Lake Berryessa
Water Recreation Carrying Capacity Analysis

SOLANO PROJECT, CALIFORNIA

SEPTEMBER 1988

As the population grows and interest in water-based recreation increases, the already heavy recreation pressures on water resources will reach critical proportions. The problems stemming from this pressure are among the most difficult in the entire outdoor recreation field.

- OUTDOOR RECREATION RESOURCES REVIEW COMMISSION, 1962 -

AN ANALYSIS OF THE WATER RECREATION CARRYING CAPACITY OF LAKE BERRYESSA

SOLANO PROJECT, CALIFORNIA

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ABSTRACT

Lake Berryessa Recreation Carrying Capacity Analysis

Bureau of Reclamation regional personnel are preparing a RAMP (Reservoir Area Management Plan) for Lake Berryessa of the Solano Project, California. The lake, which is developed, operated, and maintained for recreation by Reclamation since 1975, received 1.9 million visitor days of use in 1986.

Public information meetings for preparing the RAMP were held in the spring of 1987. Testimony expressing a desire for a recreation carrying capacity study on the lake was given by many of the recreation visitors. The region requested assistance from the Division of Water and Land Technical Services to do a recreation carrying capacity study. The study would become a part of the RAMP.

There was no time to conduct original research on the recreational carrying capacity of Lake Berryessa. The outdoor recreation planner, who has expertise in recreation carrying capacity of water resources, conducted an analysis of the water recreation use of the lake. An ecological consortium for population distribution and organization analysis was conducted. Forty-four activities occurring on the water surface were identified by Lake Berryessa recreation management personnel. The interaction of the forty-four activities were analyzed for conflict, compatibility, neutrality, and intraspecific competition among each other, and for recreation resources in short supply. Of the forty-four activities, only eleven have any recreation standards. Standards are useful for planning. They are not applicable to the management of a diverse and disorganized recreation population participating in forty-four activities on a large lake. Activity transparencies were overlaid to identify areas of conflict on the lake.

The analysis resulted in the following conclusions:

1. The recreation use is not evenly distributed on the water surface.

2. Recreation use is in concentrated pockets along the west and south portions of the lake in proximity of the concession and public access areas.

3. Even distribution of the water surface can be achieved by developing additional public day use access in the north area of the lake.

4. The most vulnerable activities to conflict are those with passive solitary experience expectations.

5. Conflicting uses which usually cause the perceptions of crowding must be separated by time, space and enforcement.

6. Management, with public input, must decide if solitary uses are desirable and resources should be committed for that experience on the north part of the lake.

Additional development could reduce the amount of area that could be zoned for solitude and nonmotorized use. "Carrying capacity" is an unusable concept for

ACKNOWLEDGEMENTS

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managing recreation use on water at the lake.

Management techniques for achieving optimum recreational use of the water surface are included in the analysis. Management and the public must decide what techniques to use to reduce conflict, and enhance the public health and safety of lake users. Education, boat registration, permits for specific uses, minimal new regulations, and public involvement and support are essential to achieving optimum use. Water recreationists will determine what their saturation of use levels are, and management has the power for ultimately determining what activities to allow and disallow to reduce conflicts.

Education of resource use and expectations have been successfully used by other agencies which abandoned the carrying capacity concept for management. Lake Berryessa can achieve greater use, have an improved quality of user experience, meet more recreational needs of the general public, and minimize resource degradation through education. Management cannot rely solely on enforcement provided by outside entities, nor by the Bureau which has no law enforcement authority. Education is a means to get cooperation from lake users who could apply peer pressure.

The ecological consortium analysis is a useful tool to sort out recreation uses and identify the conflicts occurring on the water. The analysis allows identification of the managment problems, an understanding of the nature of activity conflicts, and how the problems may be resolved. An ecological consortium analysis requires an intimate in-depth knowledge on the recreation use of a water body such as Lake Berryessa.

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CHAPTER I

INTRODUCTION

INTRODUCTION

Lake Berryessa is a water storage facility of the Solano Project built by the Bureau of Reclamation in the 1950's. Since June 1975, Reclamation managed the recreation planning, development, operation, and maintenance of Lake Berryessa.

Reclamation has responsibility to prepare a RAMP (Reservoir Area Management Plan) which will orchestrate all the uses of Lake Berryessa now and in the future. Preparation of the RAMP began during 1987. Reclamation held several public information meetings during May to receive viewpoints of people who live in the region and use Lake Berryessa. During the meetings, the people expressed concern and a need to look at the recreation carrying capacity of the lake.

This recreation carrying capacity analysis is prepared for Reclamation's Mid-Pacific Regional Office and the Lake Berryessa Recreation Office in response to the public request for determining capacity. This analysis will become a part of the RAMP.

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CHAPTER II

PURPOSE

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The purpose of this analysis is severalfold:

A. Provide management an understanding of the recreation carrying capacity concept.

B. Apply the recreation carrying capacity concept to the recreation use of Lake Berryessa through an ecological consortium analysis.

C. Provide management the tools to manipulate the recreation use of Lake Berryessa to optimize capacity, and enhance the experience, quality, and safety of the lake users.

This analysis is empirical and academic. There is no new original research involved nor is any recommended for Lake Berryessa at this time. The analysis is based on the authors' observations and information provided by Reclamation personnel who are very familiar with the lake.

This analysis will not recommend any absolute numbers of participants who would be allowed to use the water surface of Lake Berryessa. Subsequent research should be considered for such specific management decisions. As long as adequate recreation land facilities for water access are available for public use, people will not be turned away from using the water. Concessions will not

be deprived of making a profit due to imposing water capacity limitations on the lake.

This analysis only applies to Lake Berryessa and no other water body which receives public use.

CHAPTER III

METHODS AND PROCEDURES

METHODS AND PROCEDURES

A. Describe Lake Berryessa resources, development, management, and use characteristics as a part of capacity. This analysis will not evaluate resource deterioration.

B. Conduct a selected literature review on recreation capacity observations, studies and subjects related to carrying capacity.

C. Describe the activities, resource requirements, and locations for each.

D. Conduct a recreation activity matrix analysis using an ecological consortium approach.

E. Based on the matrix analysis, findings, and results, this effort will provide management options to guide recreation use of Lake Berryessa.

F. The management options should be jointly reviewed by management, the concessions, and Lake Berryessa recreation users. Full cooperation by all parties is essential to establish a meaningful recreation capacity use of the lake.

G. If time permits, a review of this analysis will be requested from others who are knowledgeable and have expertise about the recreation carrying capacity of water resources. Their viewpoints will be included as an appendix to this analysis.

CHAPTER IV

DESCRIPTION OF LAKE BERRYESSA

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General Description

Lake Berryessa is the storage facility for the Solano Project in mid-California. (See Figure IV-1 Location map.) The project irrigation service area is located in Solano County adjoining the northeast extremity of San Francisco Bay. The lake is located in Napa County within a 1-1/2-hour drive of the San Francisco Bay area and Sacramento, California. The Lake Berryessa recreation service area population in 1986 was about 6.8 million people.

The reservoir, impounded by Monticello Dam located in Napa County, stores drainage from a 576 square mile basin of Putah Creek. The water is stored for irrigation and municipal and industrial use. In winter, the runoff occurs almost immediately after precipitation. During the late summer, Putah Creek has little or no surface flow. There usually is subsurface drainage.

The Solano Project was built by the Bureau of Reclamation and completed in 1957. Recreation use began in June 1959. There are 8,958 acres of project land adjacent to the lake available for recreation.

At the top of conservation pool, the lake is 25 miles long, has a maximum width of 3 miles and 165 miles of shoreline and a atorage capacity of 1.6 million acre-feet. At 440 feet elevation, which is the top of the conservation pool,

