CL	Clay Loam
	SCL	Sandy Clay Loam
Fine	SiC	Silty Clay
	SC	Sandy Clay
	C	Clay
	HC	Heavy Clay

Soils are also classified, by texture, for engineering purposes. The Unified Soil Classification System is an engineering classification system which groups soils according to particle size, gradation, plasticity index and liquid limit.

Soil type is further defined by its consistence: the resistence of soil particles to separation or deformation. It is described in terms such as loose, soft, friable, firm, hard, sticky, plastic or cemented. The consistence of the soil affects the ease with which it can be worked.

A soil may be further described by its structure and organic content. Structure has a significant effect on soil aeration, infiltration, percolation and the ability of a soil to resist erosion. Three common structures are: block-like; plate-like; prism-like. Organic content affects the soil's susceptibility to compaction.

Whereas the textural qualities of a soil are important in determining the engineering capability of a soil, consistence, structure and organic content indicate soil productivity and site sensitivity to use. Soil type influences: foundation capability, waste disposal, fertility, trafficability and erosion potential.

UNIFIED SOIL CLASSES

GW	Well-graded gravels, gravel-sand mixtures, little or no fines
GP	Poorly graded gravels, gravel-sand mixtures, little or no fines
GM	Silty gravels, gravel-sand-silt mixtures
GC	Clayey gravels, gravel-sand-clay mixtures
SW	Well-graded sands, gravelly sands, little or no fines
SP	Poorly graded sands, gravelly sands, little or no fines
SM	Silty sand, sand-silt mixtures
SC	Clayey sand, sand-clay mixtures
ML	Inorganic silts, very fine sands, rock flour, silty, clayey fine sands, clayey silts with slight plasticity
CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
OL	Organic silts and organic silty clays of low plasticity
MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
CH	Inorganic clays of high plasticity, fat clays
OH	Organic clays of medium to high plasticity, organic silts
Pt	Peat and other highly organic soils

from Caminos, Goethert (1978)

FIGURE 3.6

SOIL DEPTH

Soil depth is the distance from soil surface to bedrock or other impermeable surface. It is described by five classes:

A. bare rock

B. very shallow < 50cm

C. shallow 50-90cm

D. moderate 100-199cm

E. deep 200cm

SOIL DRAINAGE

Soil drainage is a product of soil permeability, depth to water table and topography. It is classified as follows:

RAPIDLY DRAINED - Water is removed from the soil rapidly in relation to supply. Excess water flows downward rapidly if the underlying material is pervious. There may be subsurface flow on steep gradients during heavy rainfall. Soils have a low available water storage capacity. Soils are coarse in texture or shallow or both.

WELL-DRAINED - Water is removed from the soil readily but not rapidly. Excess water flows downward readily into underlying pervious material or laterally as subsurface flow. Soils have intermediate available water storage capacity. Soils are intermediate in texture and depth.

MODERATELY DRAINED - Water is removed somewhat slowly in relation to supply. Excess water is removed somewhat slowly due to low perviousness, shallow water table, lack of gradient or combination of these. Soils have intermediate to high water storage capacity. Soils are medium to fine textured.

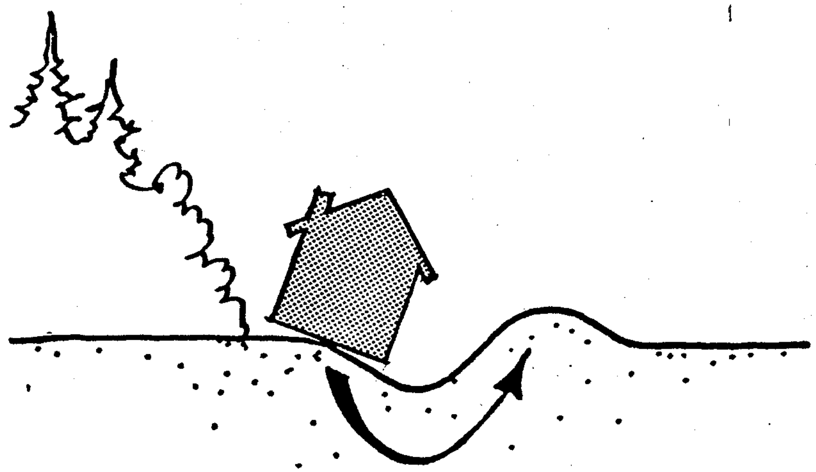
POORLY DRAINED - Water is removed so slowly that the soil is wet for much of the spring and early summer. Excess water moves slowly downward or is evident in the soil for a large part of the time. Main water sources are subsurface flow, groundwater flow as well as precipitation. Soils have a wide range of water storage capacity, texture and depth. Soils are the gleyed phases of well-drained soils, gleyed subgroups, or organic.

VERY POORLY DRAINED - Water is removed so slowly that the soil is wet for most of the time that the soil is not frozen. Excess water is present in the soil: the water table is at or near the surface. Main water sources are groundwater flow and subsurface flow. Soils have a wide range of available water storage capacity, texture and depth. Soils are gleysolic or organic.

Guidelines

ENGINEERING REQUIREMENTS

The development capability of soils is determined, in the first instance, by the "engineering" requirements (foundations, servicing) of proposed development. For certain types of development or servicing, soil requirements can be quite specific. For example septic tank/tile field systems require a minimum depth of soil over rock or seasonal high water table and rather narrow soil percolation requirements.



poorly drained soils are unstable and subject to heaving

FOUNDATIONS

Soils for road and building foundations require adequate load-bearing capacity, low compressibility and resistence to frost-heaving. Coarser textured, well-graded soils with good internal drainage are generally best. Such soils are resistant to compaction, swelling or slippage.

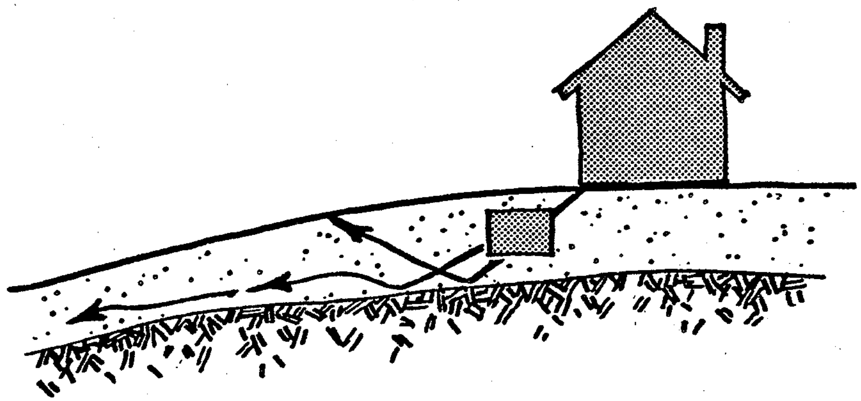
For structures without basements shallow soils over bedrock enable the construction of solid, inexpensive foundations. Shallow soils are a constraint, however, to road construction and structures with basement-type foundations.

WASTE DISPOSAL

Fine textured soils have slower infiltration rates, making them less suitable for seepage type waste water disposal (tile fields, sullage pits). Impermeability can cause lateral drainage and resurfacing of waste. Coarse textured soils may be too permeable, allowing insufficient treatment of waste. Coarse soils also have poor nutrient retention capacities. The best soils for seepage type systems are sandy soils.

Sewage disposal by septic tank/tile field, sullage pit, or pit privy requires a minimum depth of available overburden of 1 meter. (Man. Reg. 85/81). With this depth fill (up to 1 meter) will still be required to construct a tile field. Deeper soils (ie. 200cm +) are therefore preferred for septic tank/tile field systems.

Sewage lagoons require sufficient soil on site to permit construction of dikes and a flat bottom. Bottom and sides must be impermeable; clay soils are preferred. Where soils are too permeable a clay or sysnthetic liner must be installed.



shallow soils are unsuitable for on-site sewage disposal

SITE SERVICING

Underground services (sewer, water) need to be installed below the depth of frost penetration. A soil depth in excess of 2 meters is generally required. Soils should be well-drained and stable to avoid damage to pipes.

	COARSE-GRAINED SOILS								FINE-GRAINED SOILS						
	GRAVEL & GRAVELLY SOILS				SANDS & SANDY SOILS				SILTS & CLAYS LL < 50			SILTS & CLAYS LL > 50			HIGHLY ORGANIC SOILS
	GW	GP	GM	GC	SW	SP	SM	SC	ML	CL	OL	MH	CH	OH	Pt
Workability as a Construction Material	1	2	2	2	1	3	3	2	3-4	3	4	4	5	5	NS
Compaction Characteristics	1	2	3	3	1	2	3	3	3-4	3	5	4-5	4-5	5	NS
Shearing Strength When Compacted & Saturated	1	2	3	4	2	3	4	5	5	5	5	5	5	5	NS
Compressibility & Expansion	1	1	2	3	1	1	2	3-4	2-3	3	3-4	4	4	4	5
Drainage Characteristics	1	1	3-4	5	1	1	3-4	5	3-4	5	4	3-4	5	5	3-4
Potential Frost Action	1	1	2-3	2-3	1	1	4	4	3-5	3-4	3-4	3-5	3	3	2

1 Excellent   4 Poor
2 Good   5 Very Poor
3 Fair   NS Not Suitable

Source: Caminos & Goethert, 1978

THE ENGINEERING CAPABILITY OF SOILS

FIGURE 3.7

SOIL TOLERANCE TO DEVELOPMENT

Once the minimum requirements for servicing and foundations are met, soil tolerance to development in terms of fertility, trafficability and erosion determine development capability.

FERTILITY

Coarse textured soils are loose, frequently arid, and often deficient in nutrients. Fine textured soils will harden when dry but are high in available moisture. Medium textured soils have good capacity to hold and supply nutrients and have good moisture retention and tilth.

A high water table and poor drainage conditions inhibit root growth, increasing windthrow potential. Excessive drainage tends to cause arid and infertile conditions.

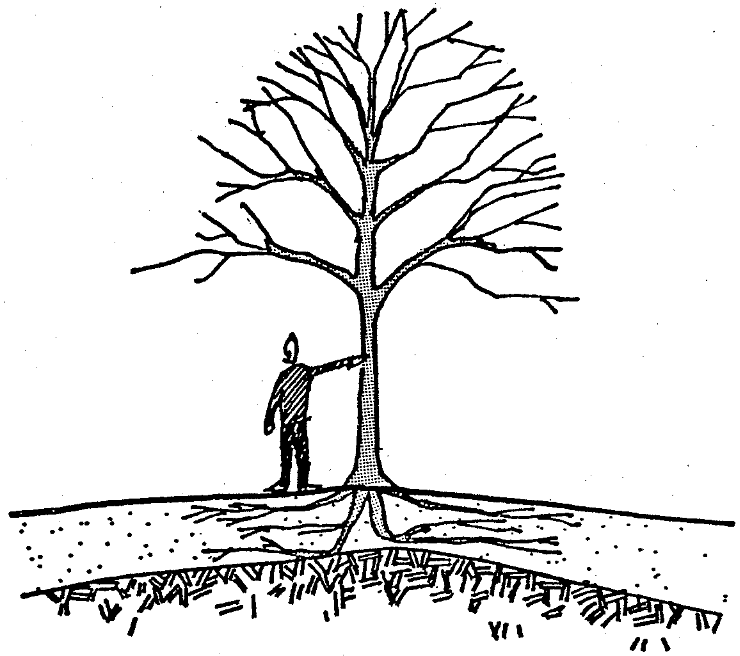
Root penetration is also restricted by shallow soils. Vegetation growth is often sparse, increasing visual penetration.

AVAILABLE WATER IN SOME MANITOBA SOILS

Soil Texture Group	Kind of Soil	Available Water to 1200mm
coarse	S, LS	145
moderately coarse	LVFS, SL	240
medium	VFSL, L, SiL, Si	255
moderately fine	CL, SCL, SiCL	260
fine	SC, SiC, C	260

from Manitoba Department of Agriculture (no date) Manitoba Soils and Their Management.

FIGURE 3.8



shallow soils prevent deep root penetration

TRAFFICABILITY

Coarse textured soils with low fertility and low organic matter are sensitive to compaction from recreational use. Vegetation growing on coarse-textured soils is more sensitive to trampling due to the twisting action of foot traffic. Coarse and stony surface textures are less desirable for play areas. The permeability of fine textured soils decreases when compacted, decreasing infiltration and increasing runoff. Clay textured surface soils compact when trampled in the presence of moisture causing surface ponding and the formation of a hard crust on drying.

Shallow soils are susceptible to damage by foot traffic which may loosen the soil from the underlying rock. Shallow root systems can be easily exposed and damaged.

Slow drainage causes waterlogged conditions and surface ponding restricting use of such areas in the spring and early summer and following periods of rain.

EROSION POTENTIAL

The susceptibility of a soil to erode is influenced by all three soil characteristics. Generally, soils which are deep, well-drained, with a coarse but well-graded texture are least susceptible to erosion. Refer to the erosion section for a complete discussion.

In general, soils with the highest capability for cottage development are deep, well or moderately-well drained loam soils which have a good organic content and structure. Such soils have adequate engineering capability, are generally fertile, and are usually tolerant of development stress. Selection of these soils will tend to reduce development costs and increase environmental protection.

Other soil conditions may be preferred to satisfy specific needs. For example, to ensure firmness of foundation a coarser-textured soil may be required. However, this selection will probably be made at the expense of soil tolerance.

As levels of use decline and the quality of development becomes more "primitive" the range of soil conditions suitable for development expands. Site tolerance to foot traffic and automobile movements is less critical in a low density subdivision. Soils which are somewhat susceptible to frost-heaving may be acceptable for cottage foundations provided that structures are built to permit adjustments.

Soil capability for specific cottage development requirements is presented in the tables which follow.

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<u>SEPTIC TANK ABSORBTION FIELDS</u>	GOOD	FAIR	POOR	VERY POOR
TEXTURE	50-70% sand <clay 40%	>sand 40% <sand 80% <clay 40%	<sand 40% >sand 80% >clay 40%	
DRAINAGE	well	rapid moderate	poor	very poor
DEPTH	>200cm	100-200cm	<100cm	

<u>SEWAGE LAGOONS</u>	GOOD	FAIR	POOR	VERY POOR
SUBGRADE TEXTURE	GC, SC, CL, CH	GM, ML, SM, MH	SW, SP	OL, OH, Pt, GP, GW
SOIL PERMEABILITY	0-0.5cm/hr	0.5-5cm/hr	5-15cm/hr	>15cm/hr
THICKNESS OF SLOWLY PERMEABLE LAYER	>100cm	100-50cm	50-25cm	<25cm
ORGANIC MATTER	<2%	2-10%	10-30%	>30%
SOIL DEPTH	>150cm	150-100cm	100-50cm	<50cm

<u>THE DEVELOPMENT CAPABILITY OF SOILS</u>

FIGURE 3.9

FOUNDATIONS	GOOD	FAIR	POOR	VERY POOR
ROADS & BUILDINGS	GW, GP, GM, SW , GC	SP, SC, SM*	ML, CL*	OL, MH, CH, OH, Pt
DRAINAGE	rapid, well	moderate	poor	very poor, permanently wet
DEPTH TO BEDROCK (roads)	>100cm	50-100cm	< 50cm	
DEPTH TO SEASONAL WATER TABLE	> 75cm	50-75cm	25-50cm	< 25cm

* if building foundation built on bedrock these soils are less restrictive.

FERTILITY	GOOD	FAIR	POOR	VERY POOR
TEXTURE	L, SL, FSL, VFSL, SCL	CL, SiCL, SiL, SC, C	S, LS, Si, SiC, HC	marl gravel, diatomaceous earth
CONSISTENCE	very friable, friable	loose, firm	very firm	cemented
DRAINAGE	well, moderate if no seepage, rapid if not arid	moderate, rapid	poor	very poor
DEPTH	>200cm	100-200cm	50-100cm	< 50cm

THE DEVELOPMENT CAPABILITY OF SOILS

FIGURE 3.9

TRAFFICABILITY	GOOD	FAIR	POOR	VERY POOR
SURFACE TEXTURE	SL, FSL, VFSL, L.	SiL,CL, SCL, SiCL, LS	SL, SiC, C*, S, Si, HC	Peaty soils S, LS subject to blowing. C very poorly drained
COARSE FRAGMENTS ON SURFACE	0-20%	20-50%	>50%	
STONINESS	stones >10m apart	stones 2-10m apart	stones 0.1-2m apart	stones <0.1m apart
DRAINAGE	well drained, rapidly drained if not arid	moderately drained	poorly drained, rapidly drained if arid	very poorly drained and permanently wet
DEPTH	>100cm bare rock	50-100cm	<50cm	

* well drained SiL and C may be rated fair.

RESISTENCE TO EROSION*	GOOD	FAIR	POOR
TEXTURE	sand	loam, clay	silt
DRAINAGE	rapid, well	moderate	poor, very poor
DEPTH	<100cm	50-100cm	>50cm

* see erosion section.

THE DEVELOPMENT CAPABILITY OF SOILS

FIGURE 3.9

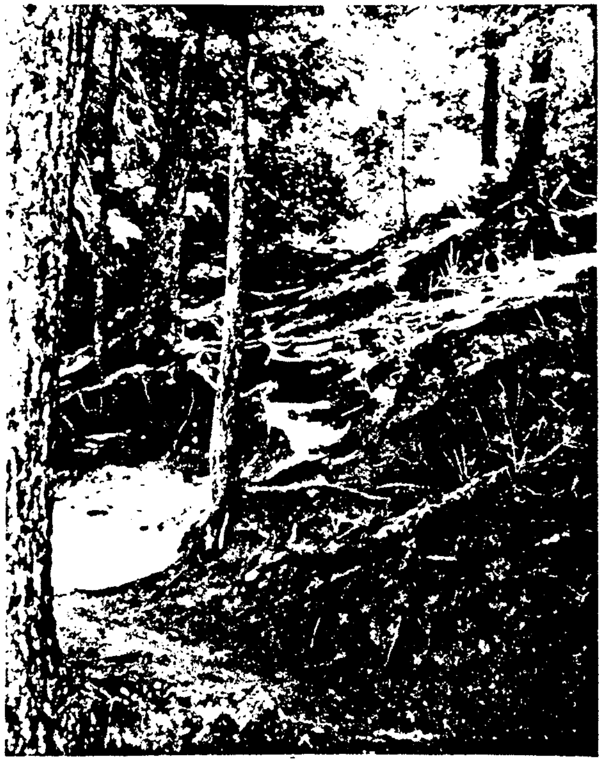
Discussion

Soil erosion is an issue with any land development project where vegetation or soil will be disturbed. It warrants treatment as a separate section because it is influenced by topography, vegetative cover, and climate as well as soil conditions.

Soil erosion is a special concern when planning lake-oriented cottaging because of the proximity of developed areas to the water body. Increased erosion impacts on fish populations by causing sedimentation of streams and shallow water areas. Sediment may cover eggs in spawning areas and increase turbidity and toxic soil chemical levels. Erosion can also contribute to nutrient-loading of the water body.

Erosion is also a concern because it reduces soil fertility. On naturally infertile soils such as those found extensively on the precambrian shield the effect of erosion in this respect can be very damaging. Erosion removes clay minerals and humus, causes a deterioration of soil tilth and decreases the capacity of a soil to absorb and retain moisture. The loss of fertility cannot be readily remedied. Spreading fertilizers on mineral soil is a fruitless activity, without storage sites the fertilizers merely dissociate and volatize or leach away in one to two years.

soil erosion

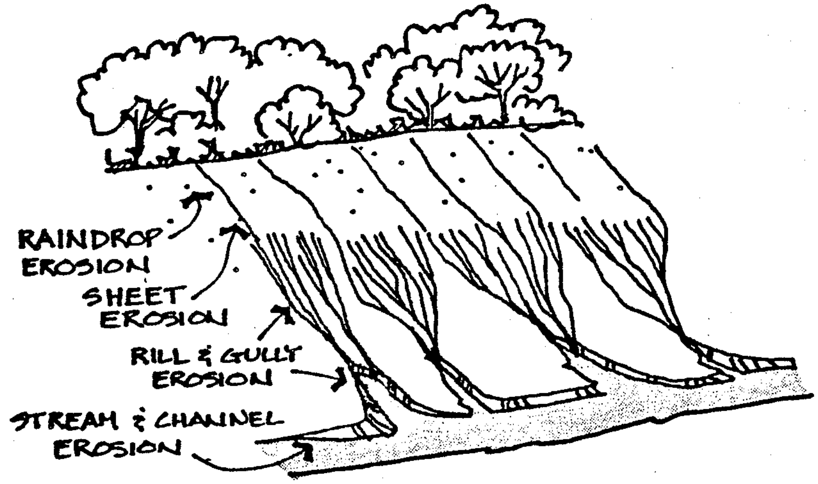


In shield areas where soils are often thin over bedrock, erosion can cause problems of root exposure which leads to mechanical damage of roots by foot traffic and reduced tree stability.

In more severe cases erosion can cause gullying and mass slumping.

Soil erosion occurs in conjunction with cottage development as a result of both construction and use. It is usually during construction that the greatest site disturbance, and therefore the greatest erosion problems occur. Higher density developments which involve the installation of underground services, site grading, and the use of heavy equipment cause more erosion than the construction of an isolated cabin using hand power. However, even construction of a small cabin can have serious local impact given poor site management practices or a site with moderate or high erosion potential.

After construction, erosion may continue on a cottage lot if vegetation is not replaced and the ground litter is lost. Human trampling can cause soil compaction and loss of groundcovers by the twisting action of feet. Erosion from higher density development declines dramatically after construction has ended but will continue to be a concern unless measures are taken to rehabilitate the site and control runoff.



TYPES OF EROSION

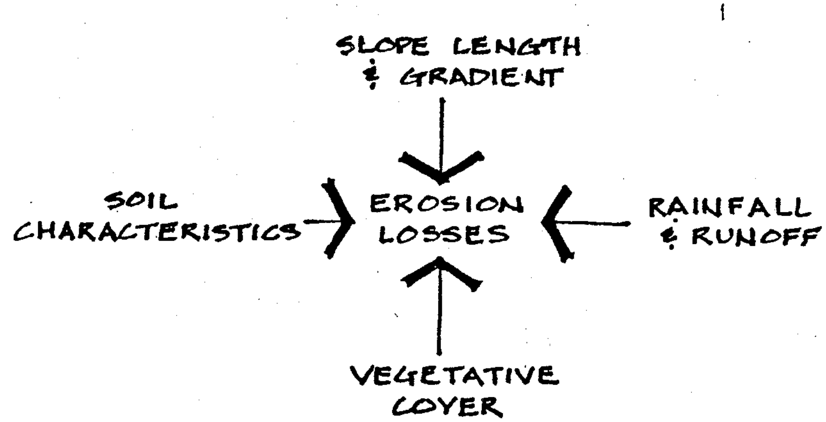
BJR Inc.(1981)

Guidelines

ASSESSING EROSION POTENTIAL

Soil erosion and sedimentation control begins at the planning stage by assessing the erosion potential of development sites and avoiding areas of high hazard. The potential of a site to erode is determined by:

- soil resistence to erosion,
- slope length and gradient,
- rainfall characteristics - duration, intensity and frequency,
- vegetative cover.



CHARACTERISTICS WHICH AFFECT EROSION

Soil Characteristics

The properties of a soil which determine its erodibility are: average particle size and gradation; percentage organic content; soil structure; and soil permeability.

AVERAGE PARTICLE SIZE AND GRADATION - Soils containing high proportions of silt or very fine sand are, generally, most erodable as these particles are easily detached and carried away. Clay acts as a binder between particles and tends to decrease the erodibility of a soil. Once detached, however, clays are easily transported and settle out very slowly. Well-graded soils (soils having a good blend of particle sizes) are more resistent to erosion.

PERCENTAGE ORGANIC CONTENT - Increased organic matter in a soil helps to maintain a favourable structure which is more permeable and more resistent to erosion forces.

SOIL STRUCTURE - Well-structured soils are more resistent to erosion. An exception are soils with plate-like structures which impede infiltration and percolation. Plate-like structures are common in the surface mineral horizons of forested soils. Two structureless soil types which are frequently encountered are: single-grained types poor in colloids (eg. sands); amorphous types which are colloid-rich (eg. heavy clays).

SOIL PERMEABILITY - High permeability permits good infiltration of rain and meltwater, delaying and decreasing runoff. Coarse, granular soils are least erodable. Clayey soils have a high water holding capacity but poor infiltration capacity making them more vulnerable to erosion.

Slope Length and Gradient

As slope length and gradient increase the rate of runoff increases and the potential for erosion is magnified. Land use and area of cleared land strongly influence the erodibility of slopes. A highly erodable slope for agriculture or urban development may pose only a slight erosion hazard to a less intensive or disruptive land use. The following may be used as a general guide for cottage development:

	ERODIBILITY	RUNOFF POTENTIAL	SEDIMENTATION POTENTIAL
SILTY SOILS AND FINE SANDS	H	M	H
CLAYEY SOILS	M	H	H
LOAMY SOILS	M	M	M
SANDY SOILS	L	L	L

HIGH H MODERATE M LOW L

ERODIBILITY, RUNOFF POTENTIAL, AND SEDIMENTATION POTENTIAL OF SOILS

from B.J.R. INC. (1981)

FIGURE 3.10

0-9%	low erosion hazard
10-19%	moderate erosion hazard
20% and over	high erosion hazard

Note that although a slope has a low erosion hazard, it may still require erosion control measures given other conditions. On the other hand, the erosion hazard on some slopes over 19% may be reduced with sensitive design, minimal site disturbance and soils with low erodibility.

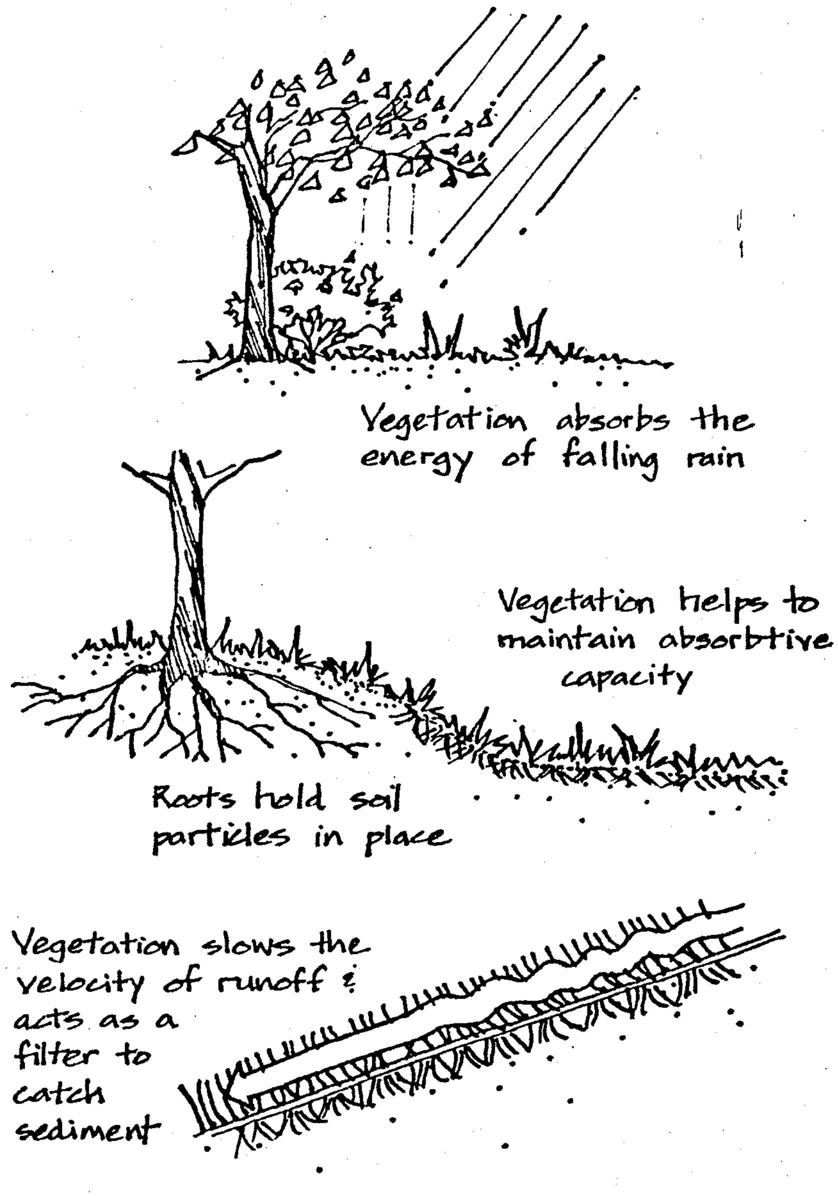
Rainfall characteristics

The frequency, intensity and duration of rainfall are important in determining the amount and intensity of runoff. As the volume and velocity of runoff increase the ability to detach and transport soil particles also increases.

Vegetative Cover

Vegetative cover is very important in controlling erosion. It decreases erosion potential in four ways:

1. Foliage and litter on the forest floor absorb the energy of falling rain, reducing the impact on the soil. The raindrops are detained so that they drain slowly into the soil.



B.J.R. Inc. (1981)

2. Roots of plants, ground covers and forest litter are a myriad of small obstacles to the downslope movement of water. Infiltration is encouraged.

3. Plants transpire and evaporate soil moisture from previous rainfalls, creating space in the soil for additional rains. Plant roots and organic matter maintain a permeable soil structure. Forest litter prevents soil from dying out and forming on impervious crust.

4. Plant roots help to increase the soil's ability to resist detachment and transport by runoff.

The erosion potential of an undeveloped, vegetated site is determined from slope and soil conditions (rainfall is assumed to be constant). While soil and slope influence erosion separately, in certain combinations the erosion hazard can be significantly increased. For example, a moderately erodable soil on a slope with moderate erosion hazard has a severe erosion potential.

Erosion potential increases further when vegetative cover cannot be sustained. Sites where vegetation cannot withstand the stresses of development and use or where plant growth is difficult (eg. arid conditions) pose a higher erosion hazard.

SLOPE EROSION HAZARD		ERODIBILITY OF SOIL: LOW	MODERATE	HIGH
0-7%	LOW	slight	moderate	severe
8-15%	MODERATE	moderate	severe	v. severe
16+%	HIGH	severe	v. severe	v. severe

SITE EROSION POTENTIAL

FIGURE 3.11

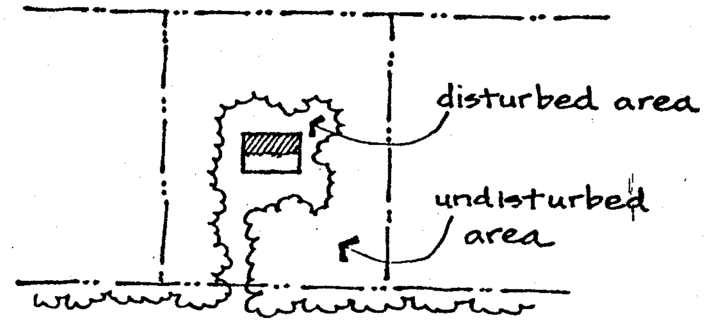
SITE MANAGEMENT

As the area and degree of disturbance of vegetation and soil increase the potential for erosion rises. Erosion control becomes a major concern, therefore, of "urban" type cottage development where densities are higher and site manipulation is greater. Such development should be confined to areas with low erosion hazard to ensure adequate environmental protection.

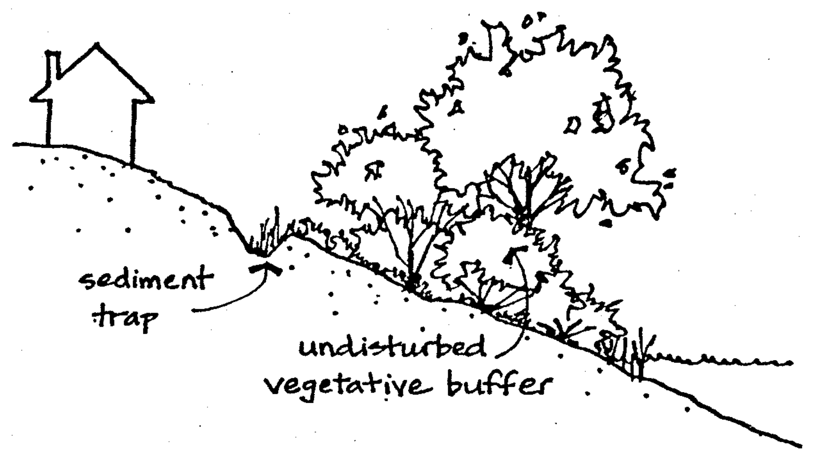
Development of sites with moderate or severe erosion potential may be possible provided site disturbance is minimized and measures are taken to control erosion. Where vegetation is disturbed and soil exposed the soil must be stabilized and the site revegetated as soon as possible. During construction, disturbed areas must be protected from storm runoff and sediment retained within the site area.

Shoreline development should occur in areas of low erosion potential to reduce sedimentation of shallow water areas. Development of moderately erodable sites is advisable only if steps are taken to control sedimentation eg. retention of a vegetated strip between the disturbed area and water.

For further information on soil erosion and sedimentation control, readers are referred to the sources which follow.



KEEP DISTURBED AREAS SMALL



RETAIN SEDIMENT ON SITE

Sources

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vegetation

Discussion

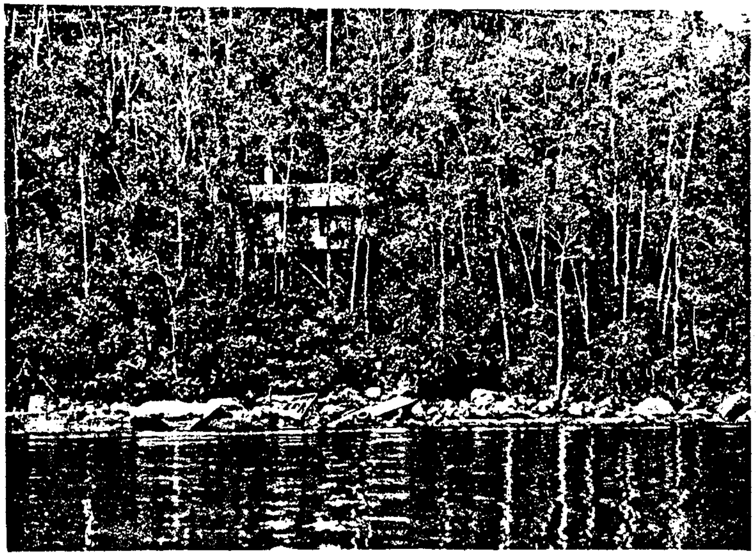
Vegetation is a very important element in the landscape. It is valued by the cottage owner, and other recreationists, for its scenic qualities, its function as a privacy screen and as a modifier of climate. The attractiveness of a lake basin or development site is strongly influenced by vegetation.

Vegetation fulfills many significant ecological functions. Plants are primary producers in the food chain and, as such, determine productivity at all higher levels. In addition to their function as food source, plants provide cover for most wildlife species and are important in the formation of soil and prevention of soil erosion.

Vegetation is an important commodity resource with value for pulp and paper, lumber and fuel.

Vegetation may also present a threat to people and property. Tree windthrow and breakage can damage structures and power lines. Forest fires are potentially devastating to cottage development.

The planning and design of cottage development should conserve vegetation values and respond to the characteristics and tolerances of site vegetation.



Guidelines

Planning for vegetation involves two tasks; a) identification of sensitive and hazardous vegetation and b) assessment of vegetation capability for cottage development.

SENSITIVE AND HAZARDOUS VEGETATION

Sensitive vegetation is vegetation which has significant value for uses other than cottaging which would be imparied or destroyed by development. Included in this category are unique and representative plant species and associations, critical wildlife habitat, scenic vegetation, and vegetation with value as a commodity resource. Hazardous vegetation is primarily vegetation which poses a potential wildfire threat.

UNIQUE AND REPRESENTATIVE VEGETATION

Preservation of unique and representative natural resources falls within Parks Branch's mandate. Plant species and associations which are rare or endangered or which have other qualities that make them unique (eg. form, size, location) should be identified and protected from development. Plant communities which are significant examples of the regional flora should also be conserved. Unique and representative vegetation have potential as an interpretive resource, particularly in the context of a provincial park or recreation area.

SCENIC VALUE

Vegetation is an important scenic element, either as a separate feature (eg. stand of mature white birch) or as a component of a view. Vegetation with scenic value should be identified and avoided by development. (Refer to the visual resource section).

WILDLIFE HABITAT

The habitat requirements of wildlife are food, cover and water. As vegetation commonly provides the first two of these elements, important habitat requires protection. (Refer to the wildlife section).

COMMODITY RESOURCE

In areas where commercial timber extraction occurs, timber of value for pulp or lumber should be avoided where practical. Maintenance of a shoreland reserve will permit future cottage development adjacent to cutting areas, however conflicts from noise and vehicle movements will be reduced if development waits until cutting operations cease. Wood is increasing in value as a fuel for heating home and cottage. Backshore areas with suitable fuelwood could possibly be reserved for this purpose.

FIRE HAZARD

Areas of vegetation which pose a potential wildfire hazard should be avoided. This includes land lying in the possible path of a fire. Fire potential depends on the amount, size distribtuion, arrangement, volatibility, moisture content and chemical content of fuel found in a vegetation type. Forest types which will be most susceptible to fire are: resin-charged coniferous forest; overmature and diseased timber; forests growing in arid conditions; and forested areas which lack natural fire breaks (water bodies, marshes, etc.).

VEGETATION CAPABILITY FOR DEVELOPMENT

The capability of vegetation for cottage development is determined by: tolerance of development stress; susceptibility to windthrow, breakage and disease; suitability as a visual and auditory screen; and nutrient retention properties.

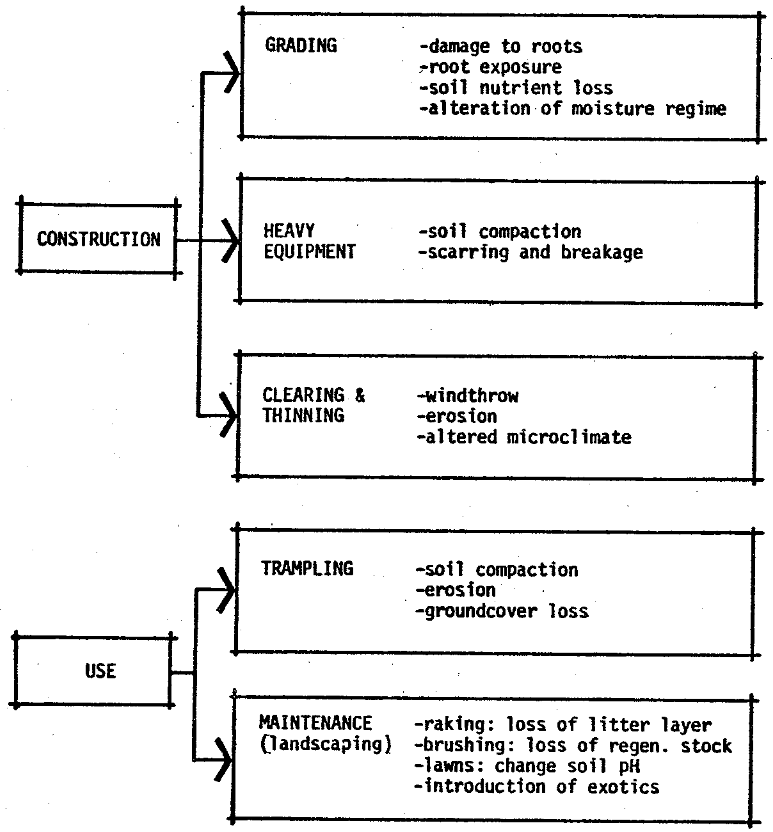
DEVELOPMENT TOLERANCE

Cottage development may stress site vegetation in two ways: physical damage to plants (eg. scarring, breakage, trampling); and alteration of micro-habitat conditions (eg. soil density, sunlight, temperatures).

Physical damage is most likely to occur during construction, as a result of the movements of construction equipment. Vegetation may also be damaged, however, after construction is completed, during use and maintenance of the site (eg. heavy foot traffic, road maintenance, vehicle movements). Once damaged, vegetation can be susceptible to dessication, insect infestation and disease.

Physical damage of vegetation is, in practical terms, inevitable on a construction site and areas of heavy use. Efforts should be directed towards controlling the extent of disturbed areas and repairing damage (eg. sealing tree wounds, replanting). Where heavy use is anticipated (eg. access point, public beach) steps should be taken to "harden" sites.

Provided it is not extensive, physical damage is not difficult to remedy. More critical, in the long term, are alterations of site growing conditions caused by cottage development. Vegetation growing on a site prior to development has grown and adapted to a particular range of micro-habitat conditions. When these conditions are altered plant growth is affected. If the change is great enough death may ensue.



SOME IMPACTS OF COTTAGE DEVELOPMENT ON VEGETATION

FIGURE 3.12

Vegetation tolerance to environment change can be species-related. Some plant species are known to be less tolerant of certain types of disturbance (eg. bur oak - sensitive to compaction). Other plant species thrive in disturbed areas; many of these are the so-called "weedy" species. The plant species which tend to be most tolerant of development are those capable of growing in a wide variety of habitats.

Sites where sensitive species are dominant have a lower capability for cottage development. Sites with a high diversity of species and age classes should be favoured, as this tends to increase the number of plants which can adapt to the new conditions.

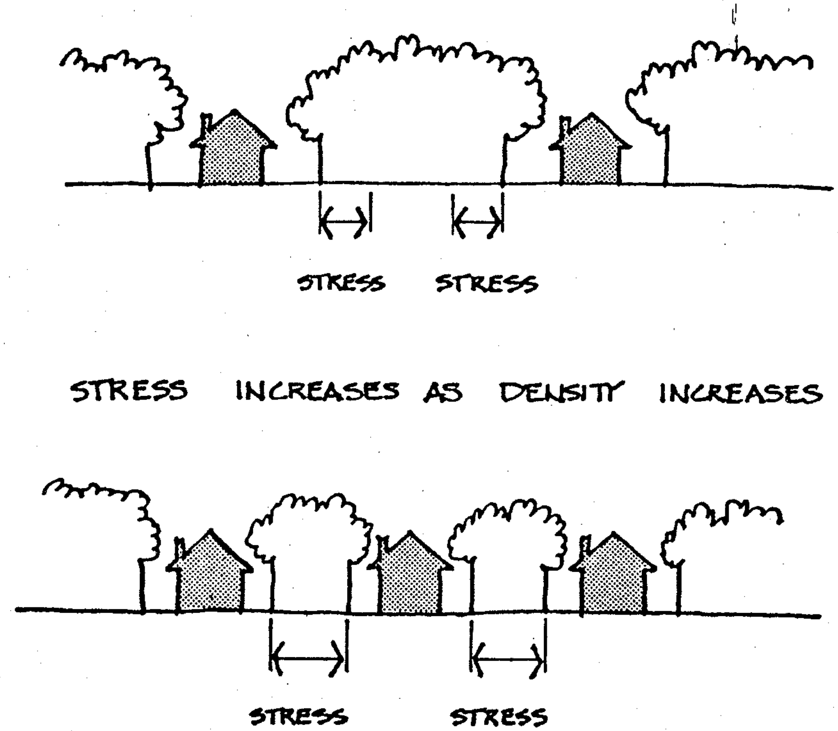
Vegetation tolerance is also determined by site growing conditions. Plants which are growing in fertile conditions and not already stressed, are more capable of tolerating development. Sites with deep, medium-textured, well or moderately-well drained soils are preferred. Also, vegetation growing on soils which are resistent to compaction and erosion will be more tolerant. (Refer to soils section).

Sensitivity of vegetation is also a factor of recovery time: the time it takes for plants to recolonize disturbed areas. In northern latitudes and arid areas where soil farming processes and vegetation growth are slower, recovery time is longer.

The greater the change in habitat conditions caused by development, the greater is the impact on site vegetation. This simple rule has two implications for the determination of development capability. The first implication is that sites with environmental conditions similar to those which will exist after construction will have the least disturbance of vegetation. For example, cottage development usually results in a more open tree canopy: vegetation growing in semi-open woodland will be disrupted less than vegetation growing in dense and shaded conditions. Put in another way, those sites requiring the least manipulation will have the highest capability for development.

The second implication is that as the density and "scale" of seasonal home development increase, disturbance also increases. Development which involves ditching, grading and the installation of underground services will have more impact than the construction of an isolated cabin with primitive services using hand labour. Higher intensity development should, therefore, be located on sites with greater vegetation tolerance.

As the density of development and degree of site manipulation increase, retention of forest vegetation becomes more difficult. Measures will be required to protect vegetation from grade changes, drainage alteration and the movements of heavy equipment. When forest cover must be cleared, select trees and shrubs should be salvaged, and topsoil and leaf litter stockpiled for rehabilitation of the site after construction.



WINDTHROW, BREAKAGE, DISEASE

Susceptibility to windthrow is determined, primarily, by environmental conditions, the most important parameters being: soil depth, soil drainage, stand density and exposure. Shallow soils restrict root growth and have little anchoring effect as a result. Wet soils also impede root growth and cause root rot. Trees growing in forested conditions are prone to windthrow when subjected to clearing and thinning. Forest trees are normally sheltered from the wind and are supported by the roots and branches of adjacent trees. When isolated these trees are very unstable. The situation is worse when trees are in exposed locations such as the crest of a hill or a lakeshore. Susceptibility to windthrow is sometimes thought to be species-related, however, it is likely that such correlations are the result of local soil conditions more than inherent species characteristics.

Limb breakage occurs as a result of snow loading and wind. Opening a stand and exposing trees to the wind will likely increase breakage for all species. Susceptibility to breakage is also determined by flexibility of wood. Species with weak or brittle wood (eg. poplar, willow) will be more prone to breakage. Older and diseased trees will also have more limb breakage.

Diseased vegetation, in audition to increasing the windthrow and breakage hazard, can be unattractive. Some tree species are susceptible to disease and pests which are widespread in the province. (eg. american elm - dutch elm disease; jack pine - witch's broom; balsam fir - spruce bud worm; white birch - birch borer and heart rot.) Sites with higher proportions of diseased and disease-susceptible species have lower development capability.

VISUAL & AUDITORY SCREENING

The effectiveness of vegetation as a visual screen is determined by the density of foliage, branches and trunks. Mixed forest with good understory development provides the greatest visual screening potential when left in a natural state. When the understory is removed visual impact is less when development occurs beneath a strong, high canopy. (Refer to visual analysis section).

Vegetation can have both a physical and psychological effect which reduces noise. Denser stands with a mixture of species and age classes have more potential to reduce noise.

NUTRIENT RETENTION

Vegetation can reduce the impact of on-site sewage disposal systems on a water body by intercepting and retaining nutrients. Where on-site disposal will be used, well-established and mature plant communities are preferable. Mature natural systems, as compared to developing of disturbed ones, have a greater capacity to entrap and hold nutrients for cycling within the system.

VEGETATION CHARACTERISTICS	DEVELOPMENT CAPABILITY		
	HIGH	MODERATE	LOW
SPECIES DIVERSITY	high species diversity	moderate species diversity	low species diversity
	mixed deciduous and coniferous	mixed deciduous or coniferous	monoculture
AGE STRUCTURE	mixed age		even age
	mature	immature	overmature
CANOPY DENSITY*	semi-open	open	closed
UNDERSTORY DENSITY	dense	semi-open	open
PERCENTAGE DISEASED, DISEASE SUSCEPTIBLE	0-20%	20-50%	50%+

* note that strong, high canopy increases visual absorbtion.

VEGETATION CAPABILITY FOR COTTAGE DEVELOPMENT

FIGURE 3.13

Sources

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shoreline

Discussion

The shoreline is the focus for most cottage recreation activities such as boat docking, swimming, sunbathing, fishing. Shoreline suitability for such activities is determined by its slope, surface material, the presence or absence of aquatic nuisances and exposure to high winds and waves.

It is essential that sensitive shoreline and heavily used areas be protected as the intensity of the activity associated with these areas makes them susceptible to damage from overuse.

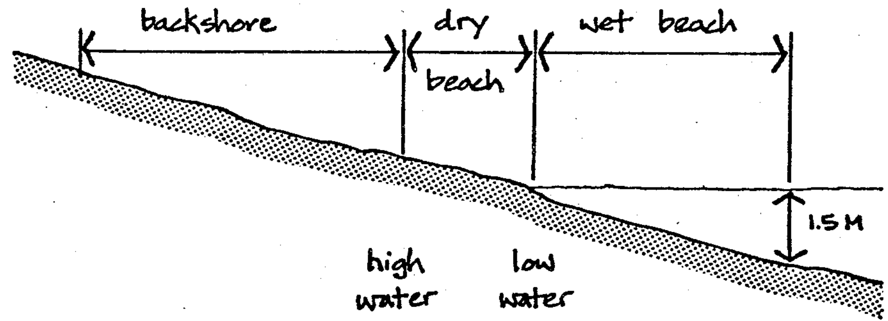
A shore area assessment to determine its potential for recreational use is part of the process of determining the capability of shoreland for cottage development.