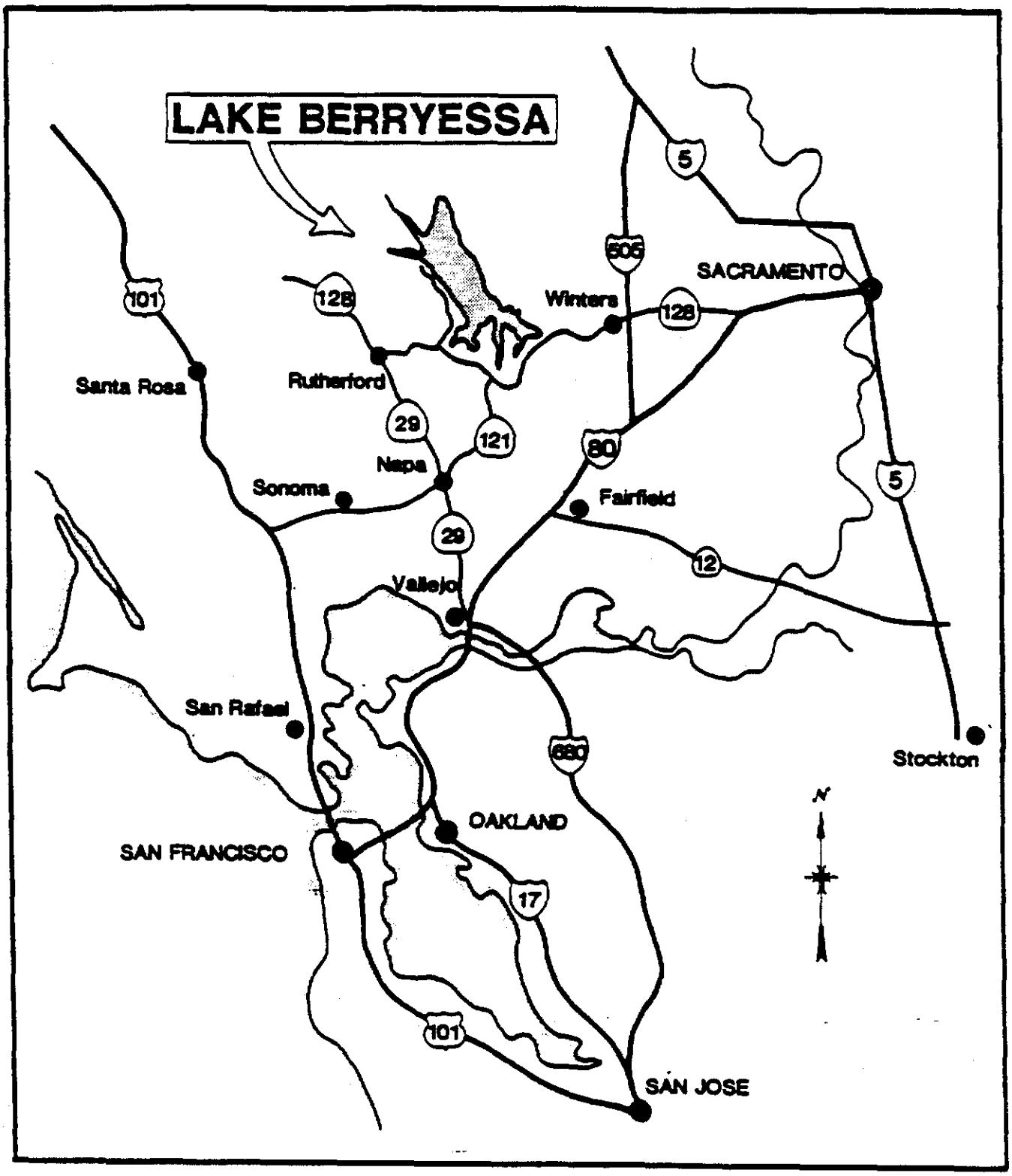


Figure IV-1. - Location map of Lake Berryessa

the surface area is 20,700 acres. During the recreation season, April 1 to October 15, the water level will usually fluctuate 17 feet due to water withdrawals for project purposes. Maximum depth is over 200 feet and no minimum pool has been established for water withdrawal or to sustain a fishery.

Physical obstructions on the reservoir are primarily the irregular and ever-changing reservoir bottom lands. As water is withdrawn, the bottom lands become exposed or form sand bars, spits, and shallow areas. The foreshore areas are muddy and, eventually, dry out after several days of exposure. Buoys are usually placed in the more heavily used areas of the reservoir to keep boats away from the shallow areas.

A Pacific Gas and Electric double circuit 115-kV transmission line crosses the south end of Lake Berryessa. The clearance between the line and water level is 37.5 feet when the reservoir is at top of conservation pool. A steel and concrete road bridge crosses Pope Creek which drains into the reservoir. The clearance of the bridge above the water at the top of conservation pool is approximately 45 feet. Another concrete bridge crosses Putah Creek about 40 feet above the reservoir water.

Concessions

There are seven concessions located along the west and south shores of the lake (see Appendix A, Lake Berryessa Map). They offer marina facilities and services, food and general stores, and some campsites. See Figure IV-2, Facilities Chart. Most of the concessions on the chart have picnic and camping facilities on the lake except Markley Cove which has houseboat rentals. The concessions have minimal swim areas on the lake. All the concessions have long-term sites that are leased to clientele on a year-to-year basis. The

FACILITIES CHART

Prices Subject to Change

707 - AREA CODE ZIP - 94558	Markley Cove 966-2134	South Shore 966-2172	Steele Park 966-2123 255-2727	Spanish Flat 966-2101	Rancho Monticello Resort 966-2188 Marina 966-2216	Berryessa Marina 966-2161	Putah Creek 966-2116	Sugar Loaf 966-2347	Monticello General Store 253-2312 Moskowite Corner	Bob Pierce 76 Station 226-6844	Turtle Rock 966 2708
Day Use	None	4.00	5.00	3.00	5.00	3.00	3.00	Yes	Free		
Day Use and Boat Launching	4.00	6.50	6.00	5.00	7.00	5.00	5.00	No	None		
Campsites w.o. hookups	None	8.00	7.00 w/Elec 10.00	7.00	1st rate 11.00 std 9.00	6.50	8.00	No	NA		Yes
Campsites w/Elec.	None	10.00	None	8.00	None	None	9.00	No	NA		
Campsites Full Hookups	None	None	10.00		1st 13.00 after 11.00	8.00	10.00	No	NA		
House Boat Parking	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes		
Fishing License	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	NA		
Boat Rentals	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	NA		
Boat & Motor	Yes	No	Yes	Yes	Yes	Yes	No	No	NA		
Ski Boats	Yes	No	Yes	Yes	No	No	No	No	NA		
Jet Skis	Yes	No	No	Yes	No	Yes	No	No	NA		
Boat Docks	Yes	Yes	Yes	Yes	No	Yes	Yes	No	NA		
Dry Storage	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Yes
Close Storage	No	No	Yes	No	Yes	No	Yes	Yes	No	Yes	Yes
Motels	No	No	41 units	No	No	No	28 units	No	No		Yes
Ice	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Restaurant	Yes	Yes	Yes	Yes	No	Yes	Yes	Yes	Yes		Yes
Snack Bar	Yes	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes		No
Bar & Lounge	Yes	Yes	Yes	Yes	No	Beer & Wine	Yes	No	Yes		Yes
Deli	Yes	No	Yes	Yes	No	No	Yes	No	Yes		No
Grocery Store	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes
Bait & Tackle	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Gasoline	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	NA	Yes	Yes
Propane	Yes	Yes	No	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
Marine & Auto Repair	Yes	No	Available	Yes	Yes	No	Yes	No	NA	Yes	Yes
House Boat Rentals	Yes	No	No	No	No	No	No	No	NA		No
Visitors Info Center								Yes	Yes	Yes	Yes
Lake Berryessa Chamber of Commerce	Markley Cove 966-2134	South Shore 966-2172	Steele Park 966-2123 255-2727	Spanish Flat 966-2101	Rancho Monticello Resort 966-2188 Marina 966-2216	Berryessa Marina 966-2161	Putah Creek 966-2116	Sugar Loaf 966-2347 966-0114	Monticello General Store 253-2312 Moskowite Corner	Bob Pierce 76 Station 226-6844	Turtle Rock 966 2708
ZIP	95694	94558	94558	94558							

Figure IV-2. - Lake Berryessa facilities.

lessees have placed travel trailers and mobile homes on the long-term sites which are maintained year-round. The lessees use the travel trailers and mobile homes as secondary recreational homes primarily during the recreation season. Some lessees occupy their travel trailers and mobile homes year-round.

The resorts provide rudimentary camping facilities, picnic areas, and other facilities for the short-term users. Short-term users will fill the resort facilities to capacity on occasion.

Public Facilities

Reclamation is responsible for the overall recreation administration, public facility development, and operation and maintenance of Lake Berryessa. Public Law 93-493, Title VI "Solano Project Recreational Facilities" dated October 27, 1974, authorized Reclamation to, "...develop, operate and maintain such short-term recreation facilities...for the safety, health, protection, and outdoor recreation use of the visiting public."

Since June 1, 1975, Reclamation developed and now operates three day-use facilities located on the west side of the lake. The facilities at Capell Cove, Smittle Creek, and Oak Shores offer boat launching, parking, picnic sites, swim beaches, and trails. Only Oak Shores is a United States recreation fee area.

Many of the short-term visitors prefer Bureau-developed day-use areas or undeveloped areas. Demand for Bureau day-use areas is extremely high; all facilities are usually full on most weekends during the peak seasonal use period. Moderate to heavy use occurs on the weekdays.

Existing Developments

Of the 8,958 acres of land around the lake available for public use, 18 percent, or 1,611 acres, are developed; 1,299 acres are developed by the concessions; and 312 acres are developed by the Bureau. The limiting factors for development include topography that causes inaccessibility to the water and slopes in excess of 25 percent being unsuitable for development.

Lake Berryessa has 165 miles of shoreline of which 37.7 miles (23 percent) are developed. Undeveloped access by the concessions is 27.7 miles and by the Bureau is 10 miles.

There are no Bureau-developed marinas. The seven concessions have marinas providing a total of 1,507 long- and short-term boat slips. Most of the slips are occupied by the long-term visitors who have leased sites. There are no moorage buoys at the concession or Bureau facilities to accommodate boat storage on the water.

Courtesy docks to accommodate boaters who launch and load their boats are provided by the Bureau and concessionaires. Only 4 boats can be accommodated by Bureau facilities compared to 74 by the concessionaires. The concessionaires usually accommodate boaters who stop to buy supplies.

Only the concessions have rental boats. There are 21 houseboats, 83 other boats, and a total of 28 jet skis and wet bicycles available.

There are sufficient boat-launch ramps and lanes at the concessions to launch 336 boats per hour (allowing 10 minutes per boat per lane). There are 7 ramps with 56 total lanes provided by the concessionaires compared to 3 ramps with 4 lanes provided by the Bureau.

Parking facilities for launching boats are described below:

Launch Parking	Bureau	Concessions
Total parking units - car only	362	538
Boat trailers only	0	675
Car and boat trailer	106	393

Beaches for designated swimming are available at two concessions and two of the Bureau areas. The accommodations are described below:

	Bureau	Concessions
Designated swim area	4 acres	.04 acre
Sand beach area in square feet	115,900	12,220
Beach house	0	0
Parking for swimmers - No. of units	32	215 a/
Lifeguard (manned areas)	1 yes	7 no

a/ Not truly for swimming only.