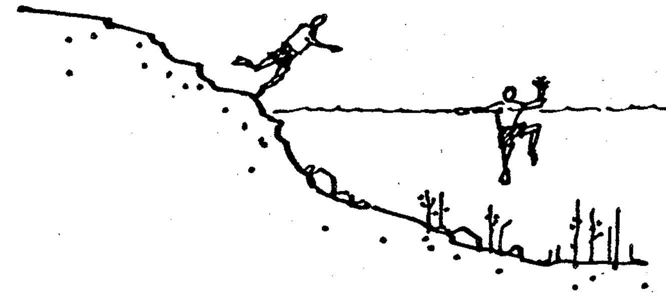
Guidelines

Assessments of shoreline capability for cottage development requires that consideration be given to three zones: wet beach, dry beach and backshore. The wet beach is the band of water extending from the normal low water mark to the 1.5 metre depth (the depth at which most swimmers loose contact with the bottom). The attractiveness of this zone for bathing is dependent on slope, bottom material and the absence of aquatic nuisances (eg. vegetation, stumps). While a steeply sloping wet beach may be attractive to stronger swimmers able to make a deep water entry from the shore, a shoreline suitable for all swimmers will require a more gentle slope. Consequently the quality of bottom is important: a soft or rocky bottom will restrict use.

For public use areas associated with sand beaches the width of the dry beach is an important determinant of capability. In such situations the dry beach usually experiences more use than the water for sunbathing, etc. Studies of public beaches verify that at any one time 3/4 of users will be on land while 1/4 will be in the water (see carrying capacity).

The backshore is the zone lying above the high water mark reaching inland up to 100 metres or more. This zone is important in public use areas as it is here that most support services (eg. parking, toilets) will be located. It is also used intensively for picnicking and active play. The characteristics of the backshore which are important in terms of capability are primarily slope and drainage.

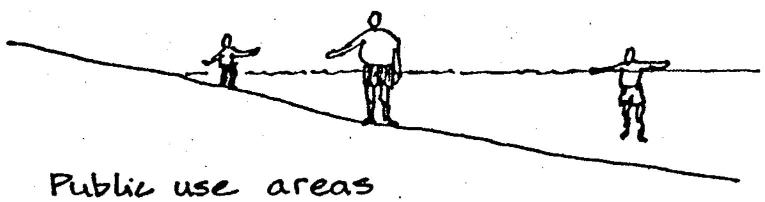




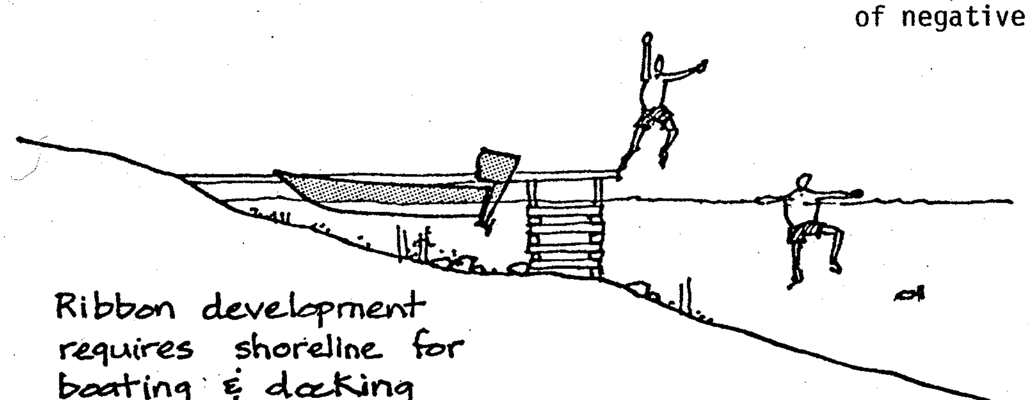
steep wet beach is acceptable for strong swimmers

Shore requirements for cottaging vary according to the form and orientation of development. Each cottage in a ribbon shoreline subdivision has its own waterfront, while a cluster development usually shares common frontage and common bathing facilities.

Ribbon shoreline subdivisions require shore suitable for docking and bathing for each lot. Preferred shoreline will have shallow water areas for paddling and non-swimmers but will not be too gentle to restrict boat docking and deep water entries from the dock. The water should be free of aquatic vegetation. The dry beach and foreshore should not be steep, restricting access to the water. Steep slopes and rocky shores are acceptable provided there is a sand beach nearby to accommodate non-swimmers. Cottage owners can modify their frontage by removing aquatic vegetation and bringing in sand fill. However, these practices should be discouraged because of negative impacts on fish habitat.

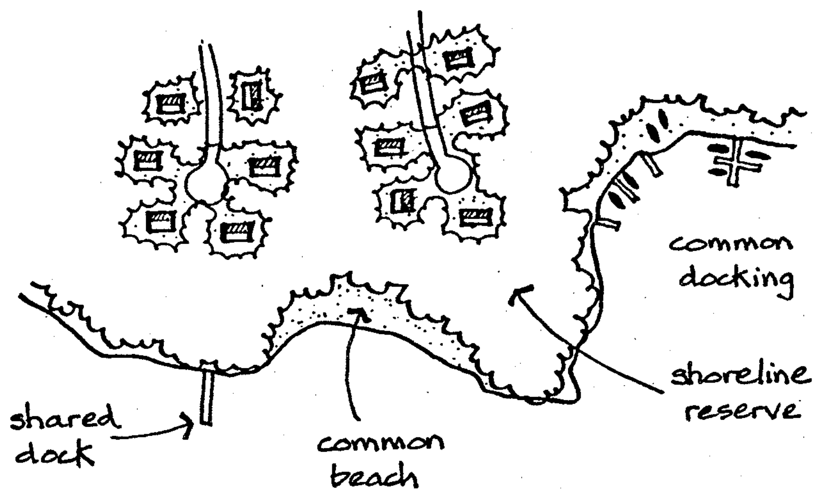


Public use areas must be suitable for all swimming levels



Ribbon development requires shoreline for boating & docking

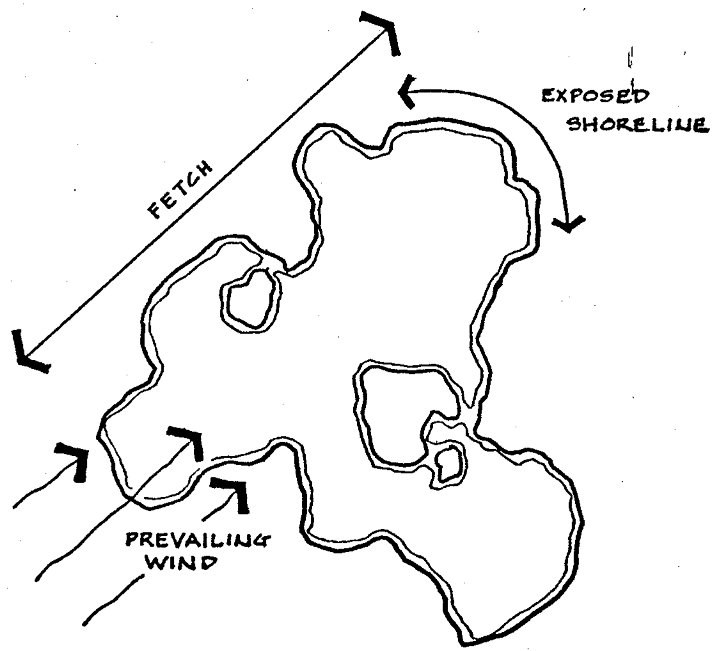
Backland development does not require all shore to be suitable for recreational use. Bathing and docking may occur in different locations, the facilities being shared by all residents of the development. Good shoreline for cluster-type cottages may have a variety of shore types: beaches, bedrock and sheltered areas for docking interspersed with lower capability ares. Measures may be required to control the locations and numbers of docks to prevent crowding and misuse of public land.



Higher level development such as a recreational village will require a large sand beach and marina facility. As the bathing area is likely to be located further from the units, the land requirements of the beach will increase to accommodate the larger number of people for sunbathing, picnicking and play. Preferred shore will be gently sloping sand or fine gravel beach which permits swimming for all levels of swimmers. A breakwater and supervised deep water swimming area may also be provided. Docking and marina facilities will be located together and separated from bathing to avoid congestion and conflict.

Shore areas which are susceptible to erosion or damage from foot traffic (eg. steep slopes, dunes, coarse sandy soils) should be avoided for public use. Where heavy use is anticipated, steps should be taken to control the movements of people by directing traffic to areas which have been "hardened" (stairways and walks). Where the shoreline is in private hands impacts may be controlled by lease covenants which restrict clearing of vegetation and the construction of structures.

Shoreline which is exposed to a large expanse of open water lying in the direction of the prevailing winds or summer storms are more likely to experience high waves. The growth of waves is a function of wind velocity, wind duration and the length of open water (fetch) over which the wind travels. Potential wave heights for a particular segment of shoreline can be predicted using empirical charts which plot wind speed against fetch length. Examples of such charts are found in the appendix.



Sources

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U.S. Army Coastal Engineering Research Board. 1966. Shore Protection Planning and Design. Tech. Rep. No. 4.

COTTAGING - BATHING & DOCKING

	Slope	Material	Dry Beach Width	Backshore Slope
Good	8-100%	sand, gravel, smooth rock	1.5-20m	0-7%
Fair	2-7%	cobbles, loam	21-75m	8-14%
Poor	< 2% > 100%	mixed stones, clay, silt, boulders	< 1.5m > 75m	15-29%
V. Poor		other		30%+

PUBLIC BATHING

	Slope	Material	Dry Beach Width	Backshore Slope	Backshore Drainage
Good	2-7%	sand	> 20m	0-7%	well
Fair	< 2% 8-14%	gravel	11-20m	8-14%	rapid moderate
Poor	15-29%	smooth rock, cobbles, loam	5-10m	15-29%	poor
V.Poor	30-100%	mixed stones, clay, silt, boulders	< 5m	30%+	very poor
Unsuitable	> 100%	jagged bed-rock, angular stones, ooze, fragments			

<u>SHORELINE CAPABILITY</u>

FIGURE 3.14

microclimate

Discussion

The term "microclimate" refers to the localized climate (ie. temperature, sunlight, wind) experienced at the site level. Adverse microclimatic conditions reduce the attractiveness of a site for seasonal home development.

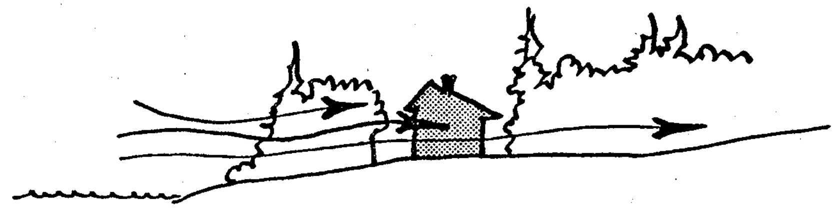
Guidelines

Access to sunlight is an important microclimatic consideration. Solar exposure is desirable in the summer for most outdoor activity, particularly swimming and sunbathing. Where year-round use is anticipated solar access becomes important for space heating. Consequently, sites which are oriented to the south are generally preferable to north facing ones. Also east facing sites are preferable to west facing. The former have the advantage of sun earlier in the day to warm the site but are sheltered from the hot afternoon rays.

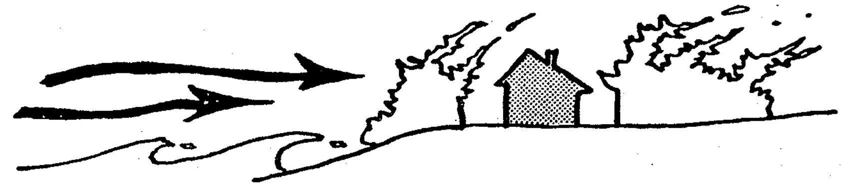
Sites which are located in depressions or at the base of a slope will tend to be colder. Cold air runs downhill and collects in "frost pockets".

Wind exposure has both positive and negative aspects. Breezes in summer can have a pleasant cooling effect and help to reduce the presence of flying insects. However, too much wind will

have a chilling effect. A site which is exposed to high winds may have problems with tree windthrow, high waves and snow drifting.



summer breezes reduces insects
& have a cooling effect



too much exposure causes windthrow
and high waves

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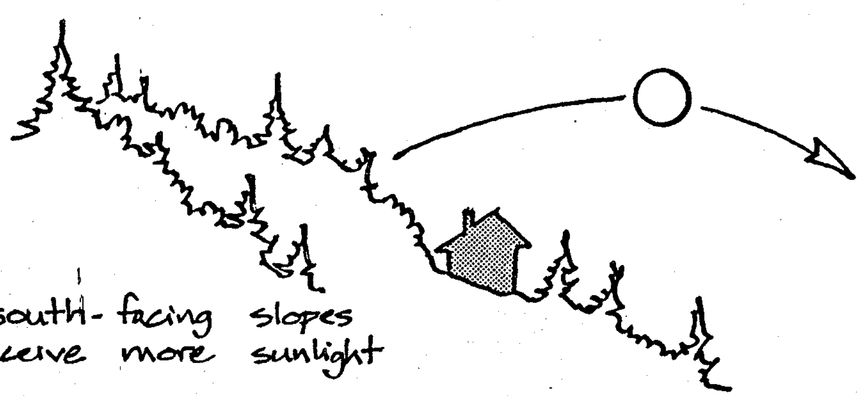
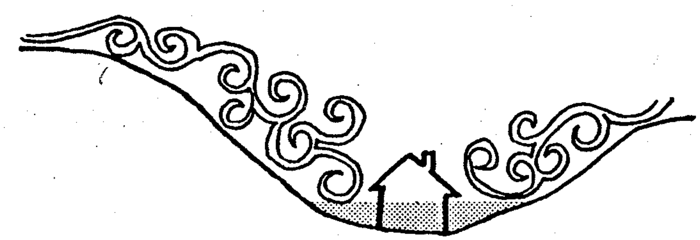


south-facing slopes
receive more sunlight



cold air runs downhill and
collects in "frost pockets"

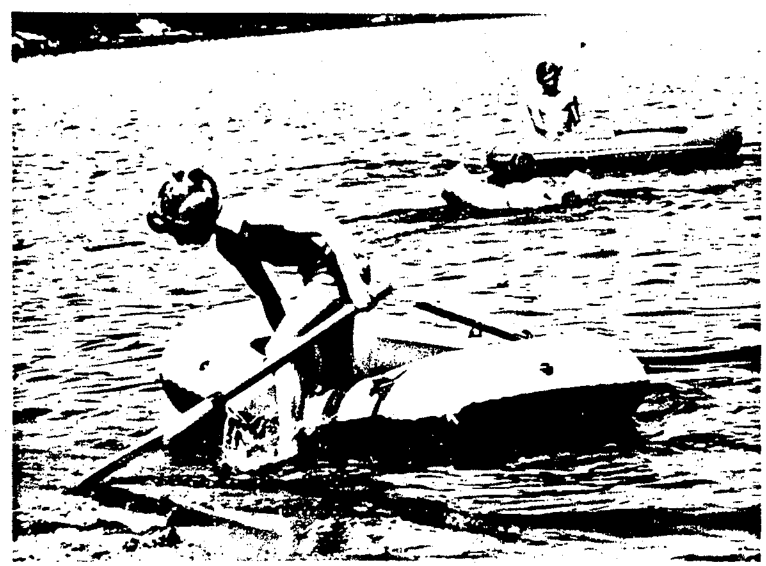
Discussion

The water body is the focus of interest and activity in a lake-oriented seasonal home development. As a result, special attention and management are warranted to ensure that the quality of the lake resource is not impaired through overuse.

Management of the water resource requires that both the spatial and water quality aspects of the lake be considered. Many uses compete for the available water surface area: water skiing, fishing, sailing, swimming. Conflicts can arise when levels of use are high or where there is inadequate separation of incompatible uses.

The quality of the water is important for contact recreation, human consumption and aesthetics: ideally it should be clear, and taste and odour free. Ironically human occupation and use of the resource tends to cause a decline in quality. Pollution takes many forms: chemical pollution from pesticides, gas and oil leakage from outboard motors; bacteriological pollution from poorly treated sewage; siltation from increased erosion; biological pollution from increased nutrient-loading.

water



Guidelines

As explained in the regional section, the greatest potential impact on water quality associated with seasonal home development is nutrient-loading from human and household waste. Sewage and certain detergents (eg. dish-washing detergent) contain high quantities of phosphorus (and, in the case of sewage, nitrogen). These nutrients, if permitted access to a water body, stimulate primary productivity which can lead to a decline in the quality of water for recreational use. Most waste disposal systems commonly used in rural areas (septic tank, tile fields, pit privies, sewage ejection systems, lagoons) do not effectively remove phosphorus and nitrogen. These systems, even when built to meet public health standards can still pollute in a biological sense. Wherever waste disposal systems which release treated waste to an aquatic system are used an assessment of the potential impact will be required. This will require the involvement of an experienced limnologist.

Lake systems can usually absorb a certain increase in nutrient-loading before water quality changes become apparent. This amount varies according to the physical, chemical and biological characteristics of the lake and watershed. By determining the permissible increase the capacity of a lake to support sewage disposal (and therefore cottage units) can be determined. A model which can assist in the determination of capacity is outlined in the carrying capacity section of this report.

Also important, but much more difficult to detect are the changes to the aquatic regime caused by land clearing, drainage alterations and water activity. Chemical pollution from pesticides and oil and gas leakage from motor boats cause deterioration in water quality in the long term but the extent of such impacts and their implications are largely unknown.

It is evident, therefore, that a comprehensive inventory of water quality is necessary prior to development to provide baseline data against which future impacts may be measured. This will provide the opportunity to learn more about the impact of cottage development. By regular monitoring, water quality changes can be observed thus facilitating prompt detection of problems and their subsequent management before they become extreme.

Surface use of the lake may be managed by controlling numbers of users and regulating user behaviour. Methods of determining boating and bathing capacity are described in the carrying capacity section. Concern here is with the latter.

Regulation of user behaviour may be accomplished by such methods as: water zoning, speed limits, and horse power limitations. Water zoning is the delineation of the lake surface into areas where only certain specified activities may occur. Water zones might include: open water zone, non-motor zone, conservation zone, beach zone, shoreline zone.

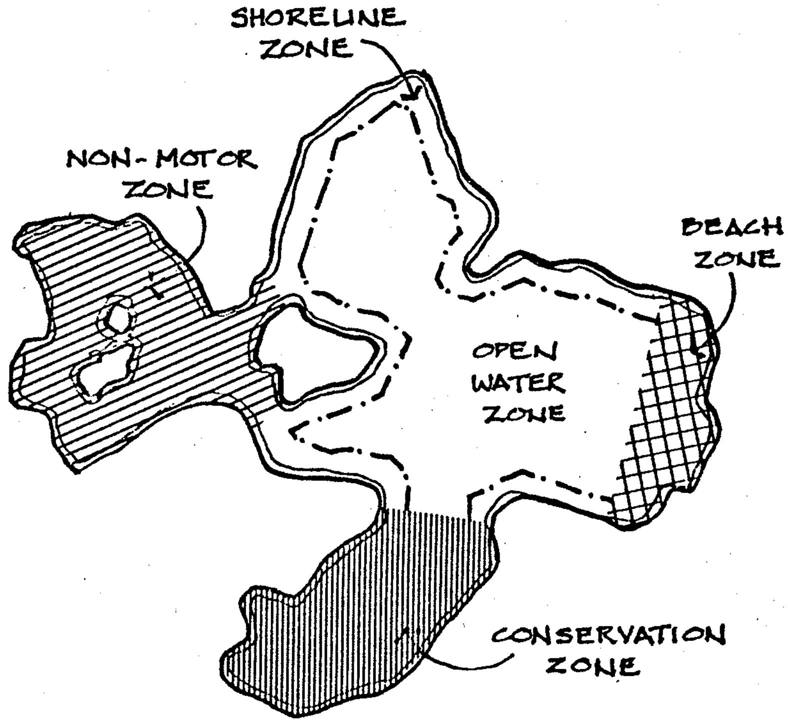
open water zone - the area of lake surface away from the shoreline, free of congestion and hazards where there are no restrictions on boating activity. Usually the largest zone of the lake.

non-motor zone - areas where no motorized traffic is permitted because of potential conflict with other, more tranquil uses eg. isolated bay suitable for nature viewing by canoe.

conservation zone - areas where boat traffic is restricted because of their sensitive nature eg. fish habitat, shallow water areas.

beach zone - an area surrounding a public beach where boating is restricted to prevent conflicts with bathers.

shoreline zone - a band of water around the shore (eg. 75 metres wide) where motor boat travel is permitted only perpendicular to the shore to reduce wake damage and conflicts with shoreline use.



Delineation and enforcement of zone regulations may be achieved by marker buoys, signage, lake user pamphlets and fines.

Speed limits may be used to control boat traffic in areas prone to congestion, such as narrow channels.

Horse power restrictions on boat motors can be used to control the more space-consumptive boating activity such as water-skiing.
Such a restriction would be most appropriate, on a lake-wide basis, for smaller water bodies and those designated for more primitive development.

While regulation of on-water behaviour through the application of such methods has significant potential for decreasing user conflicts and increasing the total boating capacity of a lake it should be recognized that enforcement of such regulations can be difficult. It is important, therefore, not to rely solely on water zoning and other regulations to control surface use but to address these issues elsewhere in the planning process (eg. carrying capacity).

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Discussion

Sport Fishing is a very important recreational activity in Manitoba. An estimated 250,000 Manitobans participated in this acivity in 1980/81 contributing $21 million in net benefits to the provincial economy. An additional $14 million in net benefits was contributed by non-resident anglers. (Manitoba, 1981) A 1972 study estimated that 380 of every thousand Manitobans participates in recreational fishing. (Manitoba, 1978.) A 1973 study of Whiteshell Provincial Park users found that fishing was second only to swimming in popularity as a recreational activity. The same study found that more than 80% of Whiteshell cottagers fish. (Manitoba, 1975). The importance of angling to cottagers and non-cottagers requires that care be taken to preserve this valuable resource when planning cottage development.

Cottage development can have both direct and indirect impacts on a lake's fishery. Direct impacts are in the form of angling pressure and disturbance by on-water activities. Indirect impacts are in the form of alterations of fish habitat: destruction or damage of spawning, nursery, and feeding grounds; changes in lake trophic state.

DIRECT IMPACTS

The provision of road access to a previously isolated waterbody usually stimulates a surge of angling activity. The increased angling pressure causes a rapid decline of game fish populations. The pressure continues until such time that the catch-per-unit-effort declines to levels similar to those of neighbouring lakes. While it is unlikely that this will lead to the total extirpation of game fish, the quality of the sports fishery will be severely reduced. Short of restricting all angling there is not much which can be done to prevent this decline. In the eyes of fisheries managers "opening-up" a lake for cottaging is tantamount to "writing-off" the sports fishery.

Development on lakes with access increases angling pressure by introducing a resident population of anglers. Coldwater (trout) fisheries are particularly sensitive to increased fishing pressure because of the lower productivity of oligotrophic lakes.

Active human on-water activity (swimming, boating) can disturb fish in shallow water areas with noise, turbulence and wave action, interfering with feeding and reproductive activities.

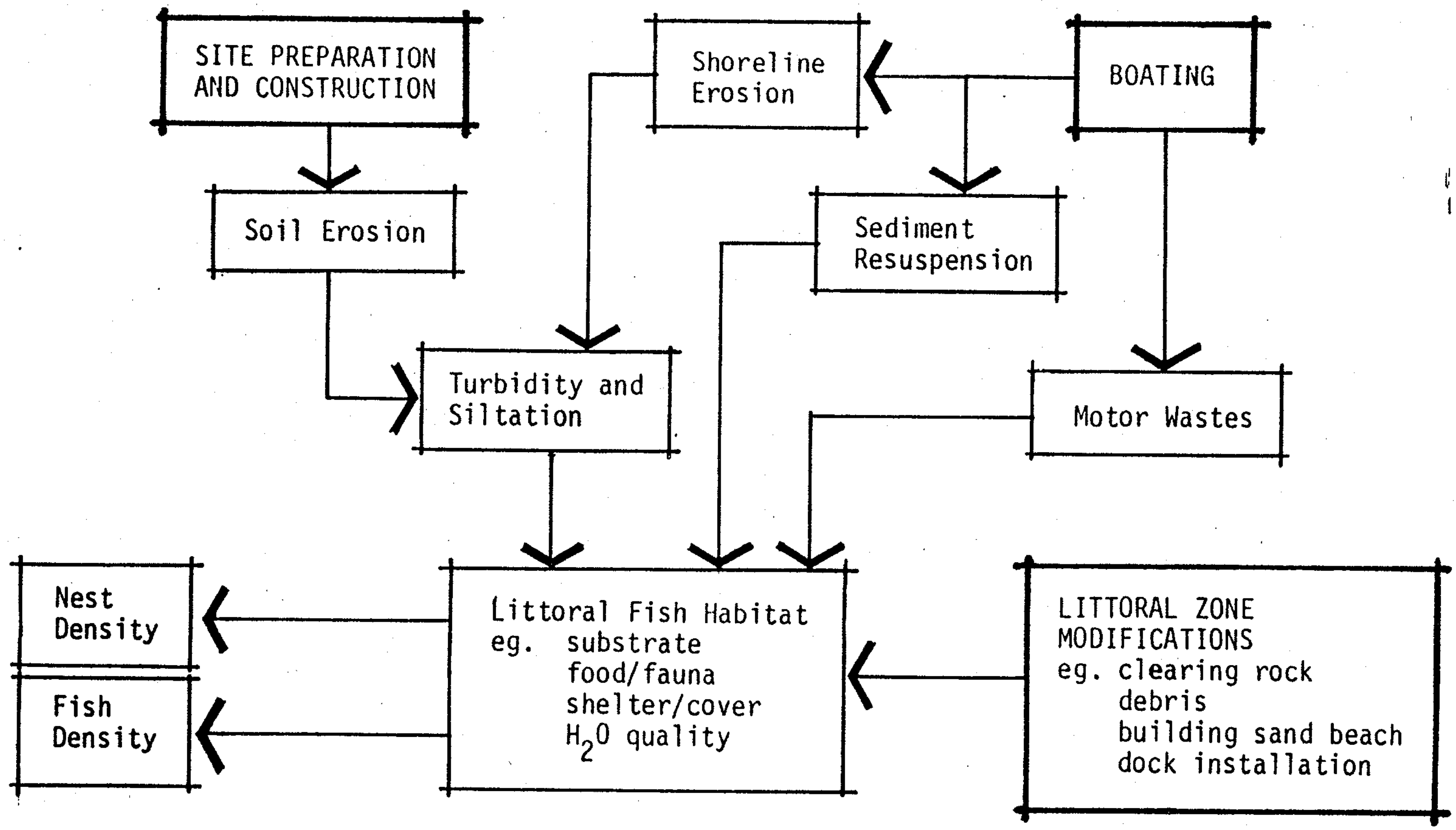
INDIRECT IMPACTS

Artificial enrichment of a waterbody caused by development can lead to depletion of dissolved oxygen in the bottom waters of a lake making it unsuitable for coldwater fish species. In more extreme cases artificial enrichment can lead to summerkill or winterkill conditions. In such cases the total game fish population is extirpated and will not be replenished naturally unless the lake is connected by river to a source of fish stock.

A lake's littoral zone (shallow shore waters) and streams are important spawning, nursery and feeding habitat for many fish species and are susceptible to damage by recreational development. Erosion resulting from construction and poor land management can cause siltation of fish eggs and turbid conditions. Road construction over streams causes increased erosion and siltation. Improperly placed culverts impede reproductive activities. Clearing of "nuisance" aquatic vegetation and creation of artificial sand beaches to improve swimming areas can destroy the suitability of the site for reproduction and feeding. Shoreline development usually removes riparian vegetation, deadheads, etc. which provide valuable shade and protection.

Guidelines

Impacts on fish populations can be reduced through sensitive planning and design. The process begins with an assessment of the fish resource. This involves three tasks: description of the resource; inventory of habitat; and determination of lake productivity.



PATHWAYS OF POTENTIAL EFFECTS OF LAKESHORE DEVELOPMENT ON LITTORAL HABITAT

(Ontario, 1980)

FIGURE 3.15

RESOURCE DESCRIPTION

Determine the species which are found in the lake and are capable of natural reproduction (ie. not introduced species such as rainbow trout). Also determine the lake's viability as sport fishing habitat (ie. deep water dissolved oxygen, history of fish kills).

Information can be obtained from Fisheries Branch records and the District Fisheries Manager.

HABITAT INVENTORY

With the assistance of the District Fisheries Manager determine areas important as spawning, nursery and feeding areas. Fish species prefer different locations for reproduction according to substrate, cover or other requirements. Habitat preferences also change depending on stage in the life cycle. In general, critical habitat are littoral zone areas, shoals and running water.

Determine areas of potential conflict between cottage development and the fishery. Preferred shoreline for cottages and public bathing facilities are generally weed-free sand and gravel beaches or bedrock. These areas are less important as feeding and nursery sites, but Centrachid species select sand and gravel beaches for nesting sites. However, provided the substrate is not altered, Centrachid spawning should not be affected by development as reproductive activity usually occurs prior to intensive summer cottage use.

SPAWNING GROUND CHARACTERISTICS, ENVIRONMENTAL REQUIREMENTS AND PARENTAL BEHAVIOR OF SOME MANITOBA SPORT FISH SPECIES

	Water temperature at spawning	Spawning date	Depth of spawning area	Spawning subtrate preference	Parental behavior
smallmouth bass (Micropterus dolomieui)	16°-18°C	late May-early July	0.5-6m	gravel, rock	male guards the nest and young
lake trout (Salvelinus namaycush)	9°-13°C	October	up to 13m	large rubble or boulder	eggs fall into rock crevices, parents leave immediately
brook trout (Salvelinus fontinalis)		Sept.-Oct.	up to 1m	gravel beds in flowing water	female covers the eggs with gravel
yellow perch (Perca flavescens)	6°-12°C	April-eary May	up to 3m	vegetation, submerged brush	eggs laid in strings and left unattended
walleye (Stizostedion vitreum)	7°-9°C	April - May		rock or coarse gravel shoals in running water	eggs fall into rock crevices, parents leave
northern pike (Esox lucius)	5°-11°C	April-early May	up to 1m	vegetation	eggs randomly scattered and left

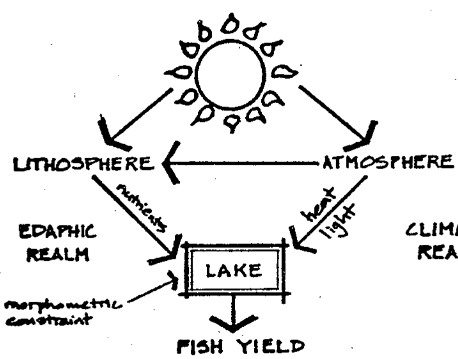
adapted from Ontario (1980).

FIGURE 3.16

Conflicts are most likely to occur when development is located adjacent to other types of littoral habitat (eg. rocky and weedy areas, streams) or where these habitat areas are disturbed by boating activity.

LAKE PRODUCTIVITY

A given lake can only produce a certain annual yield of fish depending on fertility of the water and other limnological characteristics. Lake productivity is influenced by three primary factors: climate; geology of the watershed; and morphology of the lake basin. Climate and watershed geology are fundamental in determining the temperature and nutrient regimes of a lake. The size and depth of a lake basin have a mediating effect on productivity.



SCHEMATIC REPRESENTATION OF AN AQUATIC ECOSYSTEM

Ryder, 1982

FIGURE 3.17

Smaller and shallower lakes are generally more productive, having a greater proportion of their substrate in the euphotic zone than larger and deeper lakes.

A method for estimating the potential fish yield of a lake was developed by R.A. Ryder in 1964. (Ryder, 1965) Ryder called his method the morphoedaphic index (MEI) because it uses a morphometric variable (mean depth) and an edaphic variable (total dissolved solids) to predict lake productivity. The relationship is expressed as an equation:

$$Y = R \frac{TDS^Q}{\bar{Z}}$$

where Y = annual weight of fish produced per unit area
TDS = total dissolved solids
$\bar{Z}$ = mean depth
R&Q = empirically determined constants

The MEI can be used to determine a lake's capacity to sustain angling. Angling capacity gives an indication of the level of recreation development a lake can support. This method is described in the carrying capacity section.

PLANNING AND DESIGN IMPLICATIONS

All cottage development will have some impact on the fishery. This impact can be controlled by protecting important habitat and restricting numbers of people. The degree to which the fishery should be protected will depend on its value as a commercial and recreational resource. The need for protection will be high if the lake supports a tourist lodge or is popular with local anglers. On the other hand, preservation of the fishery may be given a low priority in order to satisfy cottaging demands and relieve pressure on other, more important, angling lakes.

As a rule, important habitat areas should, where practical, be designated as "no development" or "controlled development" zones. In these areas cottages might be restricted entirely or permitted with the stipulation that no alterations of the shoreline and littoral zones will occur. (eg. backshore cluster development.) Shallow water bays and channels can be delineated as fish sanctuaries where fishing and motorized boat traffic are not allowed.

It is important to maintain a diversity of littoral habitats. The greater the variety of habitats on a lake, the greater is the variety of prey organisms and the greater is the range of fish species and size classes it can support.

Roads should be planned to avoid crossing streams. Where stream crossings are unavoidable they should be constructed to minimize negative impacts. Refer to Fisheries Branch publication: Recommended Fish Protection Procedures for Stream Crossings in Manitoba. Development areas should be set back from streams and sufficient natural buffers planned to control erosion and runoff.

Where preservation of the sports fishery is considered of equal or greater importance than cottaging, development should be planned so that the lake's angling capacity is not exceeded. Refer to carrying capacity section.

Lakes having fisheries sensitive to changes in dissolved oxygen levels (eg. lake trout lakes, summerkill and winterkill lakes) will require controls on development to prevent nutrient loading (eg. holding tanks, cutting restrictions).

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wildlife

Discussion

Cottage development can have a significant effect on wildlife populations, especially in areas where, prior to development, human activity was low. Cottaging generates noise, vehicle movements, etc. which may disrupt normal behavior patterns of some species, the most serious effect being reduced reproductive sucess. Game species may be subjected to new and intense hunting pressure as a result of improved access. Cottage development impacts indirectly on wildlife through alterations of habitat such as brush clearing, site grading, and water level controls.

Wildlife habitat is composed of food, cover and water. Riparian zones offer one of these critical habitat components and often all three. Lakeshores are also a significant source of edge condition and species diversity within the forest ecosystem. On the prairie, wooded lake shorelands function as wildlife oases. Obviously, the shore-water interface is important habitat for many wildlife species. As shorelands are also important for recreation, the potential for conflict is high.

Guidelines

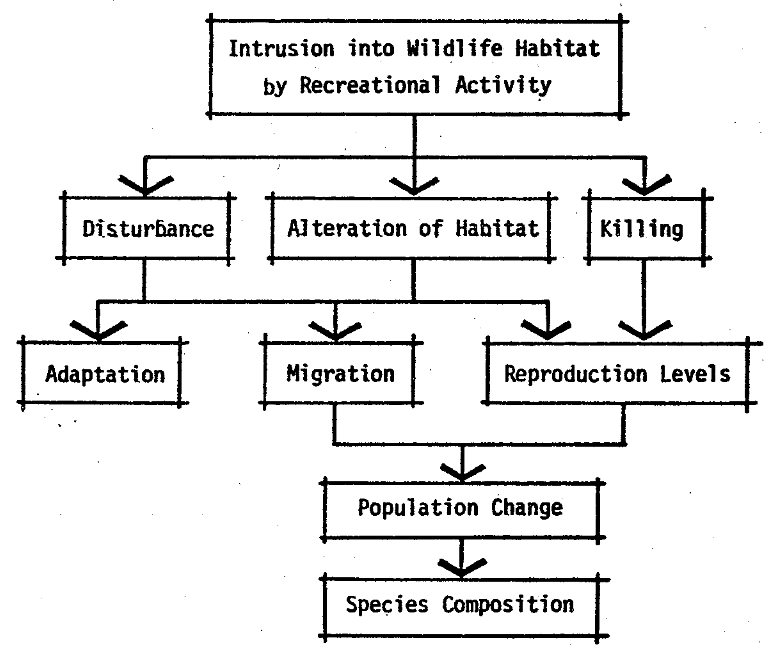
The impact of cottage development on wildlife is dependent on:

a) the size and density of development
b) the type, degree, and duration of disturbance
c) the sensitivity of individual species

As the area of a development, its density and the degree of site manipulation increase so does the impact on habitat. The effect of cottage development is to return a site to an earlier successional stage, possessing fewer habitats for animal species associated with more mature ecosystems.

The impact of development is usually confined to the limits of the disturbed area, with the species most affected by the development being those whose home ranges are lost. Provided areas of shoreland remain undeveloped and development does not damage critical habitat (eg. deer yards, travel corridors, colonial nesting sites) the impact will remain localized.

As the volume of activity generated by cottage development increases, disturbance of wildlife becomes greater. High speed boating generates noise and wake which disturb water fowl and riparian mammals. All terrain vehicles and snowmobiles extend disturbance into backshore areas. Intense cottage activity is usually restricted to a two or three



IMPACTS OF RECREATION ON WILDLIFE

FIGURE 3.18

(Wall and Wright 1977)

month period during the summer. When this period of activity lengthens, particularly into the winter months when many wildlife species are already under stress, the impact of disturbance becomes more severe.

Some animals adapt reasonably well to human presence and remain at almost the same numbers as prior to development. Other species, the so-called "urban" species increase as a result of human activity. Still others are very sensitive to human presence (eg. moose) or their behaviours seem incompatible with human activity (eg. loons). Species which are dependent on the shore-water interface are usually most dramatically affected. The habitat preferences of some wildlife types and their compatibility with humans are described in the appendix.

The impact of cottage development on wildlife can be controlled by three approaches:

1. conservation zoning
2. site planning and design
3. development controls and regulations

CONSERVATION ZONING

Zoning is used to delineate areas to preserve wildlife habitat and protect sensitive species. Within these areas cottage development may be restricted and certain activities, such as power boating, excluded. Zoning should not preserve just unique and sensitive habitats. Areas representative of the various habitat types existing on the lake should also be retained in a natural state. Designation of representative habitat will require information about species present on the lake and their habitat requirements.

Species requiring protection will include: unique, rare and endangered species; species easily disturbed by human presence; and species which depend on habitat easily damaged by human activity.

A partial list of sensitive habitat requiring protection is given below:

wetlands
sheltered marshy bays
streams and rivers
islands
rock cliffs
deer and moose yards
colonial nesting sites
raptor nesting sites
migration corridors

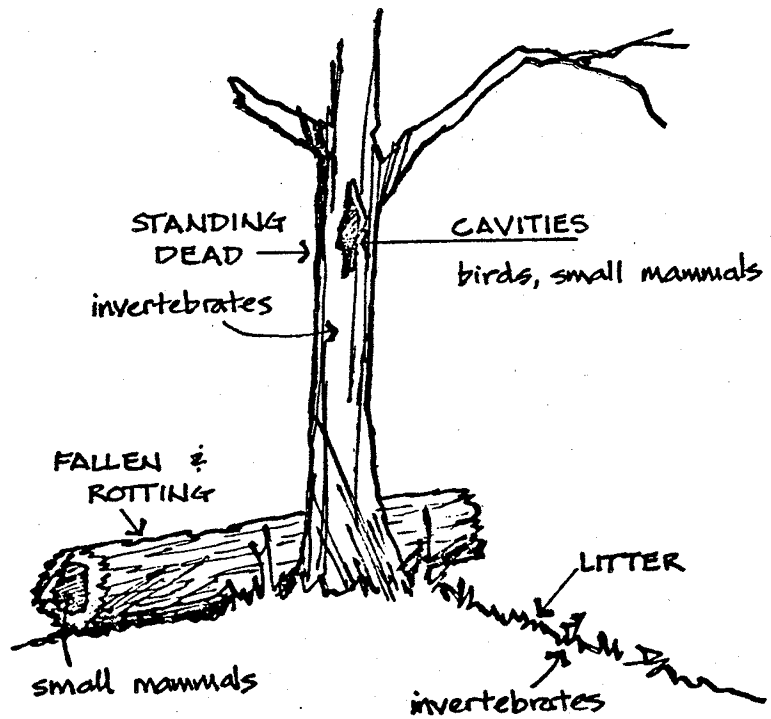
Contact the local conservation officer and Regional Wildlife Manager for assistance in identifying species present and sensitive habitat. CLI Wildlife capability mapping will give a rough indication of habitat productivity for waterfowl and ungulates.

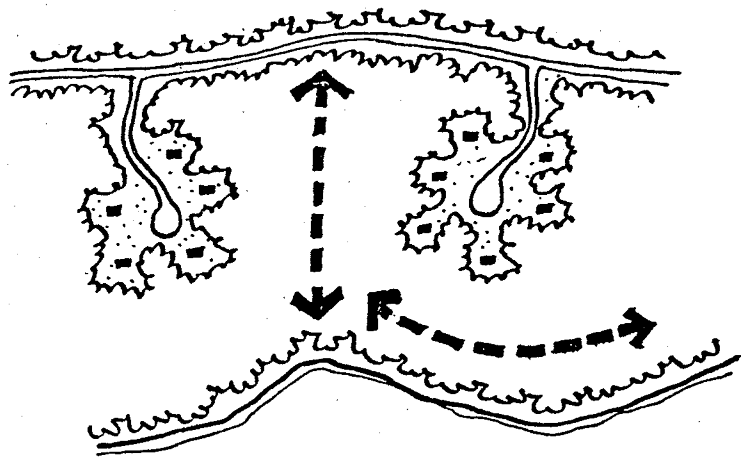
Conservation zones have recreational potential for wildlife viewing and nature interpretation. However, human intrusion into some of these areas such as bird colonies, and waterfowl nesting sites can be harmful.

SITE PLANNING AND DESIGN

Sensitive planning and design of cottage development can reduce localized impacts on wildlife. Cottage owners, generally, tend to spend much effort "cleaning-up" brush on their properties. The removal of snags, fallen and decomposing trees, and forest litter greatly reduces habitat for many species of small mammals, invertebrates and birds. The area affected by such effort is concentrated, primarily, in the vicinity of the dwelling and between the dwelling and desired view. Therefore as density increases the proportion of forest left undisturbed decreases.

Higher density development should be clustered to maintain natural vegetation between built-up areas. Ribbon development should be broken into clusters as well providing natural areas which permit wildlife access to water. Maintenance of a shoreland reserve will reduce manipulation of the shore-water interface and facilitate wildlife movement along the shore. Road right-of-ways should be developed and maintained to permit the growth of more natural edge conditions.

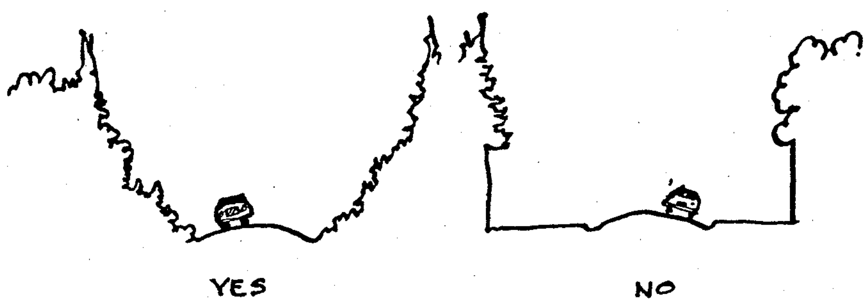




DEVELOPMENT CONTROLS AND REGULATIONS

Activity associated with cottage development can be controlled through lake-wide and site specific regulations. For example, disturbance of sensitive species by power boats may be controlled by restricting speeds or engine horse power. Snowmobile and ATV use can be limited to certain seasons and areas or banned altogether. The duration of disturbance can be reduced by controlling seasonal use of cottages. This may be achieved by restricting plowing of roads and through lease restrictions which prevent winterizing of dwellings.

The degree to which the wildlife resource should be protected will depend on: the importance of habitat in the regional ecosystem; the value of the wildlife resource in general (eg to wildlife management programs); unique, rare or endangered species; and the value of wildlife to the cottage experience.



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visual resources

Discussion

The scenic quality of a lake and its shorelands are very important in determining the overall attractiveness of a lake for cottaging. Much of one's enjoyment of the total "cottage experience" relies, at least in part, on the visual sense. Viewing may be active (eg. sight-seeing from a boat, wildlife viewing) but is more often a passive aspect of some other activity (eg. sunbathing, fishing).

The visual resource is comprised of more than general views of the lake basin as seen from the cottage or boat. Natural and man-made features of historic, scientific or scenic value can greatly enhance the cottage experience. A view may be ephemeral, such as a sunset or fall colouration or it could be detailed and small scale, such as colourful fungi or lichen.

While cottage development should be planned to take advantage of a lake's scenic resources steps are also required to ensure that new development does not impair the visual quality of the lake. Insensitive development can destroy sensitive scenic features and be a blight on the landscape.

Guidelines

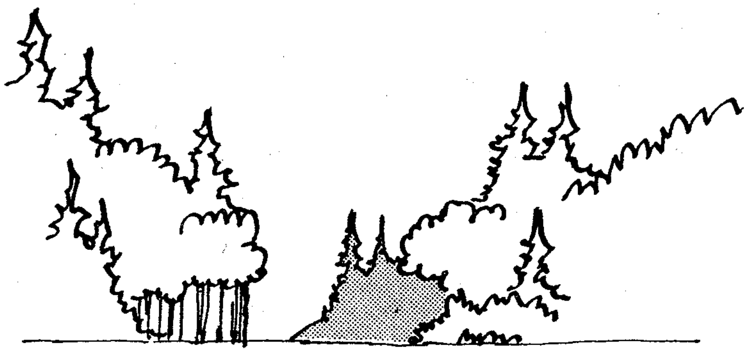
Management of the visual resources involves two tasks: the identification and preservation of significant scenic features; and the planning and design of new development to minimize negative visual impact.

SIGNIFICANT FEATURES

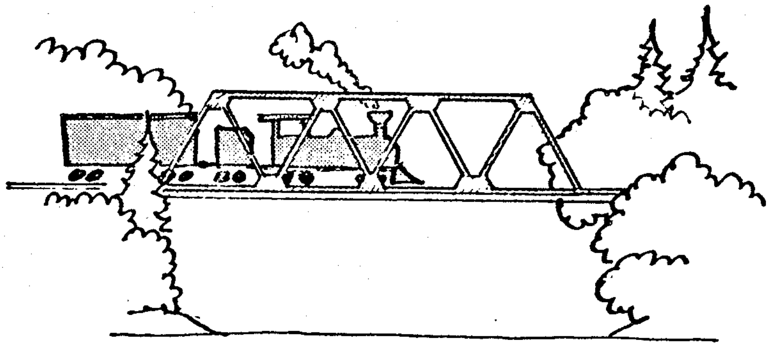
Significant scenic features are those elements of the landscape which contribute to the scenic quality of the lake for the benefit of all users and which would be impaired or destroyed by cottage development. Included would be natural and man-made features, views and veiwpoints.

The designation of landscape elements worthy of preservation is, more or less a subjective decision on the part of the lake planner. There are, however, certain features of lakes and shorelands which are commonly held in high regard by people. The following list is offered as a guide:

narrow channels
headlands and promontaries
rocky cliffs and overhangs
unique geologic features
small bays
small islands
waterfalls, streams
marshes and wetlands
unique vegetation
panoramas
viewpoints



significant features may be natural or man-made



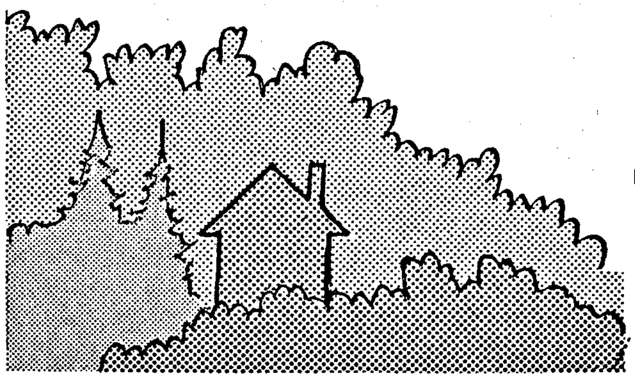
Man-made features deserving preservation might include old dams and other structures, abandoned homesteads, and rock paintings.