Visitation and Use

Lake Berryessa receives most of its annual visits between Memorial Day and Labor Day. The primary recreation season for this analysis is April 1 through October 15.

Table IV-1 "Visitor Days of Recreation Use on Lake Berryessa" shows the visitor day use of the lake more than doubled from 948,038 in 1980 to 1,938,957 in 1986.

Table IV-1. Visitor days of recreation use on Lake Berryessa 1/

Year	Visitor Days 2/
1979	989,002
1980	948,038
1981	778,278
1982	1,212,600
1983	947,863
1984	1,231,723
1985	1,742,093
1986	1,938,957
1987	1,413,411

1/ Based on U.S. Department of the Interior, Bureau of Reclamation, Summary Statistics - Water, Land, and Related Data (Annual Reports 1980-1986), Volume 1, Table 14. "Utilization of Recreation Areas on Reclamation Projects."

2/ Recreation use fluctuates from year to year for any specific area because of changes in local conditions such as precipitation and temperature, quantity and quality of reservoir water, or reported conditions for a particular activity. In 1985, recreational use on Reclamation project facilities totaled a record 50.9 million visitor days - up 1 percent from the 50.4 million visitor days in 1984. This recreation use is based on the 12-hour visitor day, or 1 visitor day per person involved in some form of recreation activity during a continuous 12-hour period. Recreation use is measured also by number of visits. Recreation visits to Reclamation project lands totaled 80.0 million in 1985.

The recreation activities are diverse on Lake Berryessa. Motorboating, fishing, and water skiing are the most popular activities. Reclamation recreation management personnel identified 44 water-oriented recreation activities for purposes of this analysis. The land activities were excluded because this analysis focuses only on water activities.

An activities list, descriptions of the activities, and their resource requirements are provided in another chapter. "Military Activities" is listed as a recreation activity only because it must compete with other activities to use the water surface. The military aircraft drop off parachutists into the lake, which preempts other use commitments of the water surface. Military activities are not recreation per se, however, occasional spectators watch the parachutists drop into the water.

The Lake Berryessa fishery has a mixture of warm- and cold-water species. Warm-water species include bluegill, large and smallmouth bass, crappie, and catfish. Nongame species include squawfish, shad, carp, and suckers. Cold-water species include brook trout, rainbow trout (steel-head), German brown, and chinook salmon. Rainbow trout are stocked, and there is some natural reproduction in the streams which flow into the lake.

Lake Berryessa Climate

Lake Berryessa usually experiences 275 days of sunshine per year with an average annual precipitation of 30 inches. Snow is rare. The mean temperature during the fall and spring is 60 °F, and in the low 70's during the summer. Occasional summer heat over 100 °F occurs during the summer with warm and pleasantly cool evenings. Winters are normally wet and cool with occasional below freezing temperatures. Lake Berryessa does not freeze over.

Prevailing winds are from west to east and less air movement is felt on the west shore. Occasionally, the prevailing winds are fairly strong and produce rough water on the reservoir main body while other areas, including the canyons of the reservoir, are calm. North winds in winter occasionally create hazardous conditions for small boats.

In general, the climate is excellent for recreation. Air temperatures during the May 1 through September 30 recreation season range from warm to hot during the day and warm to cool during the evening.

CHAPTER V

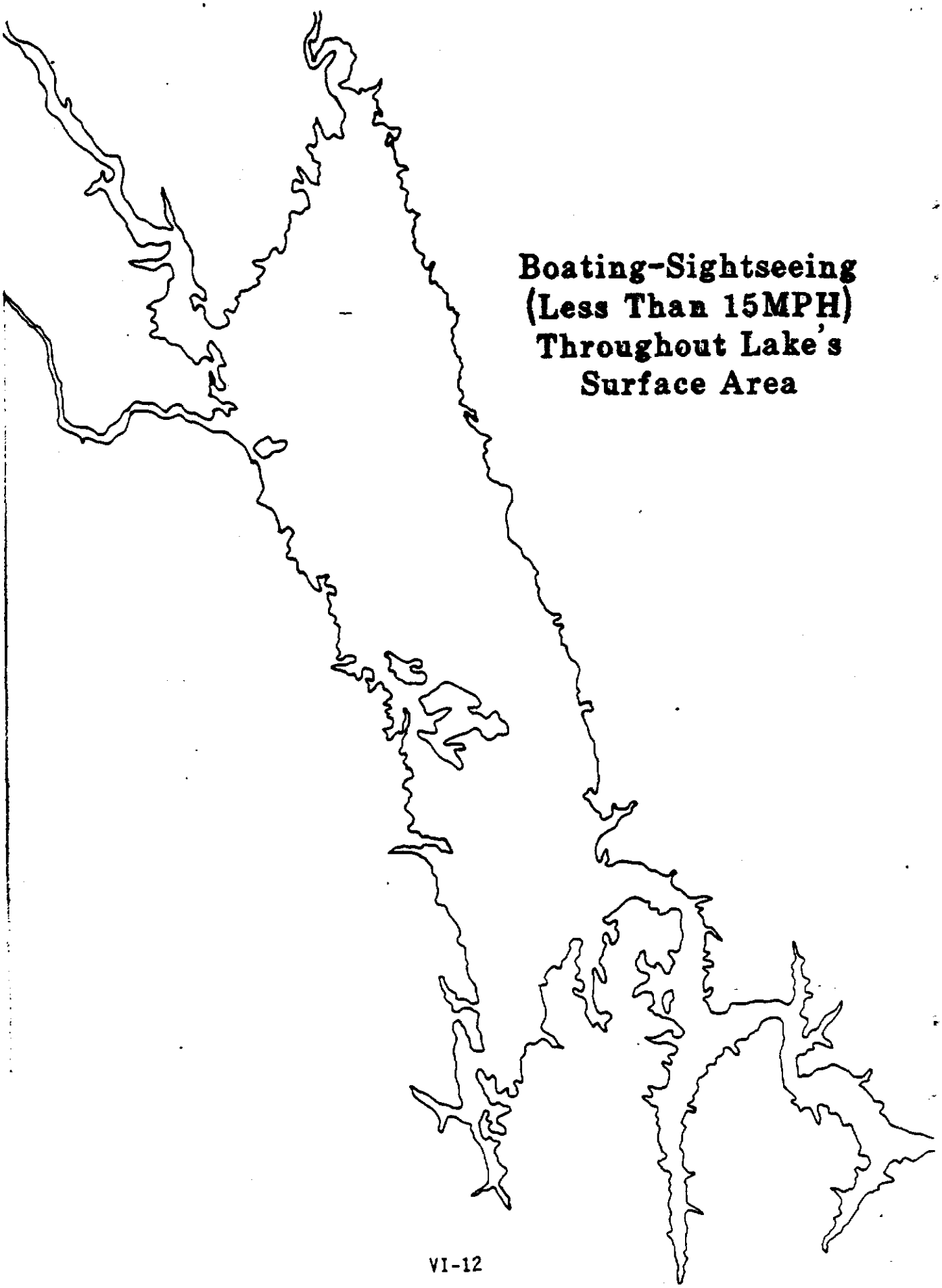
LITERATURE REVIEW

BOATING - SIGHTSEE (less than 15 miles per hour) - EXPERIENCE: Mental

Activity description. - Sightseeing is a generic term that includes people who travel at speeds less that 15 mph to look at the shoreline features, go to a fishing spot, run an errand on water, or just operate a boat for the fun of it. Usually more than one person is in the boat. Boats with small motors are precluded to slow speeds, but boats with capability of greater speeds occasionally operate slower than 15 mph. The length of boat may range up to 55 feet for houseboats. Some boats tend to leave a large wake up to 4 feet high while traveling at slow speed.

Resource requirements. - Standards for boating are in Appendix B. Surface acreage requirements range from 3 to 8 per boat and one person, to 20 acres per boat with an average of 2.5 persons per boat. Water depths will vary from a minimum depth of 2 feet for outboard motors to 4 feet with inboard engines. Water with waves less than 1.5 feet high are preferred for a smooth ride. A diversity of scenic views and natural features are desirable. This activity can occur all year since the lake does not freeze; however, the warmer recreation season is preferred.

Figure VI-5. - Boating less than 15 mph.

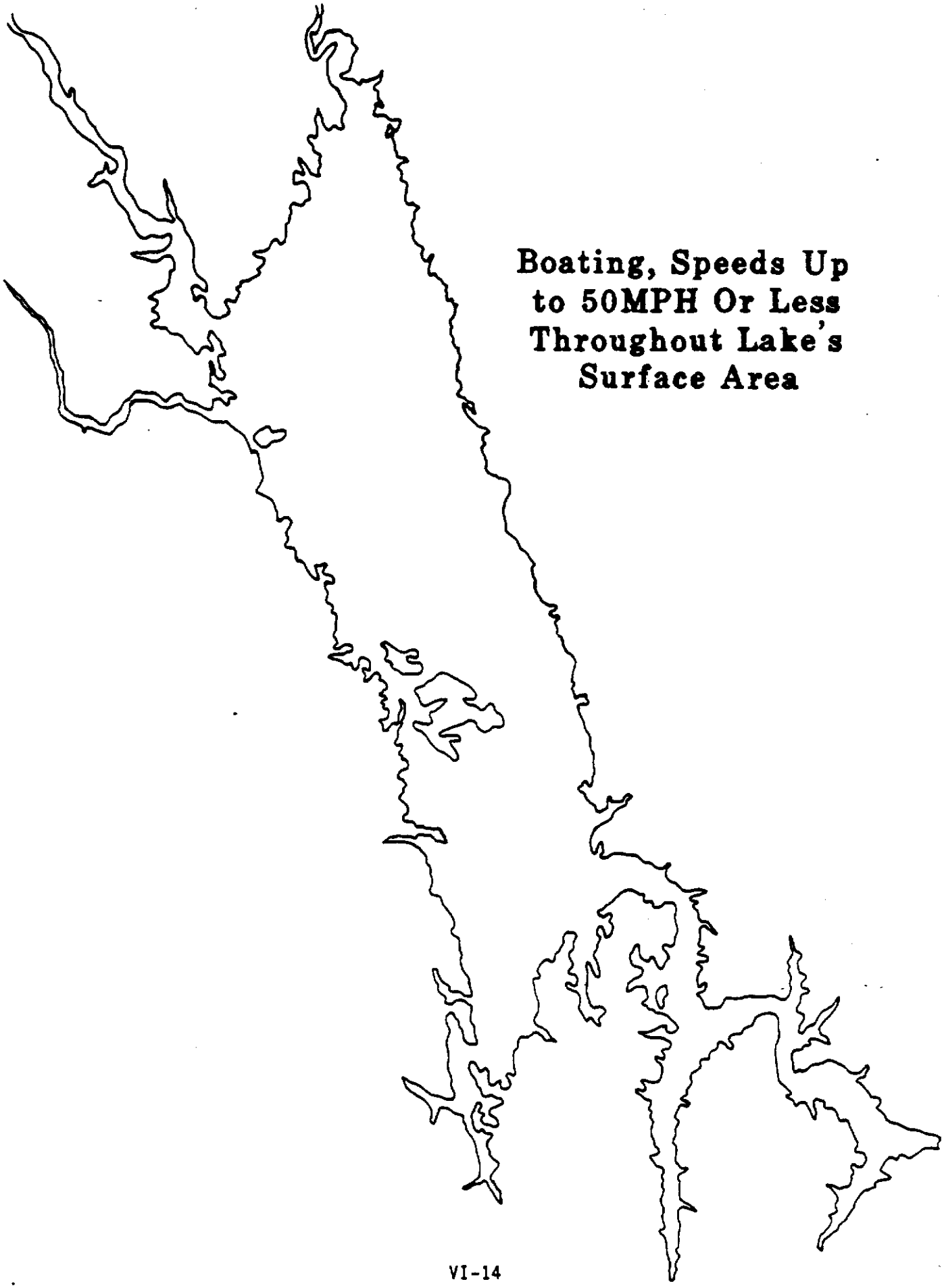

Boating-Sightseeing
(Less Than 15MPH)
Throughout Lake's
Surface Area

BOATING - SPEEDS UP TO 50 miles per hour - EXPERIENCE: Risk

Activity description. - Boats, with various hull configurations and engines with capacity to move a craft across the water at high speeds in excess of 15 mph, are used for various experiences. The high speeds test one's skills of maneuvering, especially if other activities are occurring on the water. Operators feel a "rush" when traveling at high speeds and a challenge to handle a craft at a wide open throttle. High speed boats tend to use the open areas of the lake rather than follow a shoreline. Boats may contain one or more people.

Resource requirements. - Standards for boating are in Appendix B. High speed boating requires a "large body of water," with depths greater than 5 feet and waves less than 1 foot high to calm. Long, straight shorelines without coves, canyons, bays, or confined areas are best to accommodate high speed boats. Good visibility, for operators and for others attempting to stay out of the way, is necessary. This activity can occur any time of year but warmer weather is preferred.

Figure VI-6. - Boating speeds up to 50 mph.


Boating, Speeds Up
to 50MPH Or Less
Throughout Lake's
Surface Area

BRIDGE DIVING - EXPERIENCE: Risk

Activity description. - Bridge diving usually occurs at Pope Creek bridge which accommodates the Berryessa-Knoxville Road highway traffic on the west side of the lake. People, usually in their teens and twenties, either jump or dive from the bridge 40 to 55 feet into the water below. Reclamation does not condone this activity, but it occurs. Why people jump from the bridge is speculative. Challenge, thrill, being a showoff, doing it on a dare are possible reasons. The water is used to break the fall. Another bridge located at Putah Creek is not used for bridge diving. This is an individual activity.

Resource requirements. - There are no standards for bridge diving. The phenomenon is one of those unique activities inherent in the characteristics of Lake Berryessa. The activity requires water at least 20 feet in depth to safely cushion the diver. A water temperature above 70° F is desirable to help reduce the contact shock to the body. The water below the bridge must be free of all natural or manmade obstructions. Calm water is preferred. This activity usually occurs during the warm recreation season.

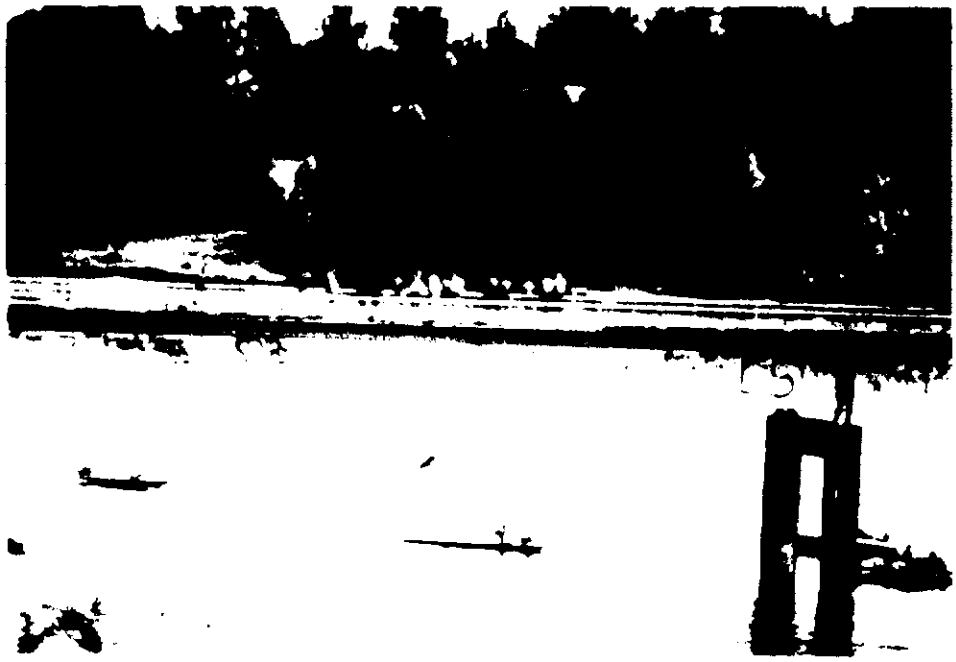
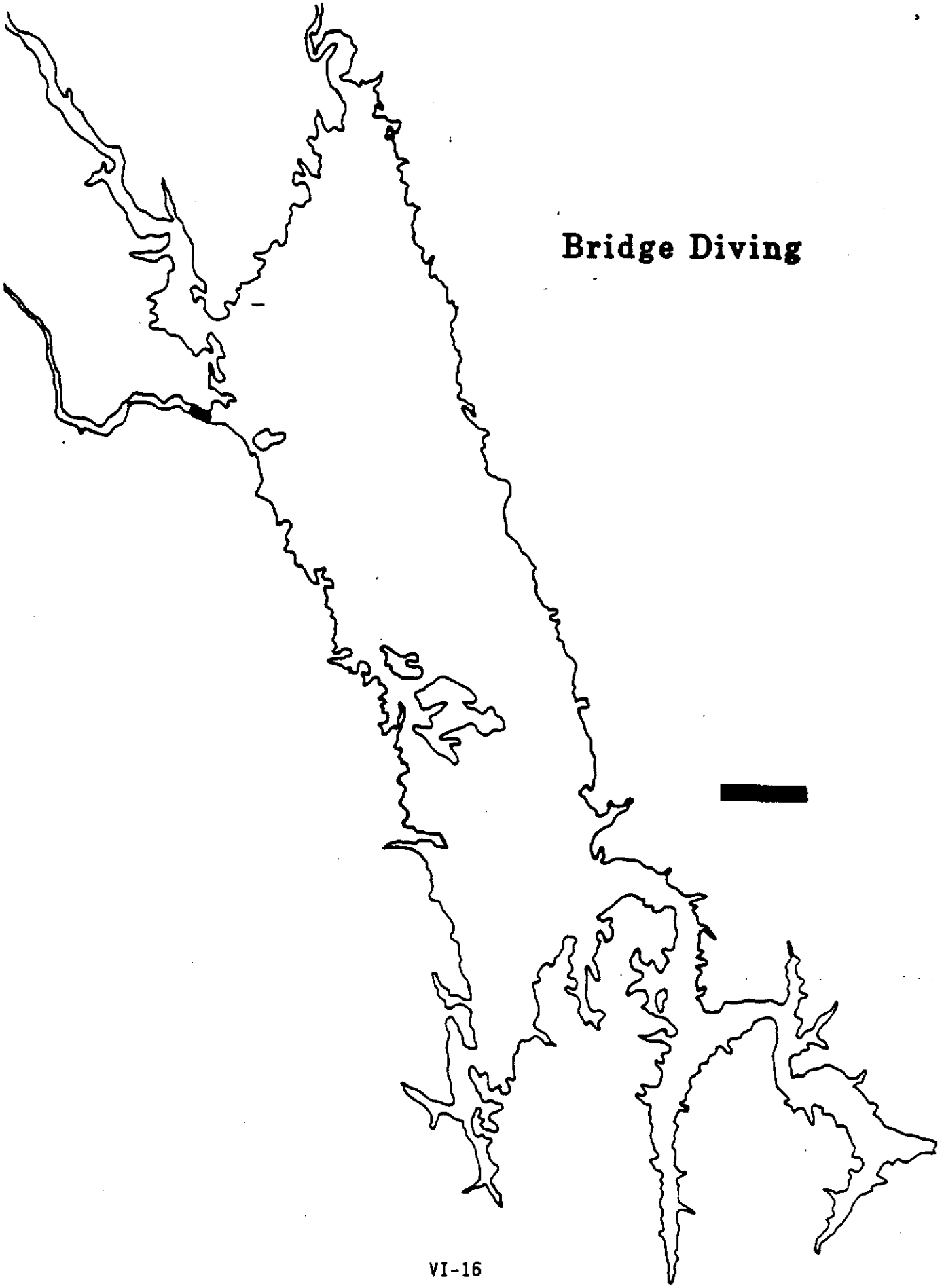