The best method for identifying scenic features is by field inventory in conjunction with discussion with local residents and Natural Resources regional personnel.

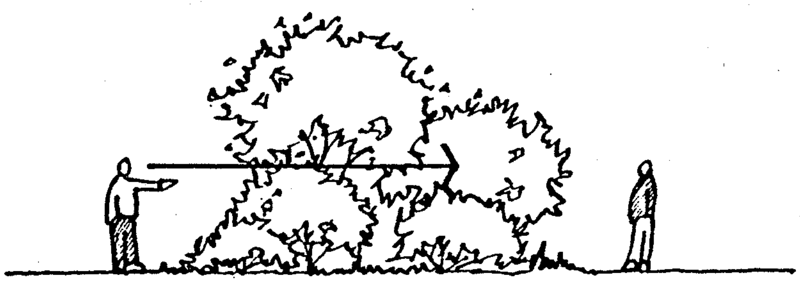
VISUAL IMPACT

The visual impact of cottage development should be considered from two aspects: from the lake or opposite shore; and from within the development itself. Poorly planned development can impair the view from other cottages or alter the character of a particular part of the lake. When a site has insufficient natural screening between dwelling units the privacy of outdoor areas is reduced and people may feel crowded.

Two concepts useful to discussions of visual impact are visual absorbtion and visual penetration. The former is the ability of the landscape to visually absorb cottage development, or, put another way, it is the ability of cottage development to "blend-into" the landscape. One should think in terms of the ability of a grouse to become lost to sight against a backdrop of dried grass. Visual penetration is the ability of the eye to penetrate vegetation or topography to perceive an object. The vegetation or topography acts as a screen or wall. In this case the "camouflage" is akin to the duck hunter's blind. Visual absorbtion operates primarily over long distances such as shore viewing whereas visual penetration is the dominant



VISUAL ABSORBTION



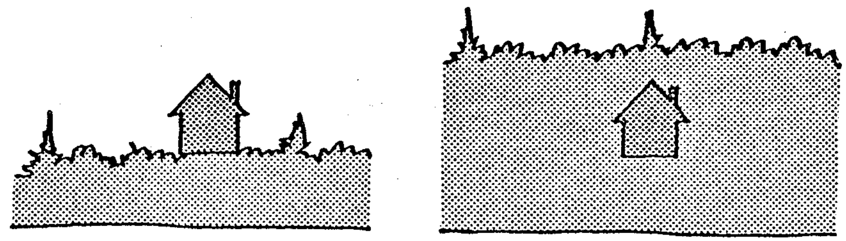
VISUAL PENETRATION

modifier of short-distance viewing such as within a development.

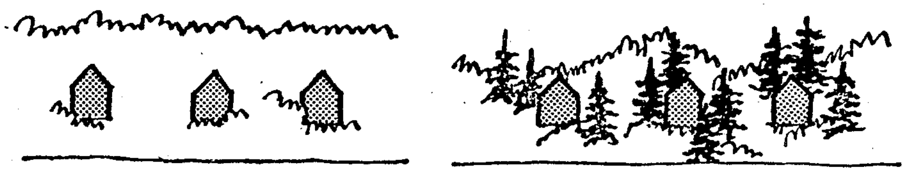
Visual Absorbtion

Visual absorbtion is a function of landscape character, viewing distance and development character. Landscapes which are more visually complex and provide backcloth to development tend to have greater visual absorbtion potential. Visual complexity is defined by the amount and clarity of visual information which must be sorted and evaluated by the viewer. More diverse vegetation (species, height) and topography increase visual complexity. Backcloth is provided by dense vegetation and landforms which visually enclose the development. Against the backcloth the edges of structures and their forms are less easily perceived.

As distance increases between viewer and subject detail is lost, edges become obscured and colour looses its hue. The average maximum range for the identification of most development types is 1 kilometre. Most people cannot discern human activity at this distance.



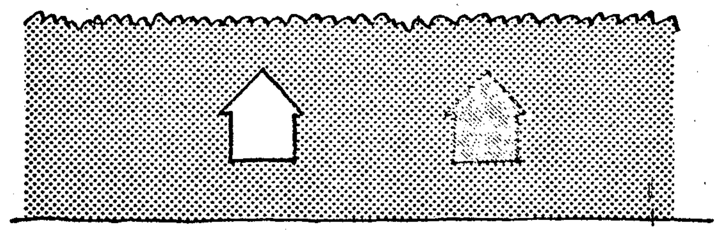
BACKCLOTH



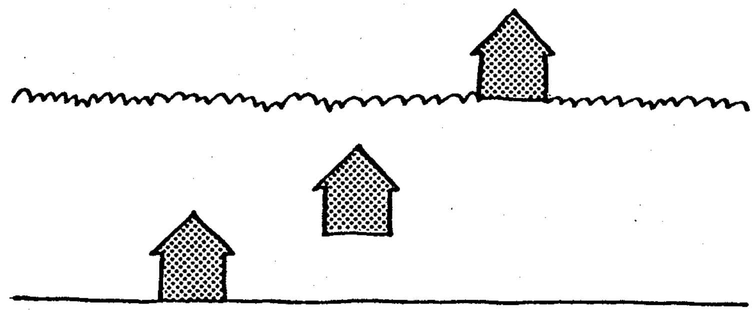
visual complexity increases absorbtion

The characteristics of cottage development such as colour, location, form and size, can be the most important determinants of visual absorbtion. A garishly coloured cottage or a structure located at the crest of a hill significantly lowers visual absorbtion potential. Extensive clearing of underbrush and canopy effectively eliminates much of the absorbtive capacity of a site.

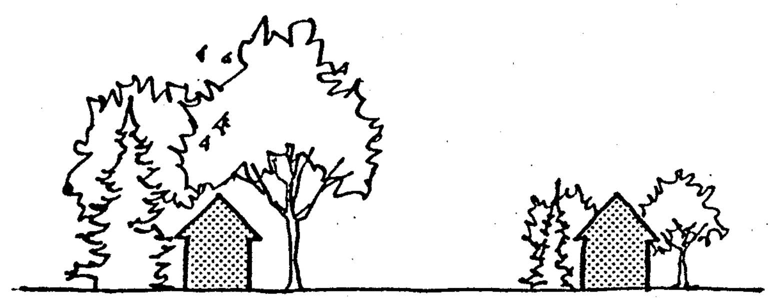
Cottages which are dark coloured or brown coloured tend to be less apparent than cottages which are painted with light or bright colours such as white, red, pink or blue. Cottages set back from shorelines are less apparent than those right on the shoreline. Geometric forms contrast more sharply than naturalistic forms which follow landform and vegetation pattern. Visual absorbtion is affected by the apparent scale of cottages relative to vegetation. Large trees with a strong, high canopy provide more visual absorbtion than low scrubby material.



COLOUR



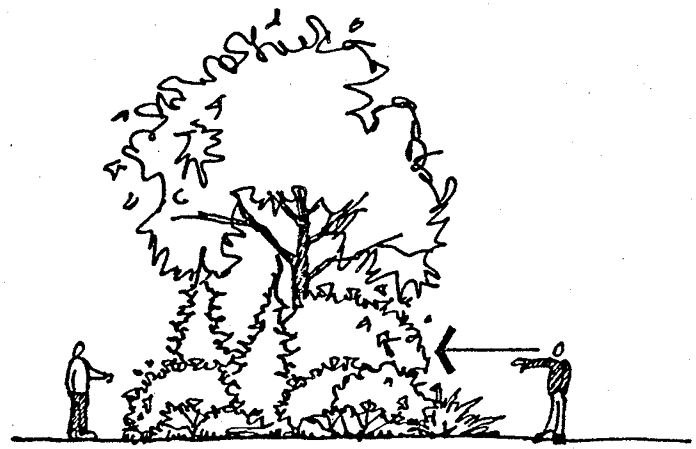
LOCATION



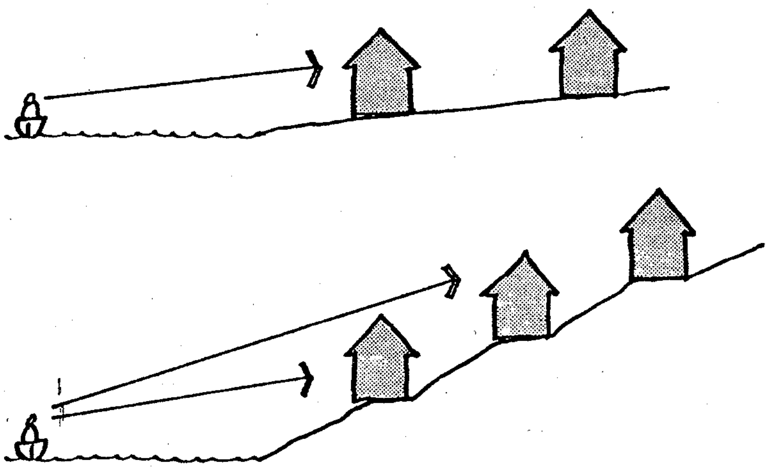
RELATIVE SIZE

Visual Penetration

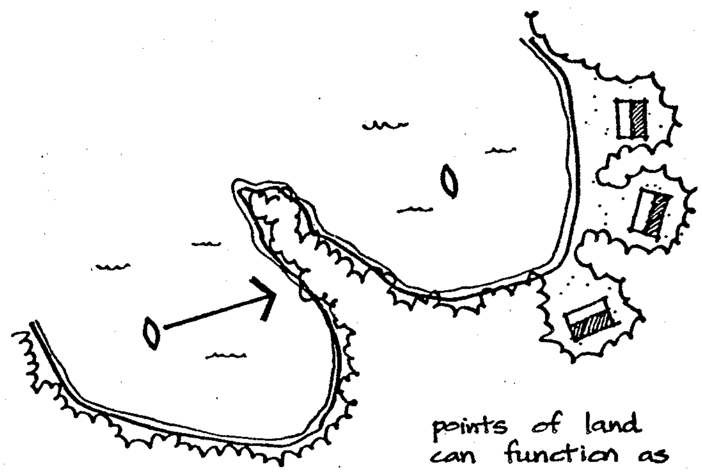
Visual penetration is a function of vegetation density and topography. As vegetation becomes more dense it becomes a better visual screen. The best screen is provided by a vigorous growth of deciduous and coniferous understory. Topography acts to conceal or reveal development. Tiered development on steep shoreland is more easily seen than similar development on gently sloping terrain. Islands and points of land function as visual barriers separating segments of a lake.



The best visual screen is a dense deciduous/coniferous understory



visual penetration can increase on steep slopes



points of land can function as visual barriers

To summarize, planning and design to reduce visual impact requires the following:

1. Where possible, cottage development should be located on sites with high potential for visual absorbtion.
2. Higher density developments, where screening between units is more critical should be located on sites with good natural screening.
3. New development should be located so it is visually separated from existing uses. Islands and points of land, which serve to visually separate uses, should not be developed.
4. Development should avoid sensitive scenic areas.
5. Development occurring within 1 km viewing distance of another development or at other locations where the potential for visual conflict is high will need greater care in the siting of buildings and possibly regulations controlling setback, land clearing and colour of structures.

Sources

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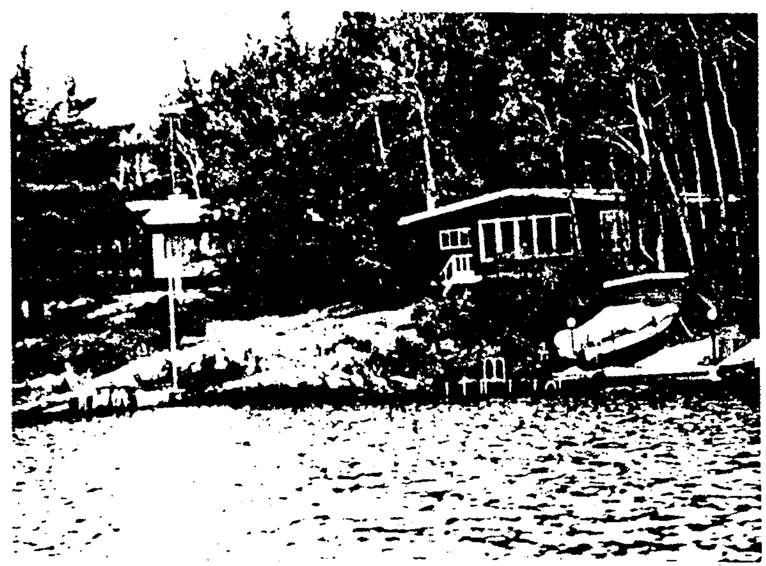
Development Capability

Discussion

Development capability is a reflection of site tolerance to disturbance and the relative ease of site development and management (assuming equal accessibility to all landscape units). Higher capability lands generally support more intensive use, will require fewer site improvements and less site management. The development of higher capability lands will ensure a greater degree of environmental protection. Lower capability lands can still be developed but can only support low intensity use. Development of these lands will require more careful design, and more intensive management thus increasing development costs.

The development capability of a site is dependent on many variables including slope, soil type, soil depth, drainage and vegetation. As the relationship between these variables is complex a method is required which integrates them to produce an overall capability rating. Such a rating facilitates comparisons between shoreland areas and the priorization of development sites.

This section outlines a procedure which permits quick and easy identification of sites with development capability, an essential step in the production of alternative plans. It provides a ready means of explaining to policy makers and the public the rational for selecting specific sites and also gives an indication of the potential costs of site development.



Guidelines

During resource inventory and analysis the shoreland areas were mapped to show soil, slope and vegetation characteristics. This information is overlaid to produce landscape units, areas with similar slope, soil type, soil depth, drainage and vegetation. The five site characteristics are organized into classes(eg. slope, gentle moderage, steep) and each class is rated according to its relative significance as a limiting factor to cottage development.

<u>DEVELOPMENT CAPABILITY</u>

PARAMETERS		RATING
SLOPE	gentle 0 - 7%	1
	moderate 8 - 15%	3
	steep 16+	6
SOIL TYPE	SL, L, SCL	1
	CL, SC, SiL*, LS**	3
	S, C, SiCL, SiC	6
	Si, HC, Pt, organic	10

* add 1 when SiL associated with moderate slope
add 2 when SiL associated with steep slope
add 1 when CL, SC, SiL associated with moderate drainage
** add 1 when LS associated with rapid drainage

PARAMETERS		RATING
SOIL DEPTH	200cm	1
	100 - 200cm	2
	50 - 100cm	6
	50cm	10
DRAINAGE	well drained	1
	moderate, rapid	3
	poor	6
	very poor	10
VEGETATION	high diversity ***	1
	moderate diversity	2
	low diversity	6

*** species and age class diversity.

FIGURE 3.19

Development Capability Classes

The ratings for each landscape unit are summed to derive a total score which reflects site capability for development: the lower the score, the higher the capability. To make the scores more managable they are assigned to Development Capability Classes, each one encompassing a range of scores which generally reflect a similar level of constraint.

Development Capability Classes

Description		Score Ranges
A	good	5 & 6
B	fair	7 - 9
C	poor	10 - 13
D	v. poor	14+

Class A

- no or slight limitations to development
- capability for high intensity of use
- high tolerance to development
- capability for on-site waste disposal, potential for underground servicing
- ease of vehicle movement

Class B

- slight to moderate limitations to development
- reduced tolerance to development
- on-site waste disposal may be possible
- vehicle movements could be impeded
- foundations may be more expensive

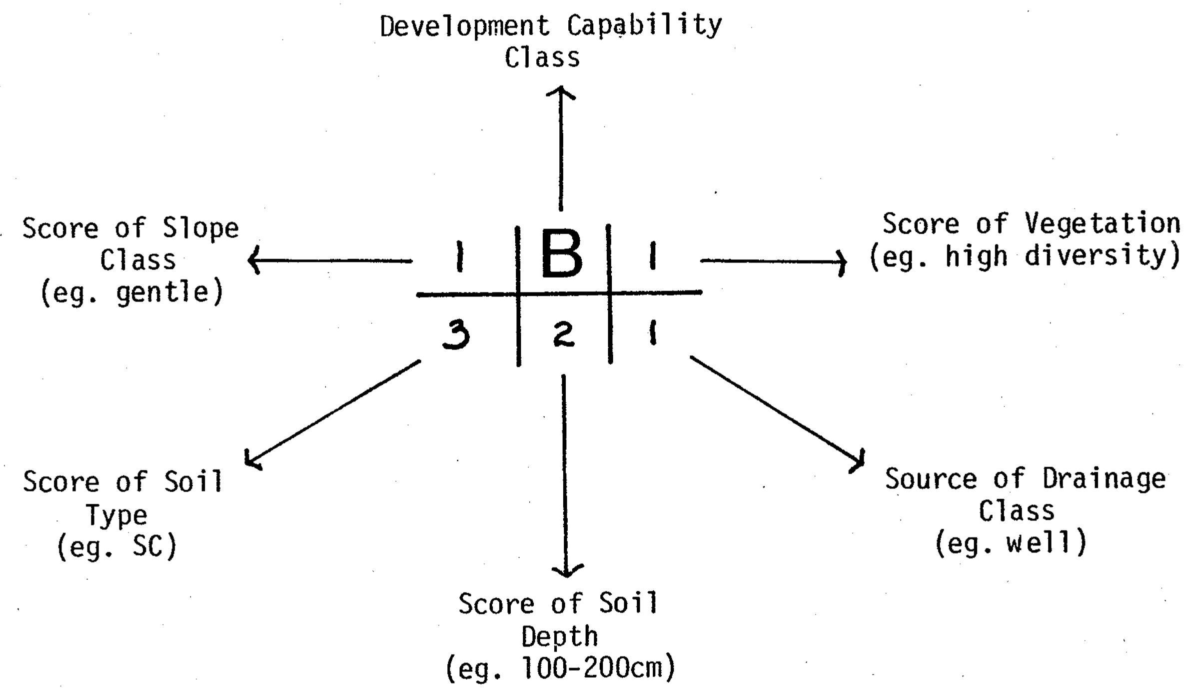
Class C

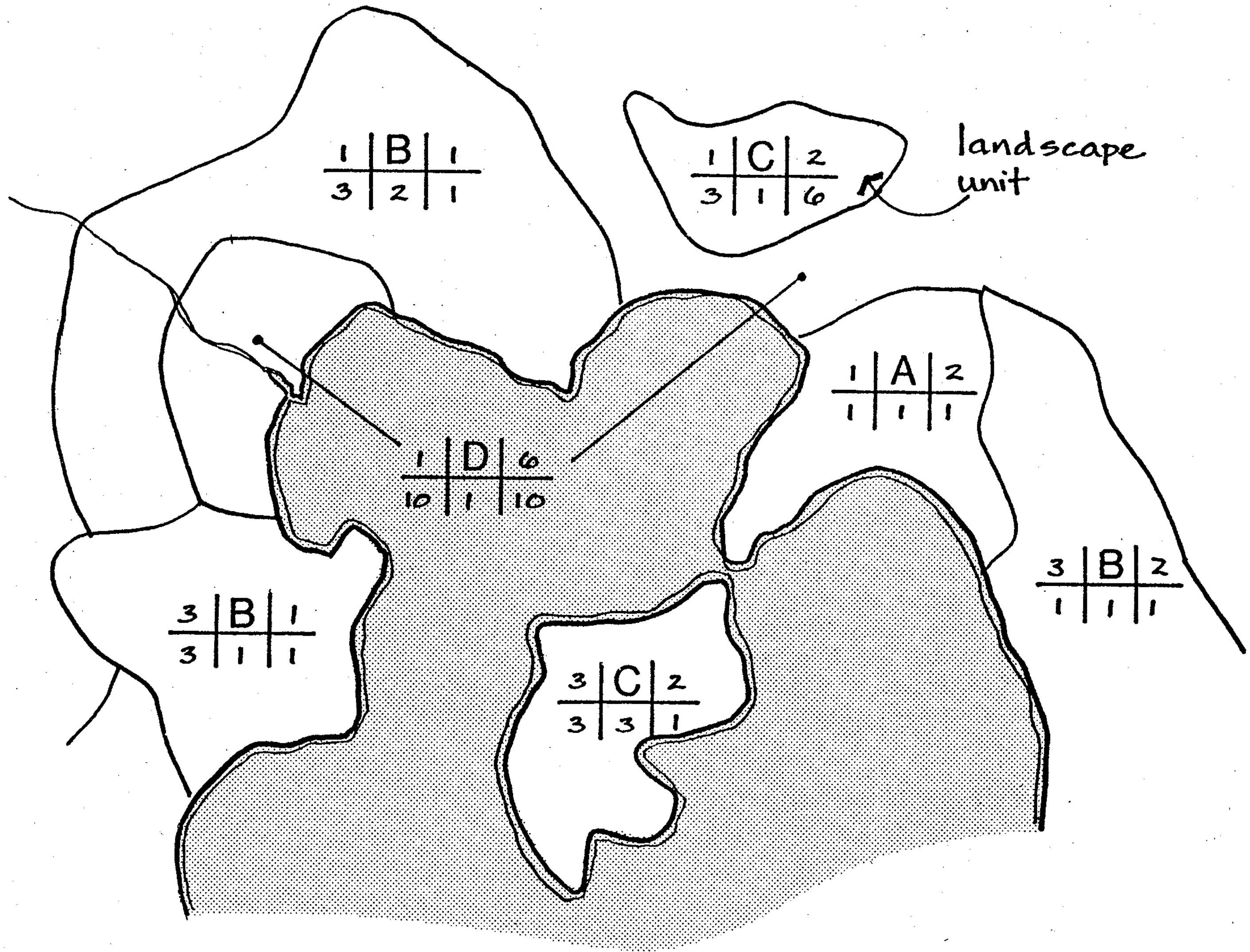
- moderate to severe limitations to development
- low development tolerance
- above average design and management required
- more care required when siting buildings
- vehicle access may be possible

Class D

- severe to very severe limitations
- very sensitive to development
- development is not feasible: site constraints are not overcome in practical terms (economic or environmental)

The capability class and slope, soil and vegetation scores are displayed for each landscape unit on the development capability map. This permits a quick review and indicates the characteristics of each landscape unit in a simple manner.





DEVELOPMENT CAPABILITY MAP

MODIFYING METHOD

The general nature of the methodology means that the capability rating may not accurately reflect site capabilities for specific uses. For example soils are not rated according to their suitability as a medium for sewage disposal by tile field. Class A development sites meet the minimum soil depth requirements for on-site waste disposal but may require imported fill to construct a tile bed.

When guideline users find that the capability formula does not accurately reflect local or regional terrain conditions or their specific needs they are encouraged to modify the parameters and ratings as required.

While the development capability rating is based on five parameters only, the capability of a site can be determined by many additional factors eg. availability of water supply, presence of disease-susceptible vegetation, shoreline, etc. This points out the need to undertake a more detailed analysis of potential development sites once development capability is mapped.

Shoreline type can be a major determinant of site capability. However, because shoreline needs vary according to development form, it was not included in the development capability formula. Shoreline information can be overlain on the development capability map to assist in the process of site selection.

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Carrying Capacity

Discussion

Carrying capacity is a potentially valuable concept applicable to lake planning that has been used by recreation planners and resource managers to estimate acceptable levels of resource use. It is defined by Lime and Stankey (1971) as:

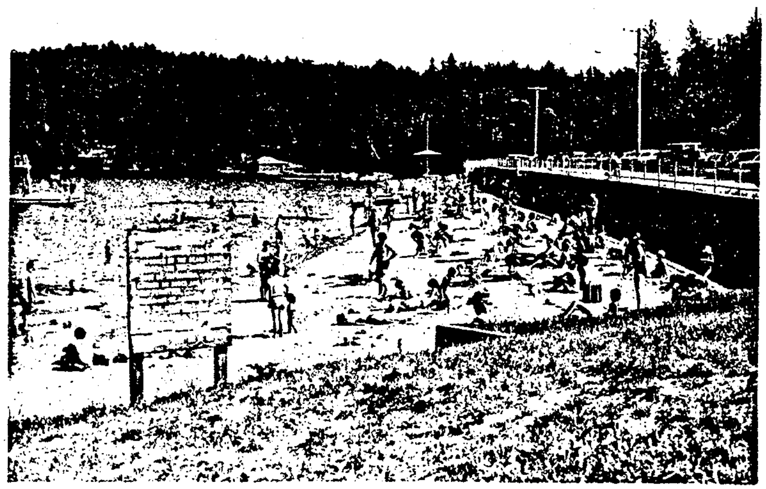
> the character of use that can be supported over a specified time by an area developed at a certain level without causing excessive damage to either the physical environment or the experience of the visitor.