Figure VI-7. - Bridge diving

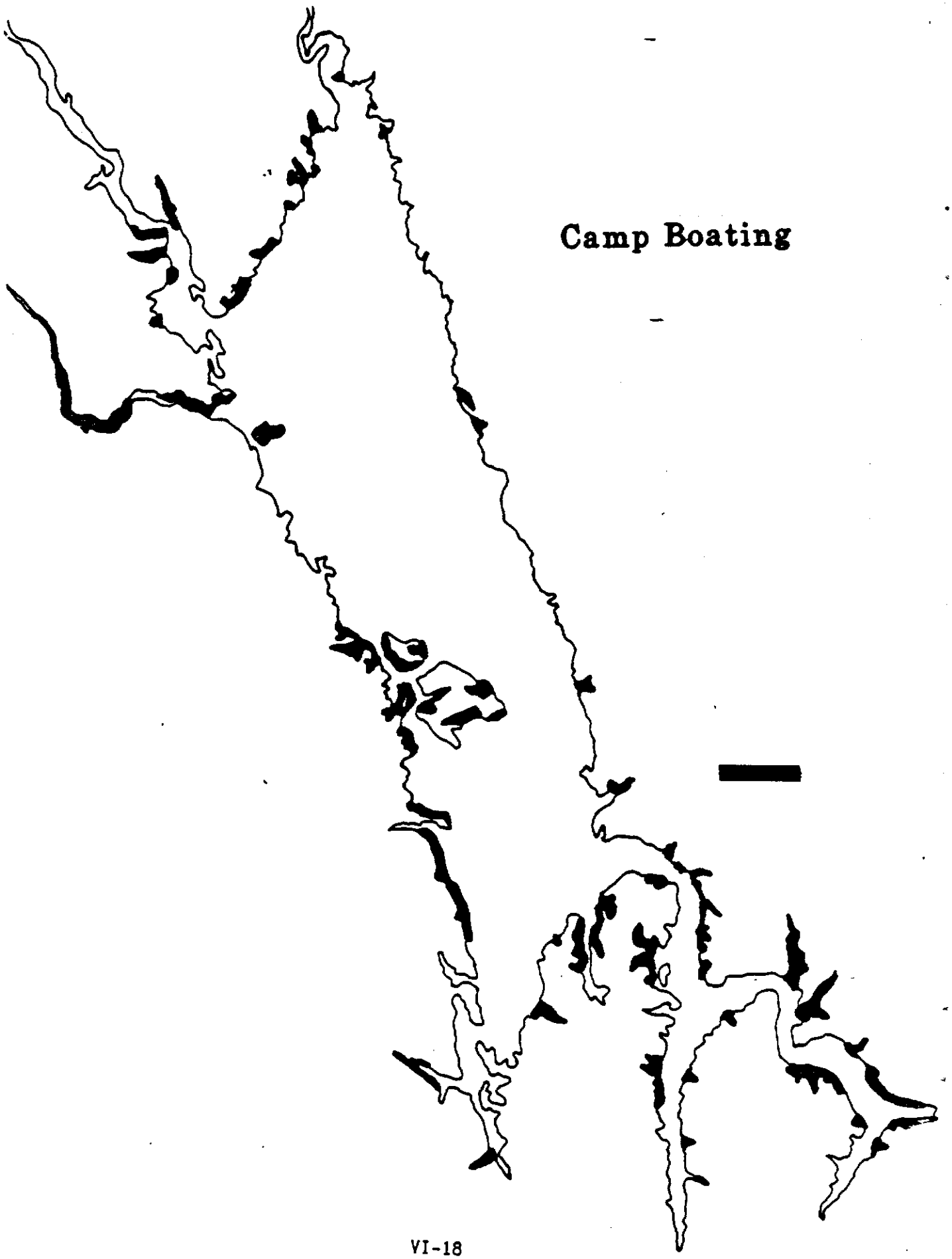

Bridge Diving

CAMP BOATING - EXPERIENCE: Solitary

Activity description. - Camp boating combines two activities. Boating provides the transportation to a remote shore on the lake to camp. Boats also provide the opportunity to participate in other water activities. The camp along the shore is a staging area for all the other activities. Usually several people participate, and it is assumed they want the solitude away from all the noise and people in developed areas. Reclamation does not condone this activity, but it occurs. People usually participate throughout the recreation season.

Resource requirements. - There are no standards for solitude camp boating unless one uses wilderness criteria. Wilderness does not fit Lake Berryessa. A large water body, which does not have development all the way around, is essential for providing solitude. An irregular shoreline can separate users and create the illusion of solitude. A beach to land and unload the boat is desirable. The lake bottom slope should be 10° to 10° so the boat can get in close to the land. No development for activities in nearby areas is essential. The activity could occur any time of the year; however, it usually occurs during the warm recreation season.

Figure VI-8. - Camp boating

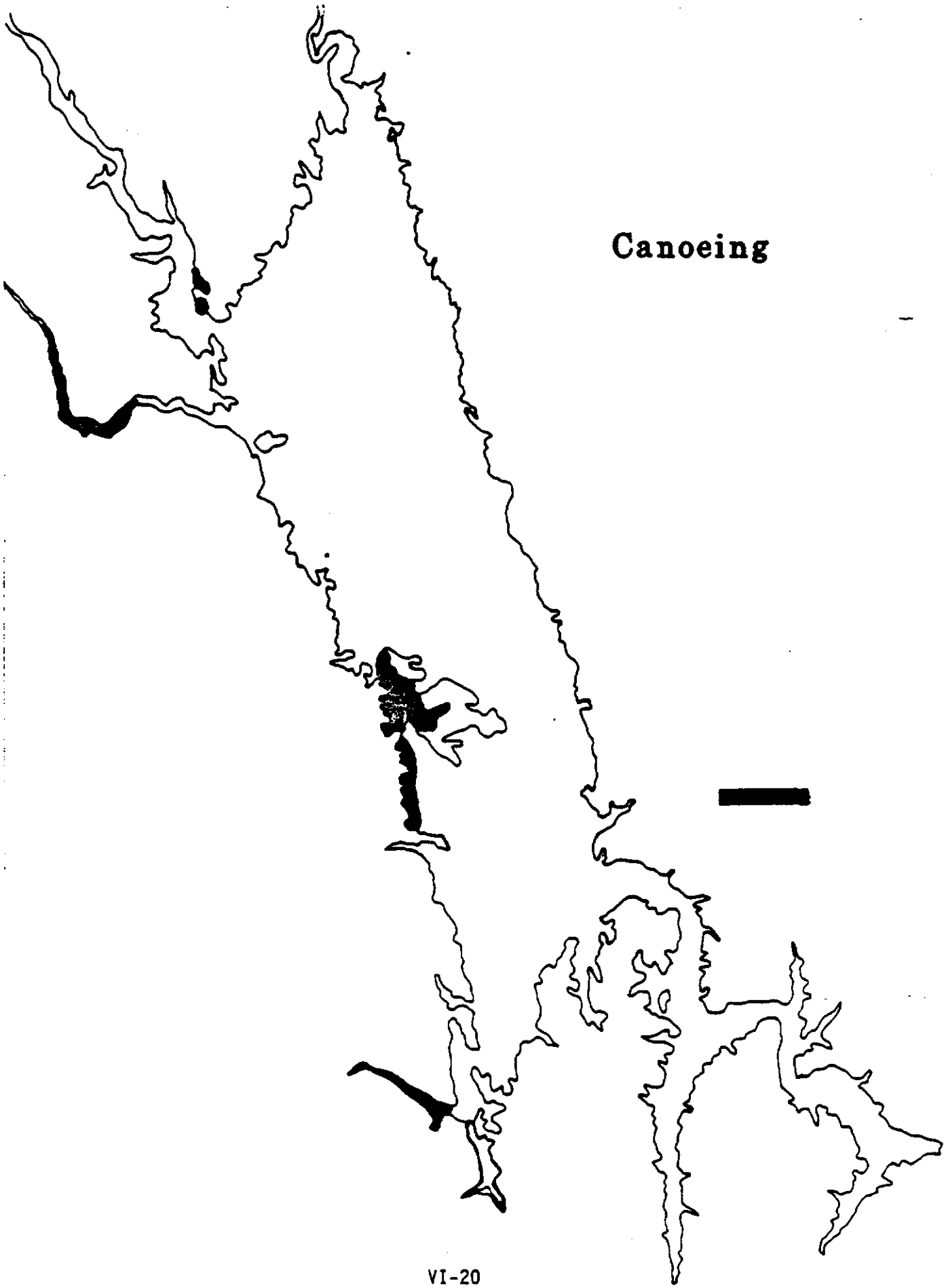

Camp Boating

CANOEING - EXPERIENCE: Solitary

Activity description. - Canoeing is usually in a light, slender boat with pointed ends and is propelled by paddles. Technological advances have varied the designs of canoes and the materials used to make them. Canoes range up to 19 feet long and have square sterns for motors. Smaller canoes have a reputation for instability. Canoes can hold from one to four people safely depending on size and design. Canoes are popular in a controlled group camp situation with water depths relatively shallow. They can go almost any place on the lake for whatever experience people seek. The activity usually occurs in areas protected from the wind.

Resource description. - There are minimal flat water recreation capacity standards of "20 acres in a community park" for canoeing. See Appendix B. Trip canoeing is an "average daily distance of 15 miles." Minimal depth for flotation is 1 foot, and a relatively safe wave height is 1 foot or less. Calm water is preferred. Water temperature can be a factor if a canoe is swamped or capsizes. People can suffer from hypothermia. Canoeing usually occurs during the warm recreation season.

Figure VI-9. - Canoeing


Canoeing

FISH AND WILDLIFE HABITAT CONSERVATION - EXPERIENCE: Mental

Activity description. - Habitat conservation is primarily the planting of willows and other vegetation, placing dead and down trees along the water edge, and placing 20- by 24-inch concrete pipe underwater for food, cover, and reproduction of fish. The willows planted are usually 5-year-old stock. They stabilize the soil. The vegetation enhances the lake esthetics by covering the exposed foreshore zone.

The habitat conservation under agreement between the California Department of Fish and Game and the Bureau is accomplished by the State Conservation Corps and personnel from the Fish and Game and the Bureau. Some volunteers participate in the activity. The experience provides gratification and education. People feel they are helping the propagation of fish and wildlife for present and future generations to enjoy. They also learn about successful planting and how fish and wildlife food, cover, and reproduction requirements are met. The activity occurs primarily in fall although there are occasional spring plantings. Fishing clubs contribute funds for stocking fish in the lake.

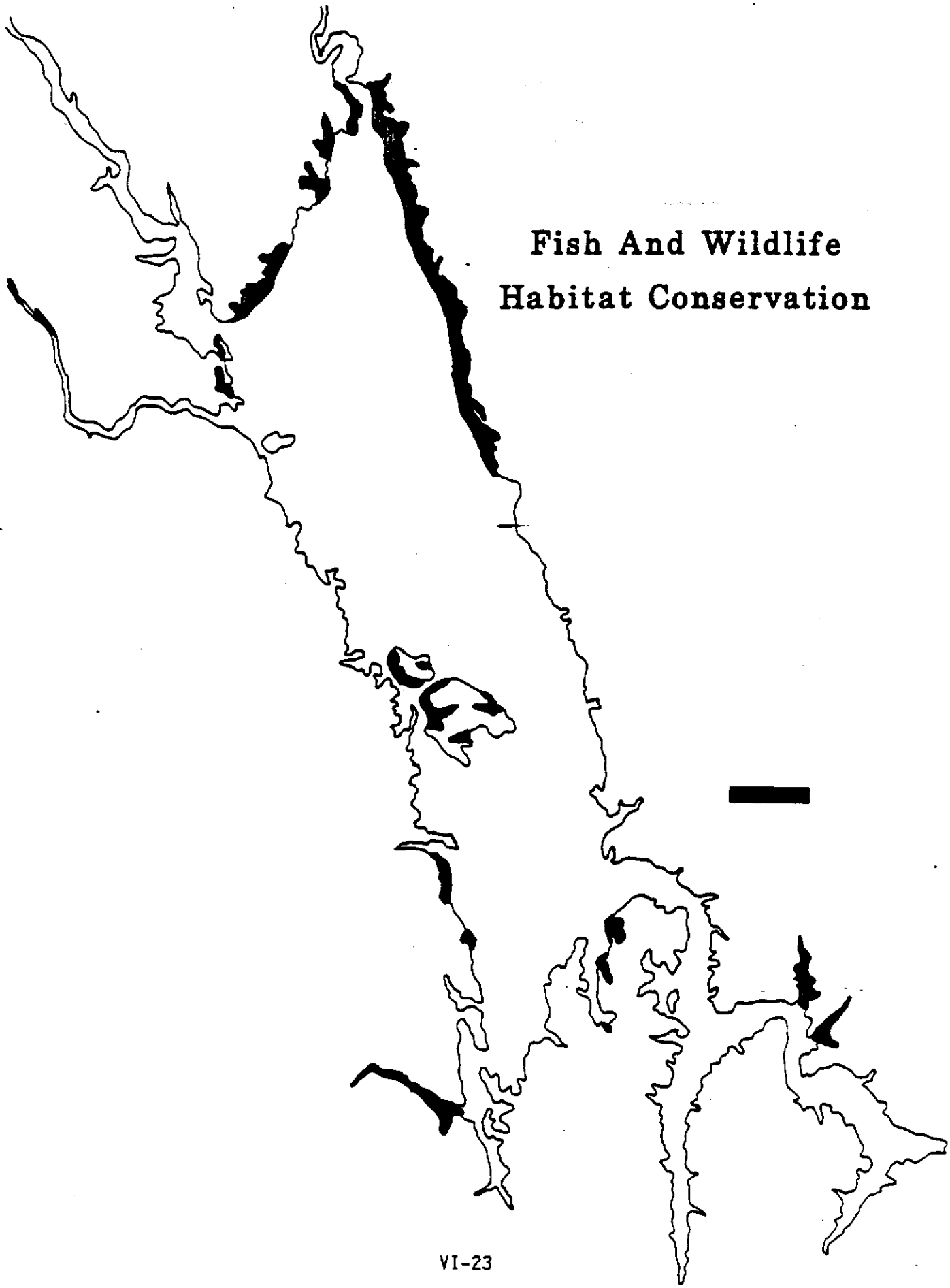
Resource requirements. - The willows must be planted in fertile mature soils at elevations ranging from 420 to 440 feet above sea level. The willows cannot be totally inundated more than 120 days in a row. Some willows require anchoring so they do not wash away. They are anchored with cables to old stumps which are up to 18 inches high. The transplants must be protected from deer. Old dead, fallen trees on project lands must be available to be hauled to the shoreline to provide wildlife habitat on land and fish habitat in the water.