Carrying capacity is concerned, therefore, with both the social and biophysical impacts of resource use.

There are three fundamental components of carrying capacity: quality objectives; the character of use; and the character of the resource. The components are interdependent and all three must be analyzed in order to determine carrying capacity.

QUALITY OBJECTIVES

Carrying capacity cannot be estimated unless minimum acceptable standards of use and environmental quality are defined. Objectives must be stated at the outset which describe the quality of environment and quality of the recreation experience to be maintained. These objectives are derived from the broader objectives of resource managers and the attitudes of resource users. Quality objectives are also dependent on the



character of the resource and the character of proposed use.

CHARACTER OF USE

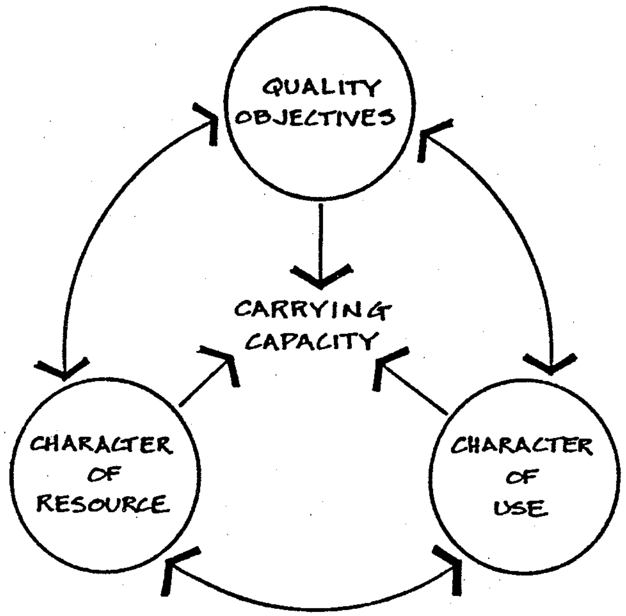
The character of resource use describes the type of activity proposed, including how, when and where it will occur. The character of use determines the types and degree of impact it will have on the resource and other uses. The character of the activity also determines minimum standards of use which must be maintained (eg. maximum permissable densities for human safety).

CHARACTER OF RESOURCE

The character of the resource (eg. biological, physical, chemical) determines its ability to withstand stress and absorb use. The inherent characteristics of the resource determine the quality objectives which are feasible (eg. the natural water quality).

A lake's capacity may be altered by managing any one of the three components: quality standards may be raised or lowered; impacts may be reduced by controlling the character of use through design and management and the resilience of the resource may be improved (eg. fish stocking, "hardening" of a site).

Carrying capacity is not a single value within which no problems or conflicts occur and beyond which lies total catastrophe. It is a multi-dimensional and dynamic concept capable of manipulation by resource managers. The need



for public participation is obvious. Resource users are often in a better position to decide what constitutes an acceptable quality of recreation experience or an acceptable degree of environmental deterioration. Furthermore, if given the option, resource users may choose voluntary behaviour modification over enforced restriction of use.

Four methods for estimating carrying capacity are outlined in this section. They are:

- boating capacity
- angling capacity
- trophic state capacity
- beach capacity

The methods are similar in that they are presented as mathematical equations which generate a capacity figure in development units. (A development unit is a cottage or its equivalent in terms of lodge beds or day use, determined on a regional basis.) Each calculation addresses a different aspect of lake use, but they will not always be applicable in every situation.

The results of the calculations may be compared to reveal the factor which is most likely to limit development. The capacity figures which are calculated should not, necessarily, be interpreted as absolute limits to the amount of use a lake can support. To begin with they are estimates, and their limitations should be acknowledged. Secondly, through design, management or reassessment of management objectives the lake's capacity can be increased.

Boating Capacity

The surface area of any water body has a limited capacity for boating. When this capacity is exceeded, conflicts may arise among various users: swimmers, water skiers, anglers, sailors, etc. Conflicts may be caused by both physical interference which creates hazardous conditions (eg. waterskiing and swimmers) and psychological interference (eg. still fishing and high speed boating).

Excessive boat use can also cause physical damage to littoral areas and the waterbody. Outboard motors can churn-up bottom sediments in shallow water areas causing increased turbidity and deterioration of fish habitat. Gasoline and oil from outboards can taint the water, particularly where boat traffic is heavy or in shallow, well-protected emboyments.

A method has been developed in Ontario to assess a lake's capacity for boating based on the size and configuration of the water surface and patterns of boating use and ownership. The method, usually referred to as the boat limit system, was developed for the Lakealert study (1972) based on earlier work by Jaakson (1968), Threinen (1964) and others.

While emphasis is on the spatial requirements of boating activity, factors such as public access, navigation hazards, shoreline characteristics and other recreation activities are integrated into the system.

Since boating is the most aggressive, space-consuming recreational activity occurring on lakes, as well as being one of the most popular activities, the system is a useful indicator of the capacity of a lake to support recreational development. The boat limit system does not consider land constraints and must be used in conjunction with an analysis of shoreland capability. This is particularly true in the precambrian shield where the capacity of lakes for boating usually exceeds the shoreland's capacity for cottages.

The method involves 5 steps:

1. Determine the surface area of the lake suitable for boating.
2. Determine total boat capacity.
3. Determine capacity available for new development.
4. Determine additional boat population permitted.
5. Determine permissable number of additional units.

1. DETERMINE THE SURFACE AREA OF THE LAKE SUITABLE FOR BOATING. (A_b)

Using an air photo or base map, plot areas of the lake where boating is to be restricted or discouraged or is unlikely to occur (eg. non-motor zone, conservation zone, shoreline zone, etc.). The following may be used as a guide:

200' wide protection zone around all lakeshore and all subdivided islands.

100' wide protection zone around all non-subdivided islands and navigation hazards.

400' wide protection zone around all marinas and public beach areas.

all open water more than one mile from shore (rarely used).

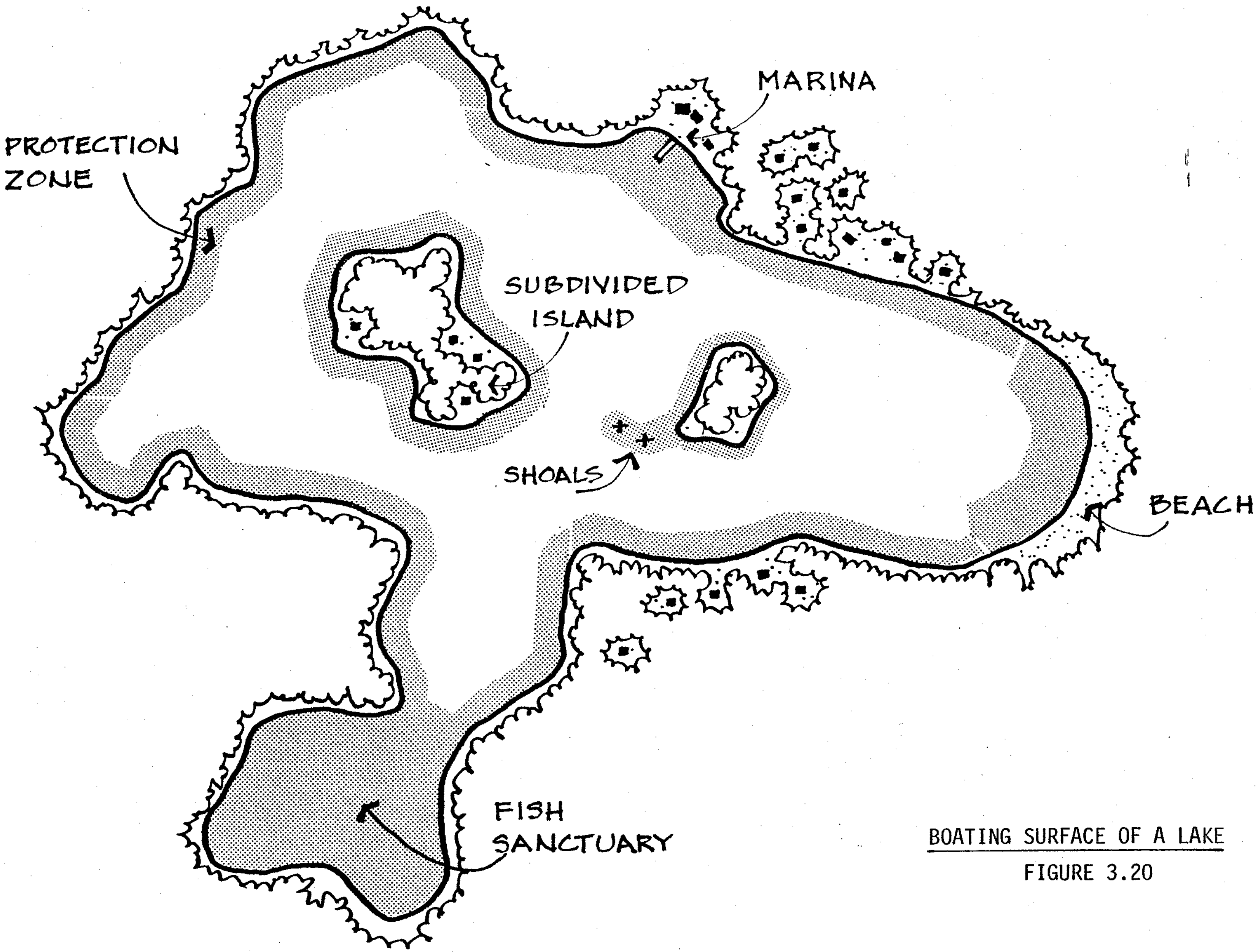
any other designated no boating zones eg. shallow bays, fish sanctuaries, etc.

Using a planimeter or dot grid, measure the area of useable water surface = A_b

2. DETERMINE TOTAL BOAT CAPACITY (B_t)

The total boat capacity, B_t is found by dividing the boating surface area, A_b by the area of water required by each boat for safe and enjoyable operation, A_x.

$$B_t = \frac{A_b}{A_x}$$



BOATING SURFACE OF A LAKE

FIGURE 3.20

The value of A_x is an average of the space requirements of various types of boating activity. A density of 1 boat per 10 acres ($0.4 km^2$) is commonly used. Regional differences vis a vis perceptions of crowding or the mix of boating types may require that this value be changed. A more accurate figure for A_x may be estimated by observing local and regional boating patterns to determine the mix of boating uses and the space requirements of each activity. For example:

Boating Type	% of Total		Space Requirement		Weighted Value
cruising	30%	x	15 acres	=	4.5
water skiing	15%	x	30 acres	=	4.5
sailing	10%	x	15 acres	=	1.5
trolling	20%	x	8 acres	=	1.6
still fishing	15%	x	1 acre	=	0.15
canoeing	10%	x	8 acres	=	0.8
average space required per boat=					13.05

3. DETERMINE CAPACITY AVAILABLE FOR NEW DEVELOPMENT (B_n).

The boat capacity available for new development, B_n is found by deducting the portion occupied by existing users, B_e from the total capacity B_t.

$$B_n = B_t - B_e$$

B_e includes boats on the lake from existing cottages, lodges and public use. It may be determined by direct observation of lake use during peak periods. Alternately, B_e may be estimated using the following methods:

public boats on lake, $B_p = N_p \times Q_p$

Where N_p = number of parking spaces at public access points.
Q_p = number of boats per parking space on lake at any one time (research has shown this value to be 0.4, equivalent to one boat per 2.5 parking spaces).

boats on lake from cottages, $B_c = N_c \times b \times Q_c$

where N_c = number of cottages
b = average number of boats per cottage
Q_c = percentage which can be expected on water at any one time (generally 10% - 25%).

boats on lake from lodges, $B_L = N_L \times Q_L$

where N_L = number of boats belonging to lodges
Q_L = percentage which are on water at any one time (expressed as %).

4. DETERMINE ADDITIONAL BOAT POPULATION PERMITTED (T_{ab})

The additional boat population which the lake can support, T_{ab} is estimated from:

$$T_{ab} = \frac{B_n}{Q_n}$$

where Q_n = the percentage of boats on the water at any one time (expressed as %).

5. DETERMINE THE PERMISSIBLE NUMBER OF ADDITIONAL UNITS (N perm)

$$Nperm = \frac{T_{ab}}{b}$$

where b = the average number of boats per cottage

Nperm is the capacity of the lake for cottage development assuming no change in public and lodge use. Where a change is expected (eg. as a result of improved access) the lake's capacity for cottages must be adjusted accordingly.

Angling Capacity

Angling capacity is based on the assumption that a lake can produce only a certain amount of fish flesh per unit area per year. Harvesting of fish in excess of this amount, over a period of years, will cause the reproductive stock to be depleted, and the fish population will diminish. Given the amount of fish a lake can produce, the capacity of the lake to support development can be found by dividing the annual production by the harvest taken by each development unit. (cottage or equivalent number of day anglers, lodge beds, etc.)

The foundation for the angling capacity calculation is Ryder's morphoedaphic index which is described in the fish section of this manual. Because of this, the calculation is subject to the limitations of the MEI. The morphoedaphic index was developed for a relatively homogeneous set of lakes and may therefore be inaccurate, without modification, for the following types of lakes: lakes in the northern part of the province; hypertrophic lakes; extremely turbid lakes; lakes experiencing extensive winter or summerkill; and lakes with excessive water level fluctuations. The index may still be applicable if calibrated for such atypical conditions.

Angling capacity becomes a limiting factor to development when maintenance of the existing sports fishery is an objective of the lake plan. Where the quality of sports fishing is secondary in importance to cottage development, angling capacity may be a minor consideration. However, developing in excess of a lake's angling capacity can lead to future fisheries management problems. The lower quality of angling may lead to dissatisfaction amongst lake users and demands for fish stocking and other management programs.

The steps required to calculate angling capacity are as follows:

STEP 1 DETERMINE THE ALLOWABLE ANNUAL HARVEST

1.1 Calculate the lake's morpho-edaphic index (MEI)

$$MEI = \frac{TDS}{\bar{z}}$$

where TDS = total dissolved solids (mg/l)

$\bar{z}$ = mean depth (metres)

1.2 Calculate the maximum sustainable yield for the total fish community (MSY_C)

$$MSY_C = 1.39\ MEI^{0.447}\ (kg/ha/yr)$$

1.3 Determine the optimum sustainable yield (OSY)

Research has shown that it is unwise to exploit a fishery to the level of the maximum sustainable yield. Fishing pressure sufficient to take an MSY_C made up of several species may have a greater impact on some species than others. In single species fisheries some stocks may be more affected than others. Also, exploitation to the full MSY_C fails to provide any margin of safety in the event of a weak year class. (Ontario, 1980) It is apparent, therefore, that some percentage of the MSY_C should be selected as a permissable yield to protect fish stocks.

Furthermore, angling capacity based on the MSY_C does not mean that fish yields will mee the expectations of anglers. Maintenance of a high quality sports fishery usually requires that the annual harvest not exceed a relatively small fraction of the MSY_C. For example Hagenson and O'Connor (1978) determined that no more than 15% of the MSY should be harvested to ensure a sustained high quality sport fishery. The researchers also estimated that maintenance of a moderate quality fishery on 7 Whiteshell lakes (similar to the quality of others in the park) limited the OSY to 49% - 67% of the MSY.

The OSY should be determined with the assistance of Fisheries Branch managers based on the quality of the fishery desired and the characteristics of the lake and its fish population.

1.4 Calculate allowable annual harvest (Ha)

$$Ha = Ao \times OSY \text{ (kg/yr)}$$

where Ao = the area of the lake

STEP 2 CALCULATE THE EXISTING ANNUAL HARVEST (He)

$$He = A \times CUE \text{ (kg/yr)}$$

where A = total angler hours per year for all users

CUE = catch per unit effort (kg/angler hour)

Total angler hours is obtained from surveys of lake users including cottagers, lodges and day users. The existing CUE is also obtained from surveys or it may be the desired CUE as identified by fisheries managers.

STEP 3 DETERMINE AVAILABLE UNHARVESTED FISH (Hu)

$$Hu = Ha - He \text{ (kg/yr)}$$

STEP 4 DETERMINE CAPACITY IN DEVELOPMENT UNITS (Nperm)

$$Nperm = \frac{Hu}{Ad \times CUE}$$

where Ad = mean angler hours/yr/development unit

CUE = desired catch per unit effort

A development unit is a cottage or its equivalent in terms of lodge beds, day use boats, etc.

The capacity of the lake may be increased (or decreased) by modifying fisheries management objectives in terms of the optimum sustainable yield and the desired catch per unit effort.

Trophic State Capacity

As described previously in this manual the form of water pollution associated with cottage development with the most serious long term implications for water quality is nutrient-loading from human and household waste. These wastes contain high quantities of nutrients, notably phosphorus, which act like fertilizers when permitted access to a water body, stimulating the growth of algae and other aquatic plants. This increase in productivity may cause a change in the lake's trophic status and a general decline in the quality of the water for recreation due to increased turbidity, algal scums and changes in fish populations.

The sewage treatment systems most commonly used in rural areas (ie septic tank and tile field, pit privy, lagoons) are often ineffective in removing nutrients. For example when septic tank systems are installed on coarse sandy soils such as those commonly found in the precambrian shield, nutrient retention is negligible. Thus, treated wastes, while acceptable by public health standards, can still pollute in a biological sense.

More recently in Manitoba holding tanks have been promoted as a solution to the problem of biological pollution. However, the use of holding tanks simply transfers the problem to another location: the lagoon wastes must eventually be released to a watershed somewhere. Further, problems have been experienced with the improper installation of holding tanks and leakage.

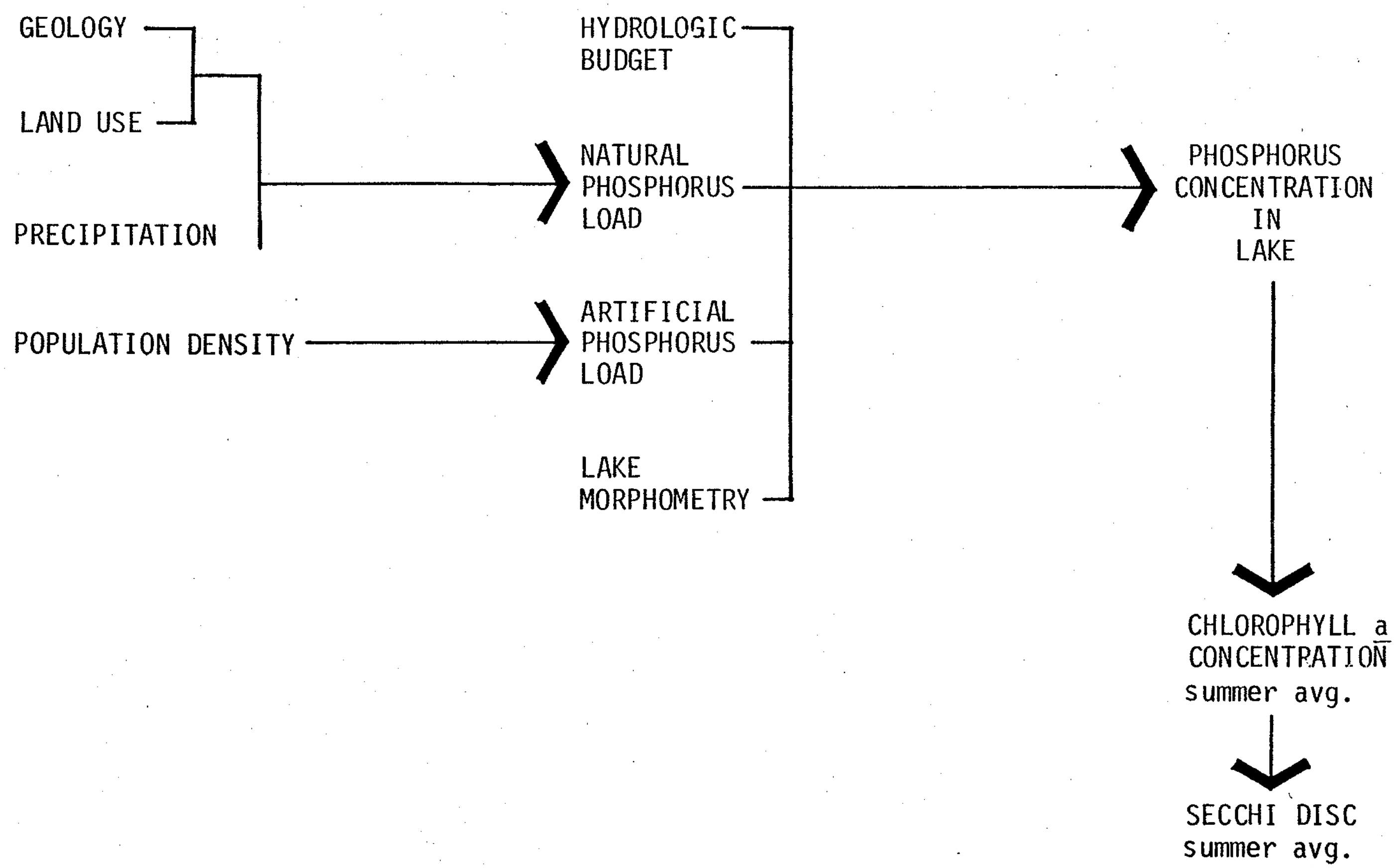
Whenever cottage development will result in an increase in nutrient-loading to a waterbody an assessment of the potential impact is required.

Any input of nutrients to a lake will cause a change of water quality although the change may be difficult to detect. The amount of nutrients a lake can absorb without an unacceptable decline in water quality is the lake's "trophic state capacity". This amount varies according to the physical, chemical and biological characteristics of the lake and its watershed.

A method has been developed in Ontario to determine a lake's capacity for development based on nutrient-loading. The method was originally described by P.J. Dillon (1974), later refined by Dillon and Rigler (1975) and continuing to be refined as a part of the Ontario Lakeshore Capacity Study (1980). The method is based on a model reported by Vollenweider (1968) which showed a relationship between phosphorus, mean depth and lake trophic state. Phosphorus is the nutrient which most commonly controls production, and therefore, trophic status, in north temperate lakes.

The method relates natural and artificial inputs of phosphorus to the lake's hydrologic budget and morphometry to predict trophic state alterations (expressed as springtime total phosphorus concentrations, average summertime chlorophyll *a* levels, and Secchi disc transparencies) resulting from land use changes. The basic steps include:

1. an estimate of natural phosphorus exported to the lake in runoff water, based on water shed geology and land use;
2. an estimate of phosphorus input from precipitation falling directly on the lake;
3. an estimate of total natural phosphorus load to the lake, by combining (1) and (2) above;
4. an estimate of total artificial loading to the lake, based on population and sewage disposal facilities;
5. a prediction of springtime total phosphorus concentration in the lake by combining the total phosphorus load with the lake's morphometry and hydrologic budget;
6. a prediction of the average summertime chlorophyll *a* concentration (a measure of productivity) from a known chlorophyll *a*/total phosphorus relationship;
7. a prediction of summer Secchi disc transparency (a measure of water clarity) from a known chlorophyll *a*/Secchi disc relationship.



SCHEME OF EMPIRICAL MODELS USED TO ASSESS EFFECTS OF DEVELOPMENT ON TROPHIC STATUS OF LAKES

from Dillon Rigler 1975

FIGURE 3.21

To determine the capacity of a lake for development the model is used in reverse. The planner sets limits for the "permissible" summer secchi disc transparency or average chlorophyll a concentration. From this, the "permissible" total phosphorus concentration at spring overturn can be calculated. This, in turn, is translated into a "permissible" artificial phosphorus laod which can be expressed in terms of development units based on anticipated use and type of sewage treatment.

The method is described in detail in Dillon and Rigler (1975). Note that the method continues to be refined as part of the Ontario Lakeshore Capacity Study, the final results of which will soon be published.

While the method was developed and has been applied primarily in southern Ontario it has been shown to have value elsewhere when adjustments are made to compensate for regional differences (eg. climate, soils, etc.). It is known that the model needs to be calibrated for dystrophic lakes (brown-stained lakes which drain bogs) which are common in the northern regions of the precambrian shield (Hough, Stansbury, 1980). Also the method has not been tested extensively for prairie lakes, prairie soils and agricultural watersheds. It would be wise,therefore, to seek the assistance of experienced limnologists from the Water Management Branch when applying the method.