Willow planting

Dead timber on shoreline

Concrete pipe for fish

Figure VI-10. - Fish and Wildlife Habitat Conservation

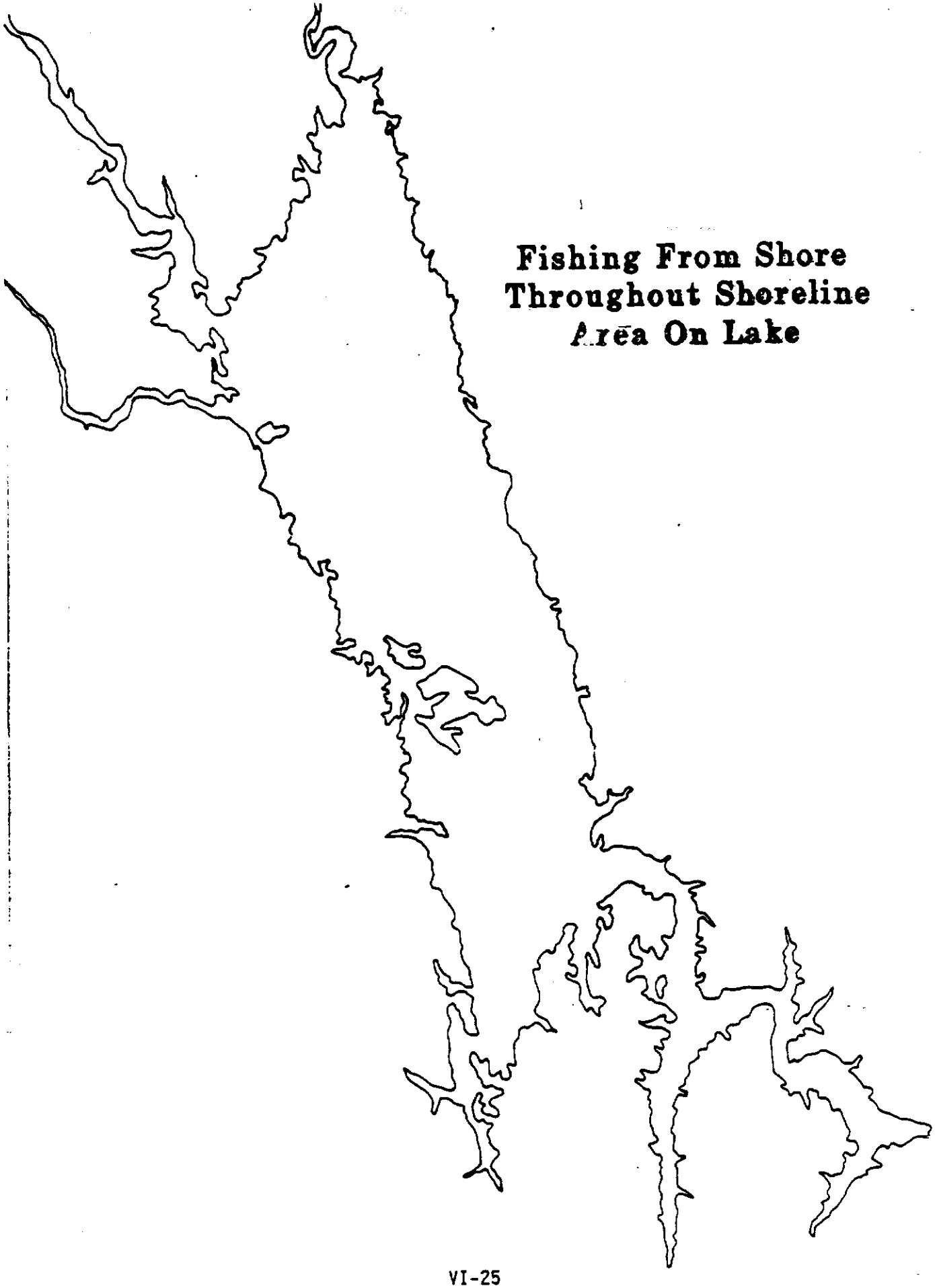

Fish And Wildlife
Habitat Conservation

FISHING FROM SHORE - EXPERIENCE: Solitary

Activity description. - Shore fishing can occur almost any place around the shoreline where there is physical access to the water. Fishermen engage in fly-fishing, spin casting, and cane pole-bobber fishing. Usually, most of the fishing from shore occurs along the west shoreline. Some fishermen want to socialize with other fishermen; however, the more serious fishermen tend to isolate themselves. The activity usually occurs during the designated game fish season, and the daily activity usually occurs in the morning and evening hours when the fish feed.

Resource requirements. - Standards for shore fishing are in Appendix B. Shore fishing requires depths greater than 2 feet within casting distances of 75 feet from the water edge. Cane pole fishing is usually best from a pier or a boat. Calm water is preferred and waves under 1 foot high are tolerated. If waves are greater than 1 foot high, fishermen tend to quit fishing. Fishing "holes" should be free of aquatic vegetation. The activity can occur all year; however, most fishing occurs during the recreation season.

Figure VI-11. - Fishing from shore


Fishing From Shore
Throughout Shoreline
Area On Lake

FISHING - STILL BOAT - EXPERIENCE: Solitary

Activity description. - Fishing can be from a boat that is anchored to stay in one spot, or the boat may not be anchored and drift with the wind. The boat is not powered by oars, paddles, or motors during fishing. The boat is a means to get to a desirable fishing place. Fishing from the boat can include spin casting, fly fishing, or cane pole and bobber. Fishing from a boat can occur almost any place on the reservoir. Fishermen usually adjust their locations to follow the fish which seek favorable water temperatures and feeding areas. The activity usually occurs during designated fishing seasons and during the morning and evening hours.

Resource requirements. - Standards for boat fishing are in Appendix B. Surface acreage requirements range up to 8 acres per boat. Fishermen usually prefer calm water and will tolerate waves up to 1 foot high. Water depth preference will vary with the type of fishing and the game fish sought. A minimum of 1 foot depth is needed for fly fishing or for spin casting with surface plugs. Designated areas solely for fishing in a lake are preferred. If fishermen are catching fish, they will tolerate more crowded fishing conditions. The fishing can occur all year during designated seasons.

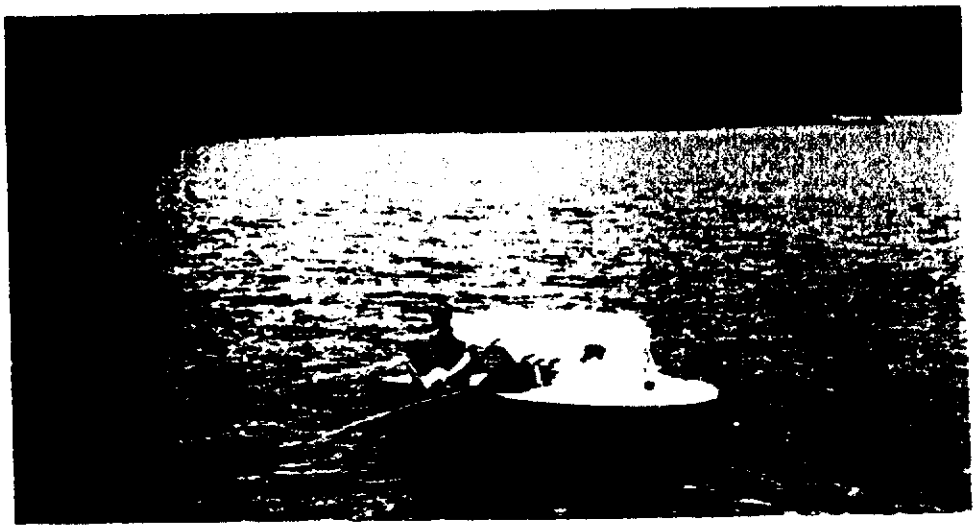
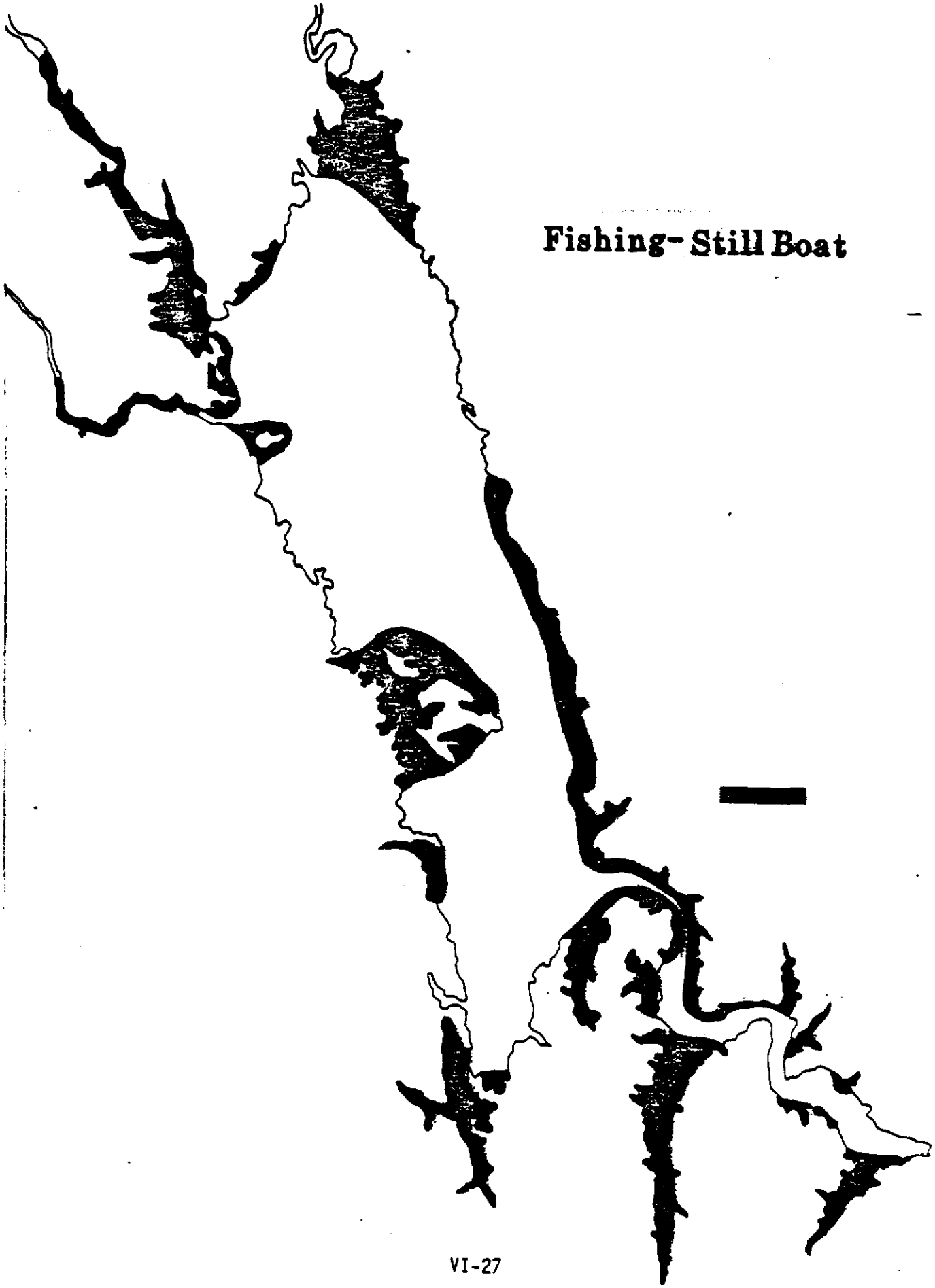


Figure VI-12. - Fishing - still boat


Fishing-Still Boat

FISHING - BOAT TROLLING - EXPERIENCE: Solitary

Activity description. - Trolling from a boat is usually at speeds about 3 mph or less. Trolling can be from any size boat usually equipped with a motor or oars. Up to 50 yards of line with various lures or "pop gear" at the end trail behind the boat. The lures usually are 3 feet or greater below the water surface. Trolling usually occurs in calm water with waves less then 1 foot high. The activity usually occurs during designated fishing seasons and during the morning and evening hours.

Resource requirements. - Standards for trolling for fish are in Appendix B. Up to four trolling boats are allowed per acre. Trolling requires depths greater than 6 feet. Smaller boats prefer waves less than 1 foot high to calm. Larger boats with greater freeboard can handle larger waves. This activity can occur all year but must be within a designated fishing season.