Some planners perceive the method as too complex for wide spread application. The method, is in fact quite simple and has been designed to minimize the need for field investigation. The simplicity of the method is both a strength and weakness. Uncertainty in regards to the modelling sequence and data inaccuracies can result in considerable error. However, as the method is based on empirical models its accuracy will increase through modifications based on experience. The model's ability to predict impact in quantitative terms makes it a valuable planning tool, provided proper caution is taken in the interpretation of results.

Beach Capacity

When backland cottage development shares a common lake frontage, the number of dwelling units can be limited by the capacity of the shared beach to support bathing activity. Beach capacity is determined by the space required by beach users for their safety and enjoyment. If the density of bathers is too great people will feel crowded and swimming will be impeded.

A beach is usually comprised of a wet beach, dry beach and backshore. For the purposes of beach capacity the three zones are defined as follows:

wet beach - the band of water lying between the water line and the 1.5 metre depth. The minimum width for public use is about 10m and the maximum width is about 60m.

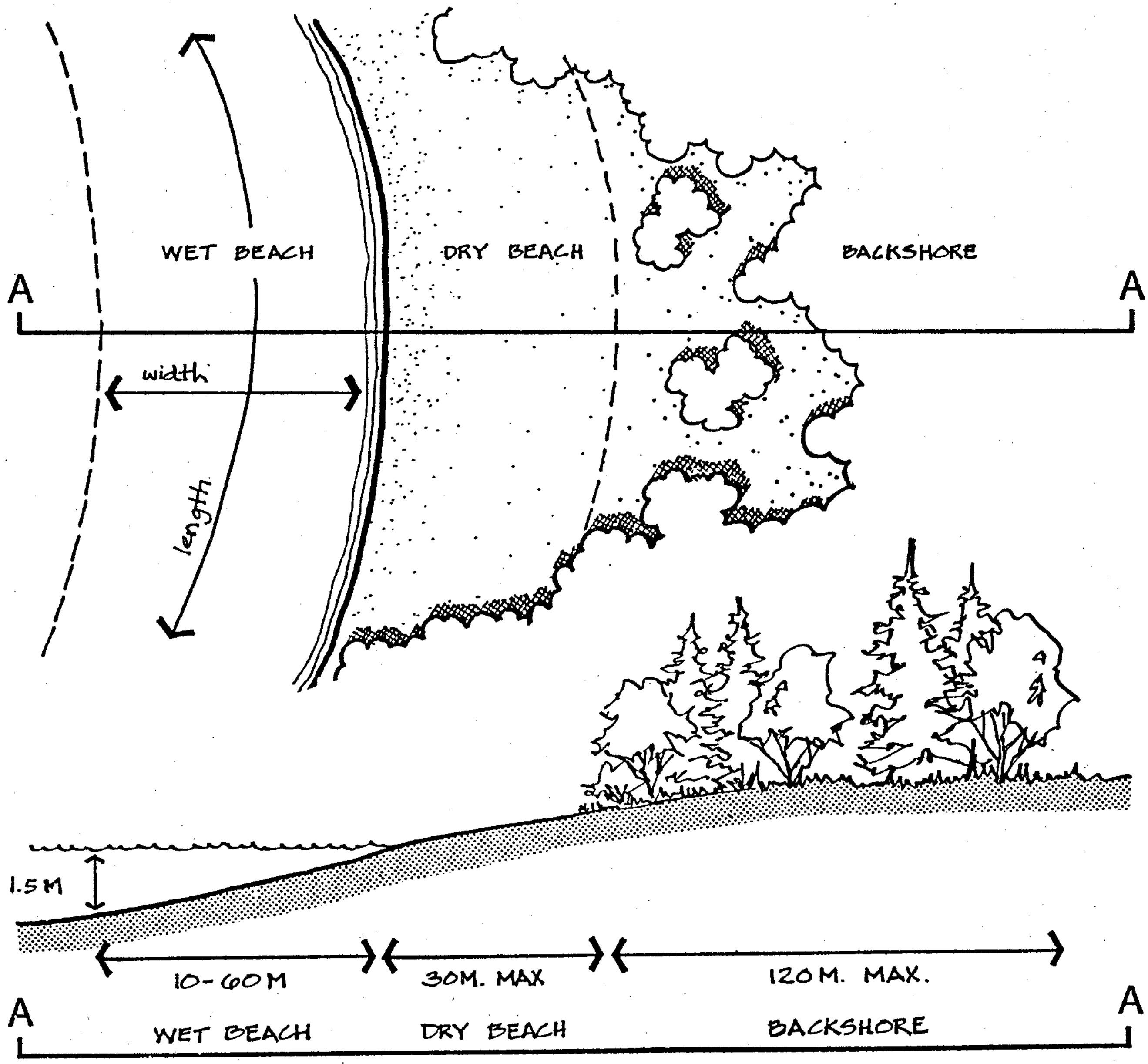

WET BEACH
DRY BEACH
BACKSHORE
A
A
width
length
1.5 M
10-60 M
30M. MAX
120 M. MAX.
A
A
WET BEACH
DRY BEACH
BACKSHORE

FIGURE 3.22

dry beach - the band of land adjacent to the wet beach extending inland 30m or to the limit of useable land (ie. well drained, gentle slope) whichever comes first.

backshore - the area of land extending from the limit of the dry beach to the extent of useable land or a distance of 120 meters from the shore, whichever is less. The backshore is more important for public beaches not associated with cottage development for it must be large enough for parking, sanitary facilities and picnicking.

Research has shown that the land area requirements of bathers are more critical than the water surface requirements. At any one time, over 75% of beach users may be found on the dry beach while only 25% may be in the water (Jaakson, 1973). As a result the land area associated with beaches is usually limiting factor in terms of capacity. Generally, the wet beach area only becomes the limiting factor when its area is less than 1/3 that of the dry beach.

To determine the capacity of a beach the steps are as follows:

STEP 1 DETERMINE IF DRY BEACH OR WET BEACH IS LIMITING

Assuming that the spatial requirements of bathers are equal for land and water the wet beach becomes limiting when it is less than 1/3 the size of the dry beach.

STEP 2 DETERMINE BATHER CAPACITY (N_b)

2.1 If dry beach is limiting:

$$N_b = \frac{A_d}{b}$$

where A_d = the area of the dry beach (m^2)
b = the area required by each bather (m^2)

2.2 If wet beach is limiting:

$$N_b = 3\,\frac{A_w}{b}$$

where A_w = the area of the wet beach (m^2)

the area b is determined from observations of existing use on other beaches in the region. The following is presented as a guide:

high density - $9m^2$ (100 ft^2) of dry beach per person.
medium density - $23m^2$ (250 ft^2) of dry beach per person.
low density - $46m^2$ (500 ft^2) of dry beach per person.

STEP 3 DETERMINE CAPACITY IN COTTAGES(Nperm)

$$Nperm = N_b \times Q_b$$

where Q_b = the percentage of cottage population expected to use the beach at peak period.

Other Methods

SHORELAND CAPACITY - the area of shoreland which meets the minimum requirement for cottage development in terms of shoreline, soil, slope, vegetation, etc. This area will be apparent as a result of the assessment of development capability.

WILDLIFE CAPACITY - the amount of development which is permitted without causing undesirable alterations of wildlife populations. This value is difficult to predict in quantifiable terms, although one component of the Ontario Lakeshore Capacity Study (1978) is attempting the task. Alternatively, by identifying and preserving wildlife habitat during the lake planning and site planning processes the impact of cottage development on wildlife will hopefully be minimized.

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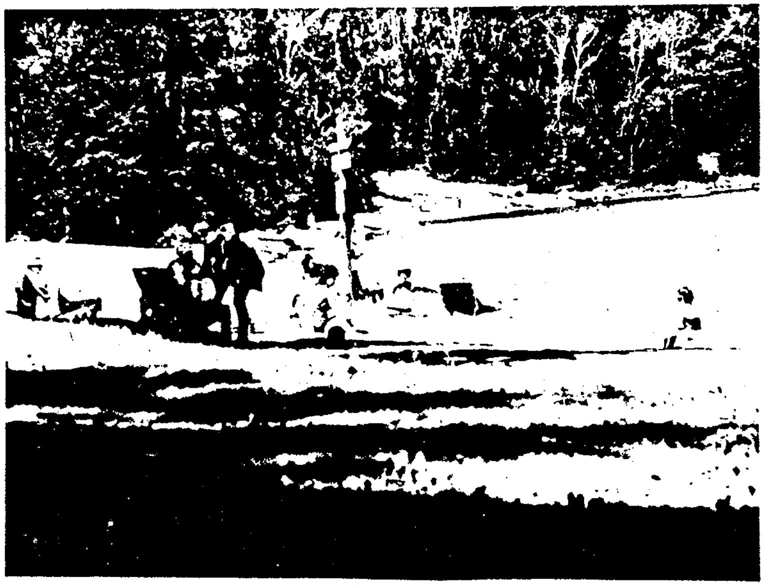
Alternative Plans

For every lake there will be a number of different ways development can occur while still fulfilling the role of the lake and meeting plan objectives. To present these options and provide a choice to decision-makers a number of alternative plans are formulated. The plan alternatives demonstrate different quantities and mixes of lake use reflecting different interpretations of the role statement.

Each plan will contain proposals for the use of land, shore and water areas. The location and form of proposed development will be shown graphically, including seasonal homes, support facilities and any other proposed use (eg. public use areas). Proposed land use and water use designations (eg. conservation zone, no development areas) will also be shown. Varying intensities of development may be illustrated by the alternatives based on different estimates of lake carrying capacity and different assumed levels of lake and site management.

A useful technique to help in the designation of land and water areas is to overlay the resource maps on a light table. For example, to aid in the selection of sites for development maps showing development capability, shoreline type, other use and sensitive features may be overlaid to reveal sites with the fewest constraints.

The advantages and disadvantages of each plan alternative should be described. The implications of each plan should be discussed in terms of the economic, environmental and social costs and benefits.



Plan Choice & Implementation

Following review of the alternative plans by regional resource managers and the public one alternative or a combination of one or more alternatives is chosen for implementation. This plan, which becomes the official plan of the lake, defines the course of new development and serves as a framework for all future development on the lake.

The plan document will include the following:

1. ROLE STATEMENT

A brief statement of the role the lake is to fulfill within the region, and a list of plan objectives.

2. OTHER USE

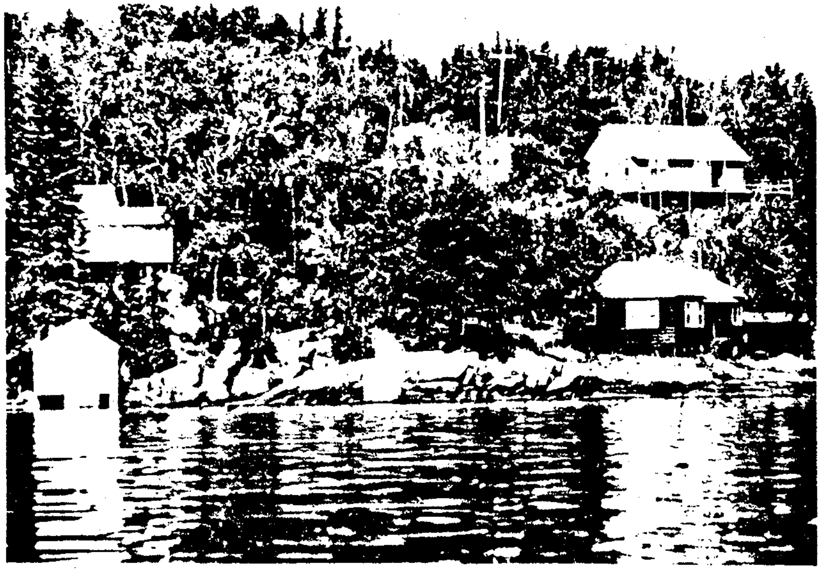
A written and graphic description of existing use and potential use areas.

3. RESOURCE INVENTORY & ANALYSIS

The results, in verbal and graphic form, of the resource inventory and analysis.

4. DEVELOPMENT CAPABILITY

A map showing the results of the development capability analysis.



5. CARRYING CAPACITY ESTIMATES

The results of the carrying capacity estimates.

6. ALTERNATIVE PLANS

Graphic plans of development alternatives with verbal account of advantages and disadvantages.

7. DEVELOPMENT PLAN

A plan of the whole lake showing the location and layout of proposed development. A verbal description to accompany the plan.

8. ZONING PLAN

A plan designating land and water areas for specific uses accompanied by a verbal description.

9. SITE PLANS

Detailed plans of development sites showing the form of proposed developments (eg. lot locations, access roads, etc.).

10. IMPLEMENTATION SCHEDULE

A description of the timing and phasing of development.

11. MANAGEMENT REQUIREMENTS

A description of initial and on-going management requirements (eg. water quality analysis, site rehabilitation, enforcement, etc.).

12. COST ESTIMATE

An estimate of the costs of proposed development, including operation and maintenance costs as well as initial costs of development.

4. Appendices

appendix A

THE LIMNOLOGICAL CHARACTERISTICS OF LAKES

Critical to determining a lake's capability for recreation development are the limnological character of the lake and the sensitivity of the aquatic ecosystem to the pressures of human activity. In order to make judgements based on the relationship between water quality and recreational use it is important to understand some basic limnological concepts.

THE BIOLOGICAL CLASSIFICATION OF LAKES

Lakes are classified on the basis of their biological productivity. Productivity is a measure of the quality of life, in all forms, supported by an ecosystem. At the base of the aquatic food chain solar energy is converted into calories of edible food by the primary producers: the green plants (algae and macrophytes). The abundance and rate of growth of the green plants ultimately determines the productivity of all higher levels of the food chain. Plant productivity is determined by various factors; the supply of dissolved nutrients being of particular importance.

Productivity can also be considered a measure of the organic matter produced by a system. Each level in a food chain utilizes only a small percentage of the production of the level below; most decomposes. In a lake system, decaying organic matter sinks to the deeper water where oxygen is consumed in the process of decomposition. (Hough, Stansbury and Associates, 1977).

Three general lake types are delineated in a continuously rising scale of productivity. These are termed oligotrophic, mesotrophic and eutrophic.

OLIGOTROPHIC LAKES

Oligotrophic lakes have a low nutrient supply in relation to the volume of water they contain. As a result, biological productivity is generally low, the waters are clear and the deepest layers are well supplied with oxygen throughout the year. These lakes tend to be deep with mean depths greater than 15 metres and maximum depths greater than 25 metres.

Fish species such as Laketrout and Whitefish which require cool, deep, oxygen-rich water are found in most oligotrophic lakes. (Vallentyne, 1974). Two well-known oligotrophic lakes in Manitoba are West Hawk Lake in Whiteshell Provincial Park and Clearwater Lake.

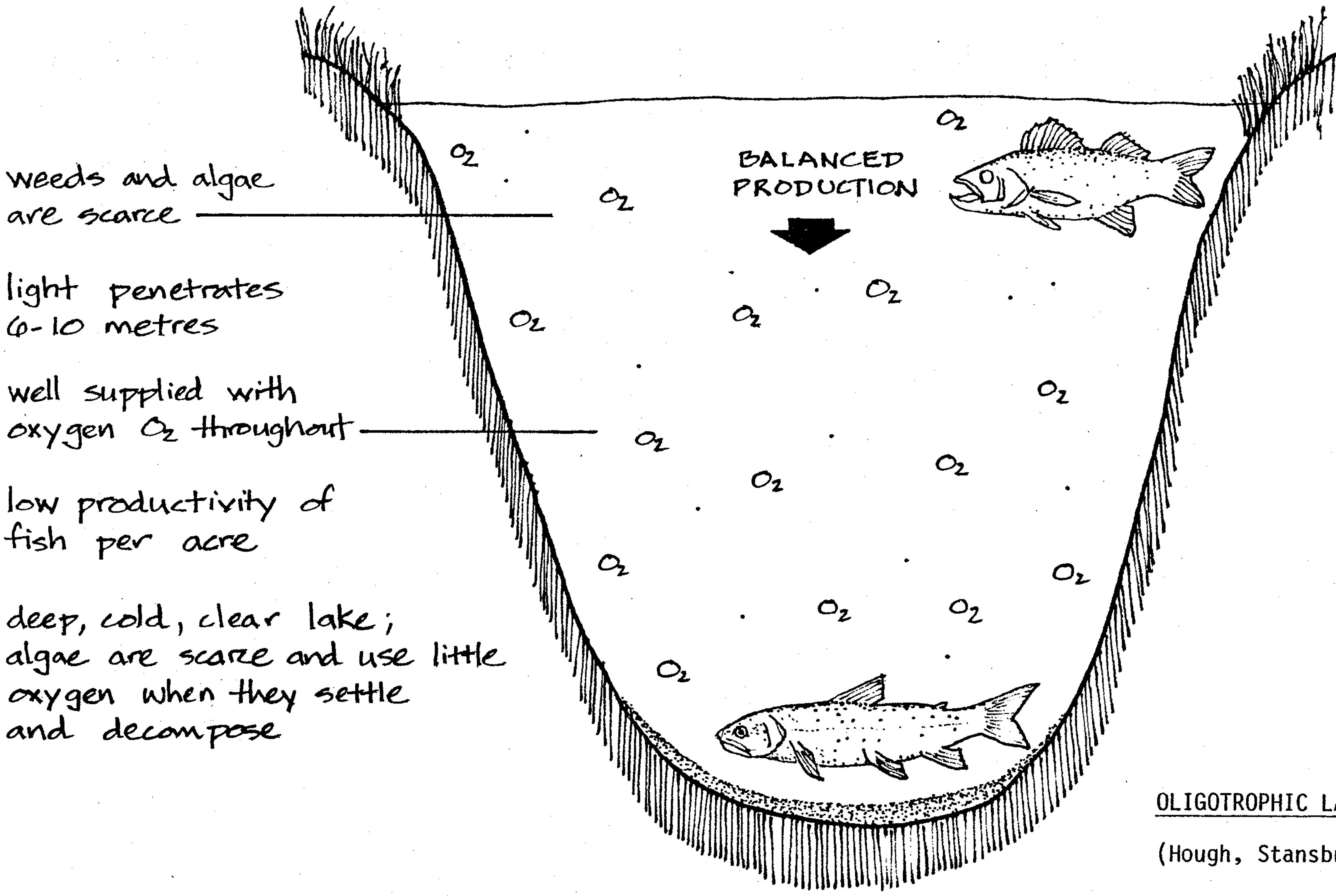
EUTROPHIC LAKES

Eutrophic lakes lie at the other end of the spectrum. They have a high nutrient supply in relation to the volume of water they contain. Biological productivity is generally high, dense growths of phytoplankton occur in surface waters. Mats of rooted plants and filamentous algae may be abundant in shallow-water areas. The deepest waters exhibit reduced concentrations of dissolved oxygen during periods of restricted circulation. Eutrophic lakes tend to be shallow with mean depths less than 10 metres and maximum depths less than 15 metres. The dominant fish are the warm water species which can tolerate lower concentrations of dissolved oxygen such as bass and pike. (Vallentyne, 1974). Examples of eutrophic lakes in Manitoba are Max Lake in Turtle Mountain Provincial Park and Rock Lake.

MESOTROPHIC LAKES

Mesotrophic lakes occupy an intermediate position between the two extremes. They are intermediate in respect to nutrient supply, depth, biological productivity, water clarity and oxygen depletion in deeper waters. Mesotrophy is just a convenient category for lakes that are borderline between oligotrophy and eutrophy. Yellow Perch is a fish species which is commonly abundant in mesotrophic lakes.

Three primary factors regulate productivity and determine a lake's trophic status: nutrient supply, morphology of the lake basin, and climate (light and temperature). Thus, deep lakes located in the nutrient-poor soils of Manitoba's precambrian shield tend towards oligotrophy and the shallow lakes in the nutrient-rich prairie soils tend towards eutrophy.



OLIGOTROPHIC LAKE

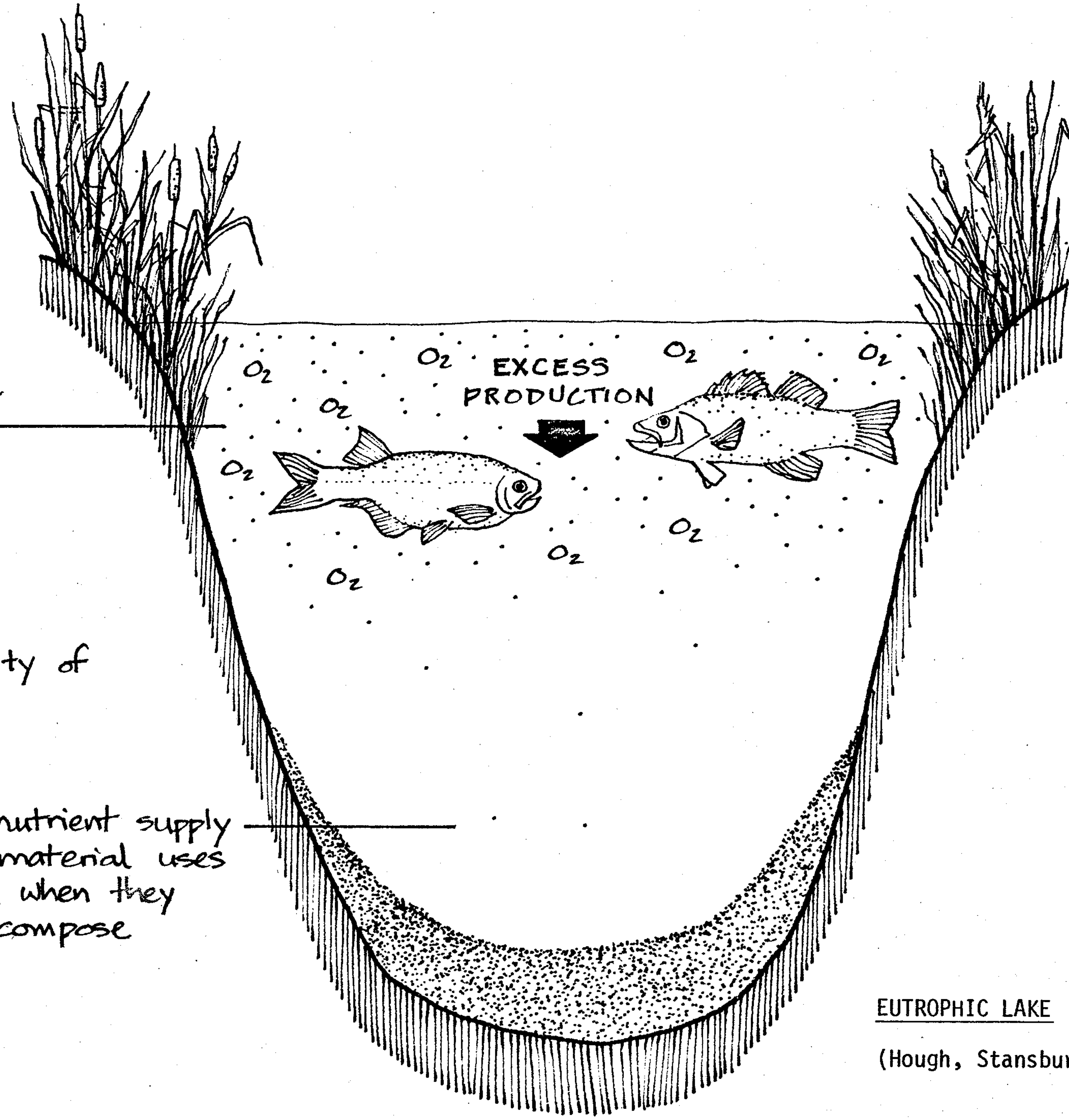
(Hough, Stansbury 1975)

weeds and algae are abundant

light penetrates 1-2 metres

high productivity of fish per acre

with increased nutrient supply excessive plant material uses most of the O_2 when they settle and decompose



EUTROPHIC LAKE

(Hough, Stansbury 1975)

In addition to the three general categories there are two other classifications used to describe Manitoba's lakes: dystrophic and hypertrophic.

DYSTROPHIC LAKES

Dystrophic lakes are high in dissolved colouring matter: brown humic materials which drain from bogs. The colouring reduces the light penetration and therefore, the productivity of the lake. Dystrophic lakes are common in the pre-cambrian shield where bogs are found.

HYPERTROPHIC LAKES

Hypertrophic lakes are those at extreme stages of eutrophy due to high nutrient loading. (Davis, 1980). Prairie lakes in agricultural areas are often hypertrophic.

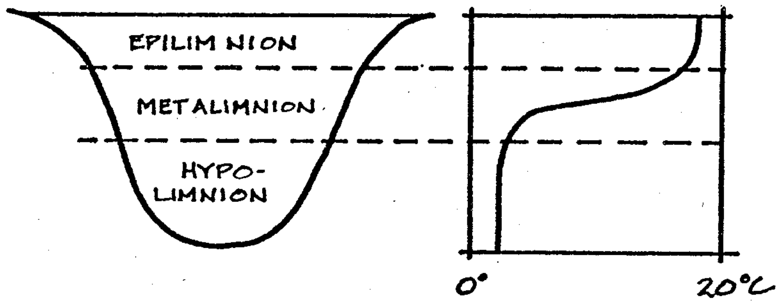
THE LAKE AND ITS WATERSHED

It is important to realize that the entire watershed and not just the lake or the lake and its shoreline, is the basic ecosystem unit. The terrestrial and aquatic portions of any watershed are inherently linked with the gravitational movement of minerals in drainage waters flowing from the land to the water. (Dillon, 1974). The geologic make-up of the watershed has a major effect on water quality. Watersheds with nutrient poor soils and granitic parent materials are usually unproductive and acidic. Lakes surrounded by alkaline surficial deposits are usually basic.

It is important to note that the aquatic portion of a watershed is "downhill" from the terrestrial portion. The implication of this in terms of lake planning is that any alteration in a watershed ultimately effects the lake. (Dillon, 1974).

TEMPERATURE AND OXYGEN CONDITIONS IN LAKES

Temperature conditions in lakes during midsummer generally follow one of two common patterns. In shallow lakes which are well-exposed to the wind the water temperature will be almost constant from top to bottom, usually varying less than 2°C. This uniformity of temperature indicates that the lake waters are well-mixed. In deeper lakes with maximum depths greater than 5-10 metres, three characteristic layers are present: the epilimnion, an upper zone of warm water with a more-or-less uniform temperature; the metalimnion, a middle zone in which the temperature declines rapidly with depths and the hypolimnion, a lower zone of cold water in which the temperature is again more-or-less uniform (Vallentyne, 1974).



typical thermal structure of a lake
in temperate latitudes in summer

from Vallentyne 1974 p. 43.

Vertical and seasonal changes in dissolved oxygen concentrations depend, for the most part, on a lake's depth. In shallow, well-mixed lakes the waters will be well-oxygenated throughout. However, reductions during periods of stagnation such as the dull, windless days of late summer or during winter ice cover. (Hough Stansbury 1980). Manitoba's shallow prairie lakes are affected by a phonomenan known as an algal bloom. A bloom is a rapid increase in the abundance of planktonic algae which usually occurs in summer when water temperatures are elevated. When algal blooms collapse due to a change in environmental conditions (eg. onset of colder weather) the subsequent decomposition of algae causes severe oxygen depletion. The result is massive fish mortality, hence the name of this occurence: summerkill.

During the winter months (with ice and snow cover on lakes) primary production drops off and decomposition becomes predominant. As the winter progresses oxygen levels drop-off and may become depleted causing "winter-kill" (Barica 1980).

In deep lakes in summer the warm surface (epilimnetic) waters float on the coolor, more dense hypolimnetic waters. The differance in density creates a resistence to mixing by wind action. Many lakes do not become fully mixed again until the fall when surface waters cool. During thermal stratification the hypolimnetic waters receive no oxygen from the atomosphere. Depending on the interaction of a number of biophysical factors ie. rate of decomposition, size and shape of the lake basin, flushing rate, etc. the lake's hypolimnetic oxygen resource can become depleted. Under such conditions a lake is unsuitable for most coldwater species of fish (Hough, Stansbury 1980).

LAKE SUCCESSION

Lakes are temporary features of the landscape. They are continuously undergoing a gradual process of change from youth to maturity to old age, or from oligotrophy to mesotrophy to eutrophy. The death of a lake can be equated with the onset of swamp or marshland conditions. (Schenk 1971).

The process of natural eutrophication is an exceedingly slow process, measurable only in terms of geologic time. Natural sedimentation rates have been estimated at 1 millimeter or so per year. This means that, since the last ice age, some 10,000 -15,000 years ago, an average of 10-15 metres of sediments have accumulated in most lakes. (Vallentyne, 1974.)

CULTURAL EUTROPHICATION

Cultural eutrophication is a term used to describe man-induced changes in the rate of natural succession. Whereas natural eutrophication is primarily the result of sedimentation which causes a reduction of water volume relative to nutrient supply, cultural eutrophication is an increase in nutrient supply relative to water volume.

Relative to natural eutrophication, cultural eutrophication can be extremely rapid, creating conditions in months that would take thousands of years under natural conditions.

Major human sources of nutrients are sewage, detergents, industry and agricultural activity (fertilizers, erosion, and livestock waste). Forest clear-cutting and forest fires can also cause fluctuations in nutrient supply.

Recreation development can have a significant impact on lake trophic state. Septic tile fields, lagoons and other sewage treatment systems that release "treated" human and household waste to the lake are major sources of nutrients. Although such wastes may meet provincial public health standards they often contain significant levels of dissolved nutrients which can "pollute" in a biological sense. Land clearing, increased erosion, fertilizers and boating activity can also increase the supply of nutrients. (see lake water section.)

The impact from sparse population densities such as those of typical cottage development can be difficult to detect. However, development occurring steadily over a period of 10-25 years may alter the lake's trophic state depending on the physical, chemical and biological character of the lake. (Hough, stansbury and Michalski 1980.)

In deep, thermally stratified lakes increased nutrient loading stimulates productivity. The increased levels of phytoplankton create turbid conditions and a general decline in water quality for most recreational activity. Increased decomposition can lead to the depletion of dissolved oxygen in bottom waters creating conditions unfit for coldwater species.

In shallow, naturally eutrophic lakes increased nutrient-loading increases stresses on an already productive environment. There is an increase in the production and frequency of algal blooms and aquatic plants to the point where recreation activities such as swimming and boating are hindered. There is also an increase in the frequency of the summerkill and winterkill of fish.

appendix B

WILDLIFE: HABITAT PREFERENCES AND COMPATIBILITY WITH COTTAGE DEVELOPMENT

Habitat preferences of a number of wildlife types and their capability with cottage development are described below.

WATERFOWL

Most recreation lakes have low capability as waterfowl habitat because they are generally deep without extensive areas of march vegetation. Prime waterfowl habitat requires mudflats and shoreline vegetation (for nesting and loafing) in association with open water areas (for feeding and protection). Dabbling ducks prefer to nest in upland grassy or brushy cover not far from water. Islands are also preferred locations for nesting. Recreation lakes may be important as staging areas during migration.

Most waterfowl are fairly resilient to human activity except during the mating and nesting season (spring to early summer). Most waterfowl will be off the nest by the time summer lake activity peaks. Loons are very sensitive to human activity during breeding and nesting. They build their nests immediately adjacent to the waterline which greatly increases potential disturbance and damage from boat traffic.

COLONIAL-NESTERS

Colonial-nesting, fish-eating birds such as white pelicans, double-crested cormorants and several kinds of gulls and terns are highly vulnerable to humans. Human visitation to breeding colonies can result in high chick mortality when parents and chicks flee the nest.

RAPTORS

Nesting raptors can be disturbed by human activity. Raptor nesting sites, which are found in tall trees or on rock cliffs, are usually occupied annually.

SONGBIRDS

The impact of recreation development on songbird populations is usually confined to the immediate area of the development. Clearing and manipulation of vegetation causes a dramatic change of habitat with the loss of the shrub layer, thinning of the canopy and removal of standing dead and snags. This usually results in the disappearance of some species from the area (eg. ovenbirds). On the other hand, low intensity development in woodlands tends to increase the amount of edge condition which attracts other species (eg. phoebes). Consequently recreation development can actually increase the diversity of songbird species.

UNGULATES

White tailed deer

Conflicts occur between cottage development and white tailed deer when development significantly alters winter habitat or impedes movement. Deer survival and reproduction success are often linked to winter habitat conditions. As snow cover increases deer will "yard-up" in protected areas, usually cedar swamps or other coniferous woodland. Tree thinning, branch removal and ground clearing associated with recreation development can reduce a site's suitability as a deer yard. White tailed deer, like all ungulates require access to water. If a lake is ringed with cottages access is impeded.

However, on the whole, white tailed deer are reasonably compatible with cottage development. They seem tolerant of human presence especially when activities are concentrated in the summer months. Winter cottage use, especially when snowmobiles are involved, extends the period of disturbance and increases the pressures on the deer when they are already stressed by environmental conditions.

Moose

In general, moose are very sensitive to human activity and are also affected by increased hunting pressure. Preferred moose habitat is subclimax forest, shrubby open woodland, shallow bays, and alder swamps. In deep snow winters, moose will also yard-up in sheltered locations such as dense coniferous forest adjacent to a reliable food source (ie. shrubby open woodland). Moose will select islands as sites for giving birth and nursing.

Woodland Caribou

Caribou are sensitive to human presence. Hunting by people other than status indians is strictly controlled. In summer caribou feed on grasses, sedges, forbs and twigs. In winter when snow cover becomes thick caribou feed on tree and ground lichens on bedrock ridges and in spruce bogs. Caribou use ice-covered lakes for winter travel and for bedding-down during the day.

Elk/Wapiti

Elk are also sensitive to human presence. They prefer wooded hillsides and lakeshores in summer; sheltered woods adjacent to open grassland in winter. Elk are found in the Riding and Duck Mountains, in the Porcupine and Spruce Woods Provindial forests and in the Interlake.

SMALL MAMMALS

Major, localized, changes in small mammal habitat occur with the construction of a cottage or similar development. Some species will be dissipated or reduced while other, more "urban" species will increase. Where development density is low only a few home ranges will be affected. As the density and extent of development increase so will impact. It is unlikely that changes in small mammal populations caused by typical cottage development would have much impact on the regional ecosystem. However, it is important to remember that small mammals play a very important role in the ecology of any terrestrial ecosystem. They are principle primary and secondary consumers and are the major food source for many secondary and tertiary consumers.

FURBEARERS

Of the furbearing species those dependent on wetlands: mink, beaver, muskrat are likely to be most affected by lake development. Mink use the shore-water interface almost exclusively. Mink require a high diversity of habitat types to provide the high diversity of food sources they prefer. Cottage development, by tending to reduce the diversity and abundance of shoreline vegetation can have a severe impact on mink populations.

RARE AND ENDANGERED WILDLIFE

Certain wildlife species require special attention because of their rare or endangered status. Rare species include species which at one time were more abundant in Manitoba but are now seldom seen and those whose numbers are threatened in Manitoba or on a world-wide basis. Some of these such as the polar bear and white pelican are quite abundant in Manitoba.

RARE SPECIES

burrowing owl
long-billed curlew
ferruginous hawk
greater sandhill crane
gray fox
fox squirrel
northern pocket gopher
eastern tiger salamander
green frog
plains spade foot toad
northern prairie skunk

RARE SPECIES (CONT'D)

plains hognose snake
mule deer
bald eagle
peregrine falcon
great gray owl
wolverine
greater prairie chicken
white pelicans
double-creasted cormorants
western grebe
polar bear

(Manitoba, 1978).

GENERAL WATER QUALITY OBJECTIVES

General Water Quality objectives give overall guidance to water managers for ensuring that, regardless of the utilization or development of the water resource, reasonable meanures will be taken to protect water quality.

Every effort should be made to retain the natural quality of provincial waters. Should, however, it be deemed necessary to allow degradation to occur for socio-economic or other reasons, then all reasonable and practicable measures should be employed to ensure that the loss in quality does not exceed the minimum levels required to protect the most sensitive use.

Provincial waters deemed to have outstanding natural recreational and aesthetic value should be maintained in their natural state.

To ensure that the quality and overall value of provincial waters are protected and enhanced, water pollution control programs should ensure that:

1. The quality of any body of water and the life-system functioning within that body should not be allowed to deteriorate below minimum acceptable levels consistent with current knowledge and practicable technology, or if below, should be brought up to a minimum acceptable quality;

2. Certain "high quality" bodies of water whose existing quality is substantially above existing requirements, should be maintained at their existing high quality levels;

3. Where natural conditions are suitable, all bodies of water should be sufficiently high quality to permit safe direct body contact;

4. All waters should meet minimum national or international standards and objectives (statutory, recommended, or agreed) designed for the protection or enhancement of public health and well-being;

5. The quality of waters should be maintained so as not to impede optimum sustainable economic yield of Manitoba's fishery resources compatible with other desired uses of water;

6. All waters should be maintained free from, or within concentration limits designated under appropriate legislation respecting environmental contaminants or conditions, any substances which pose a threat to the aquatic or human environment. Such freedom or limitation should be corroborated by biological assessment;

7. All waters should be free from amounts of substances attributable to municipal, industrial and other discharges that will settle to form putrescent or otherwise objectionable deposits, that produce colour, odour and other conditions, in such a degree as to create a nuisance or in concentrations that are toxic or harmful to human, animal or aquatic life;

8. All waters should be free from floating debris, oil, scum and other floating materials attributable to municipal, industrial or other discharges (including those from ships and other waterborne vehicles) in amounts sufficient to cause unsightly or deleterious effects on water quality;

9. All waters should be free from nutrient substances derived from municipal, industrial, agricultural or other sources in concentrations or quantities that create nuisance growths of aquatic plants and alga.

appendix C

MANITOBA WATER QUALITY OBJECTIVES

(Clean Environment Commission, 1979)

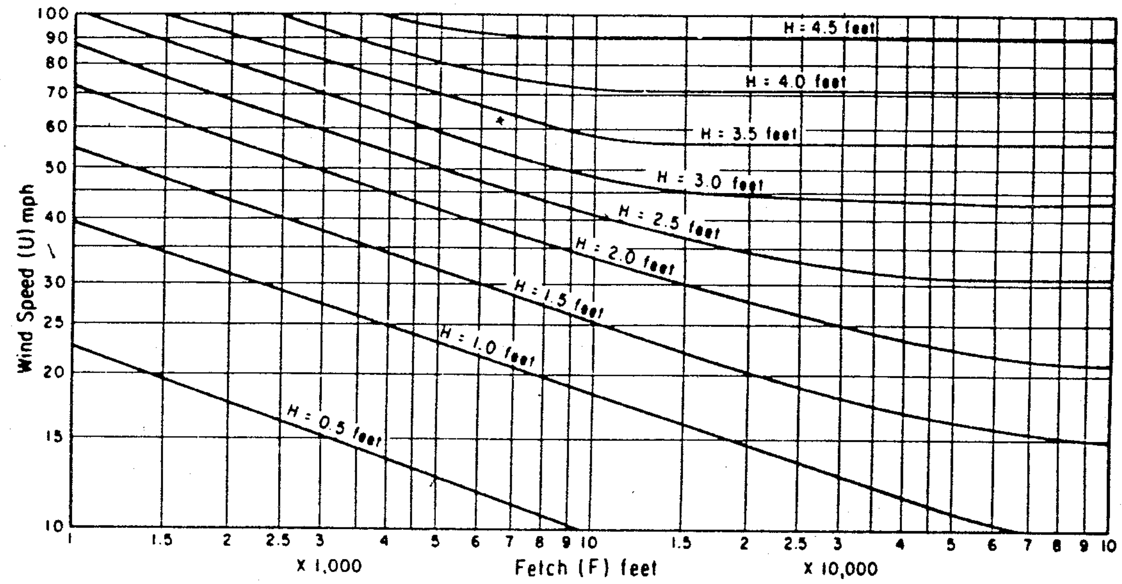
appendix D

FORECASTING CURVES FOR SHALLOW - WATER WAVES

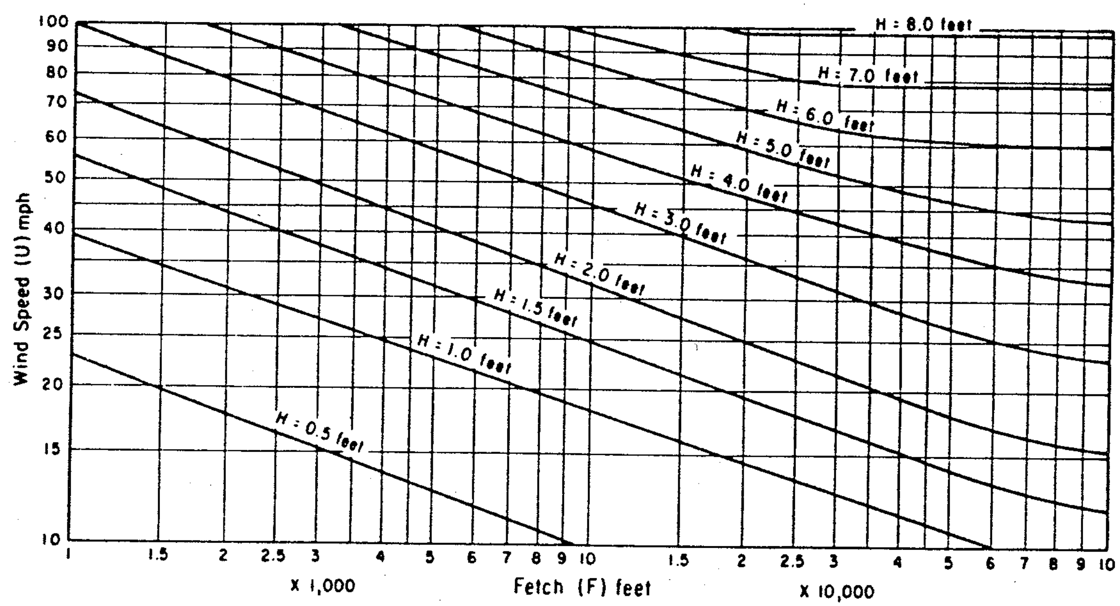
from U.S. Army Coastal Engineering Research Center. 1966. Shore Protection Planning and Design.

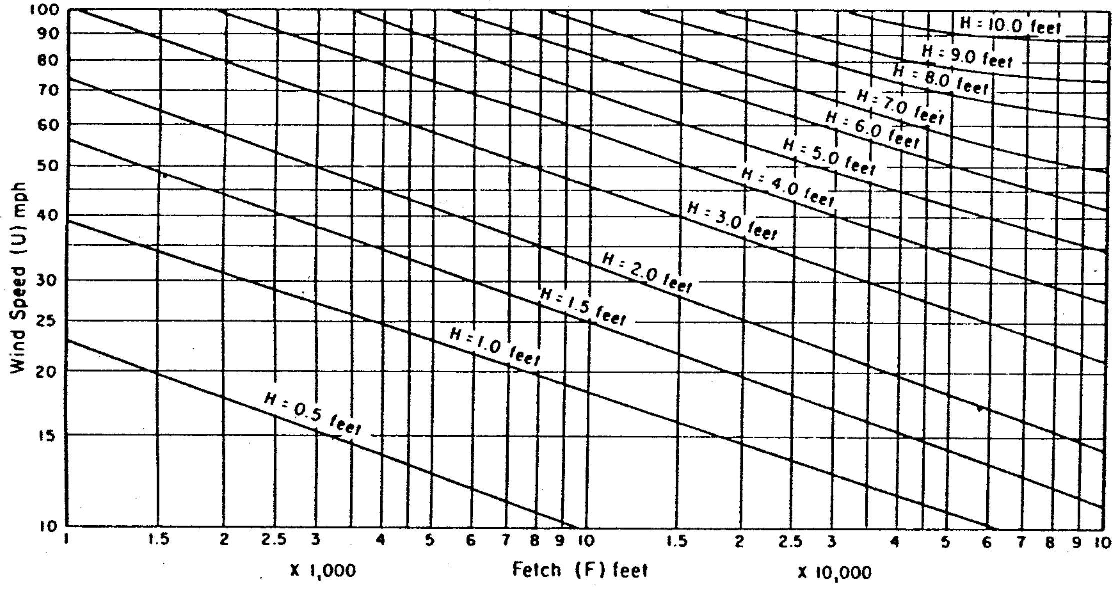
10 ft.

constant depth



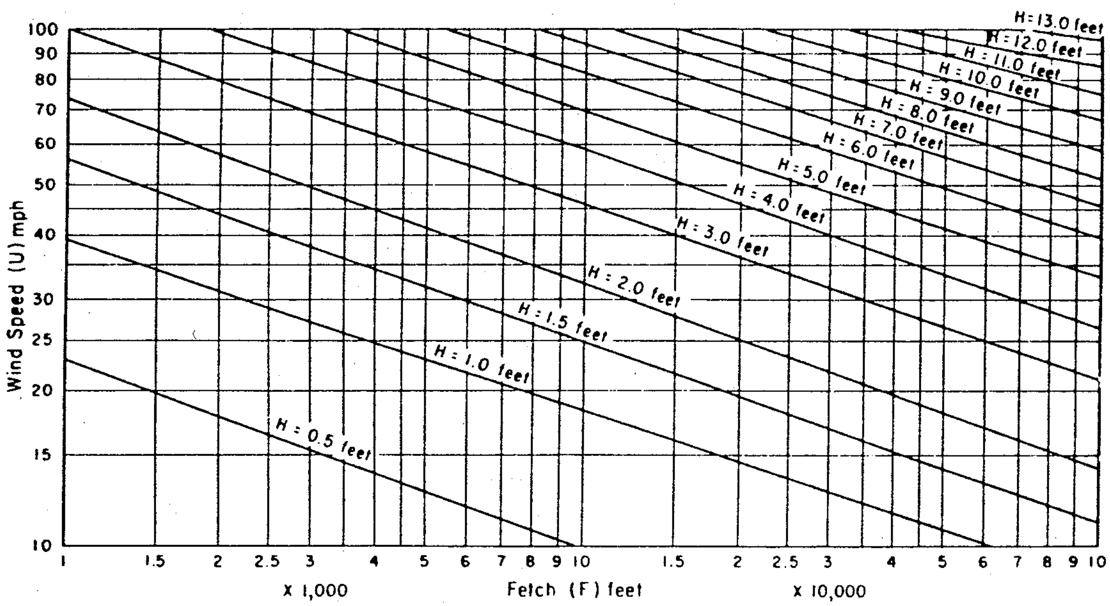
20 ft.





30 ft.

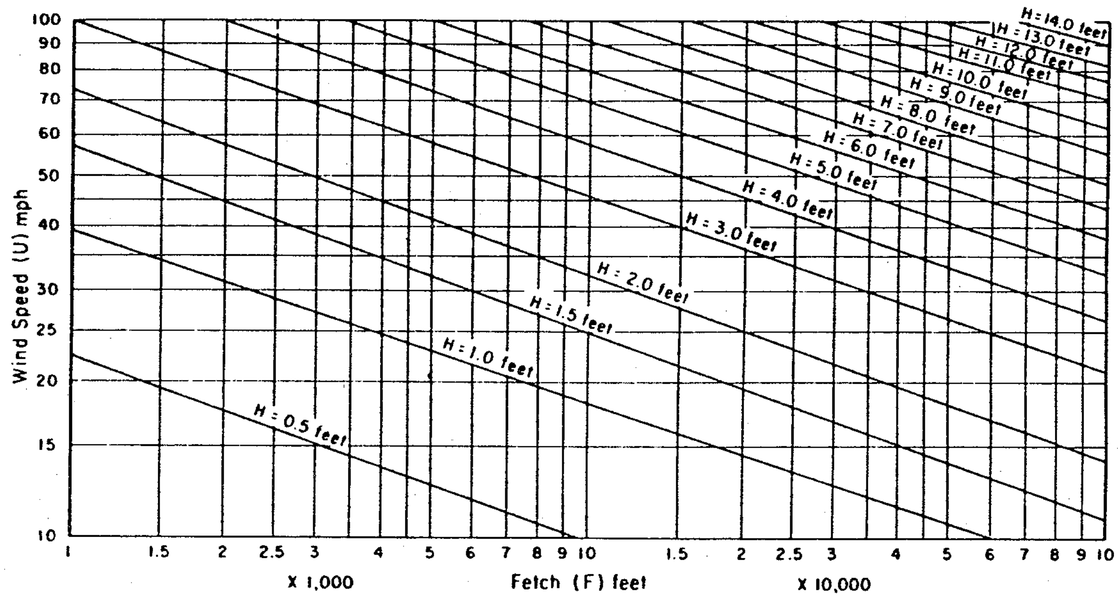
constant depth



40 ft.

50 ft.

constant depth



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