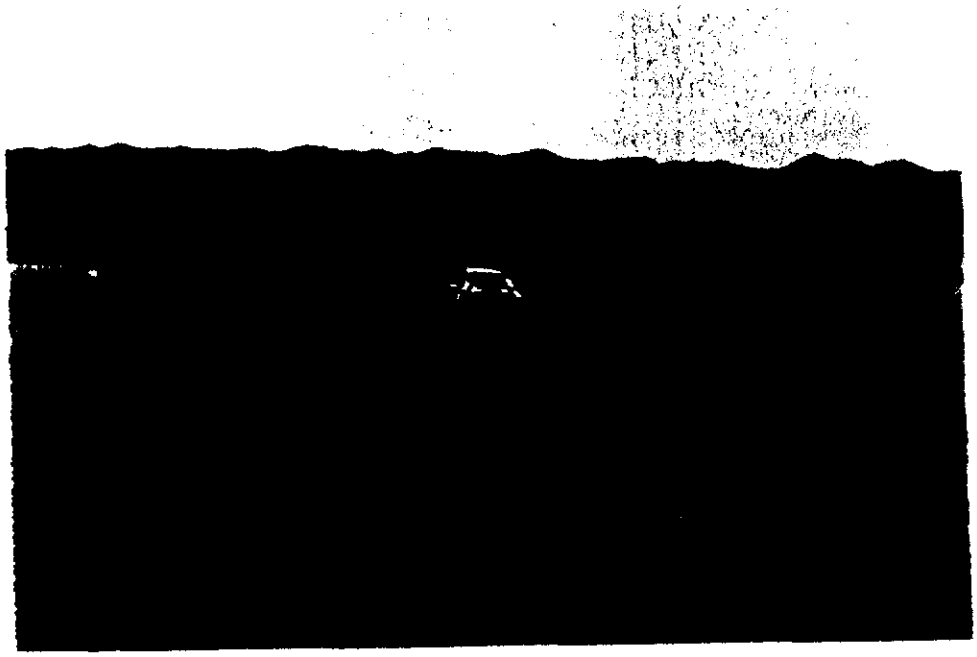
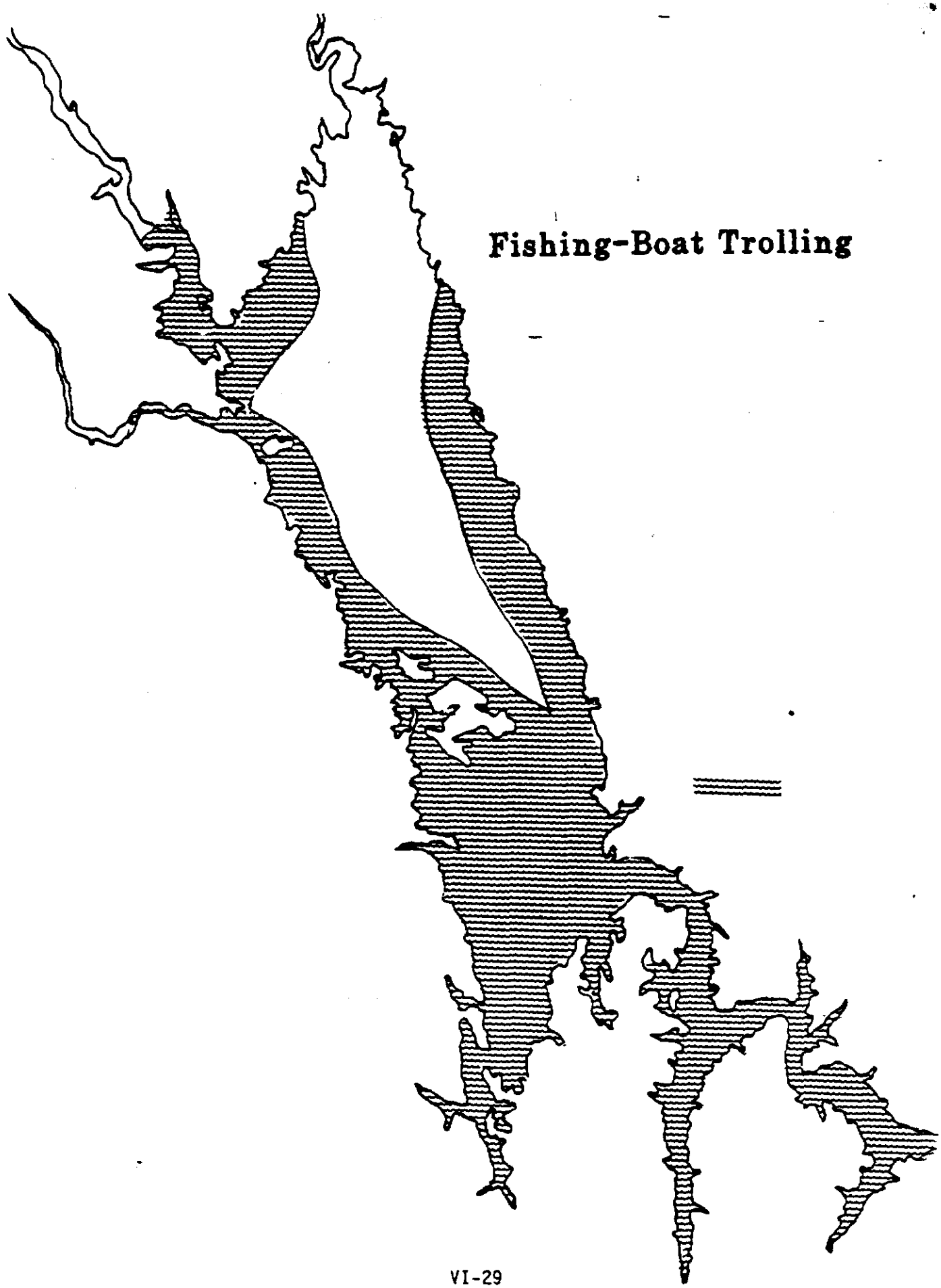


Figure VI-13. - Fishing - boat trolling


Fishing-Boat Trolling

HOUSEBOATING - EXPERIENCE: Social

Activity description. - Groups of people will rent a 55-foot houseboat(s) primarily to enjoy each other, tour the lake, eat, swim and relax. Sometimes the houseboats will go into coves for privacy, or beach on the shore. The activity usually occurs during the recreation season but can occur yearround.

Resource requirements. - There are no recreation capacity standards. The houseboat size, hull configuration, and power tend to create a large wake at cruising speeds. The size alone commands generous space. Small boats in particular feel the ominous presence of houseboats and their wake. Shorelines, which allow beaching of the houseboat for other related activities, should have about a 10° to 13° slope with water being sufficiently deep to keep the outboard motors out of the mud. Coves for privacy are desirable. Houseboats can withstand rough water on the lake and generally are not bothered by other boat wakes. There is no heat on the boat for cold weather which can limit the activity during the off-seasons.

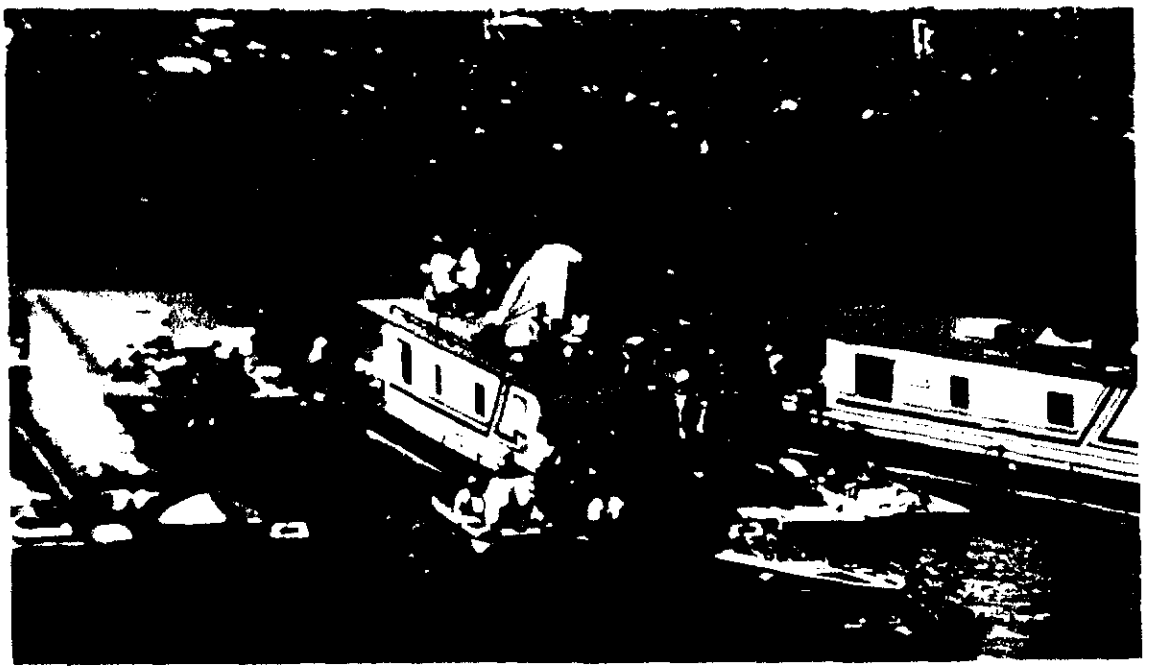
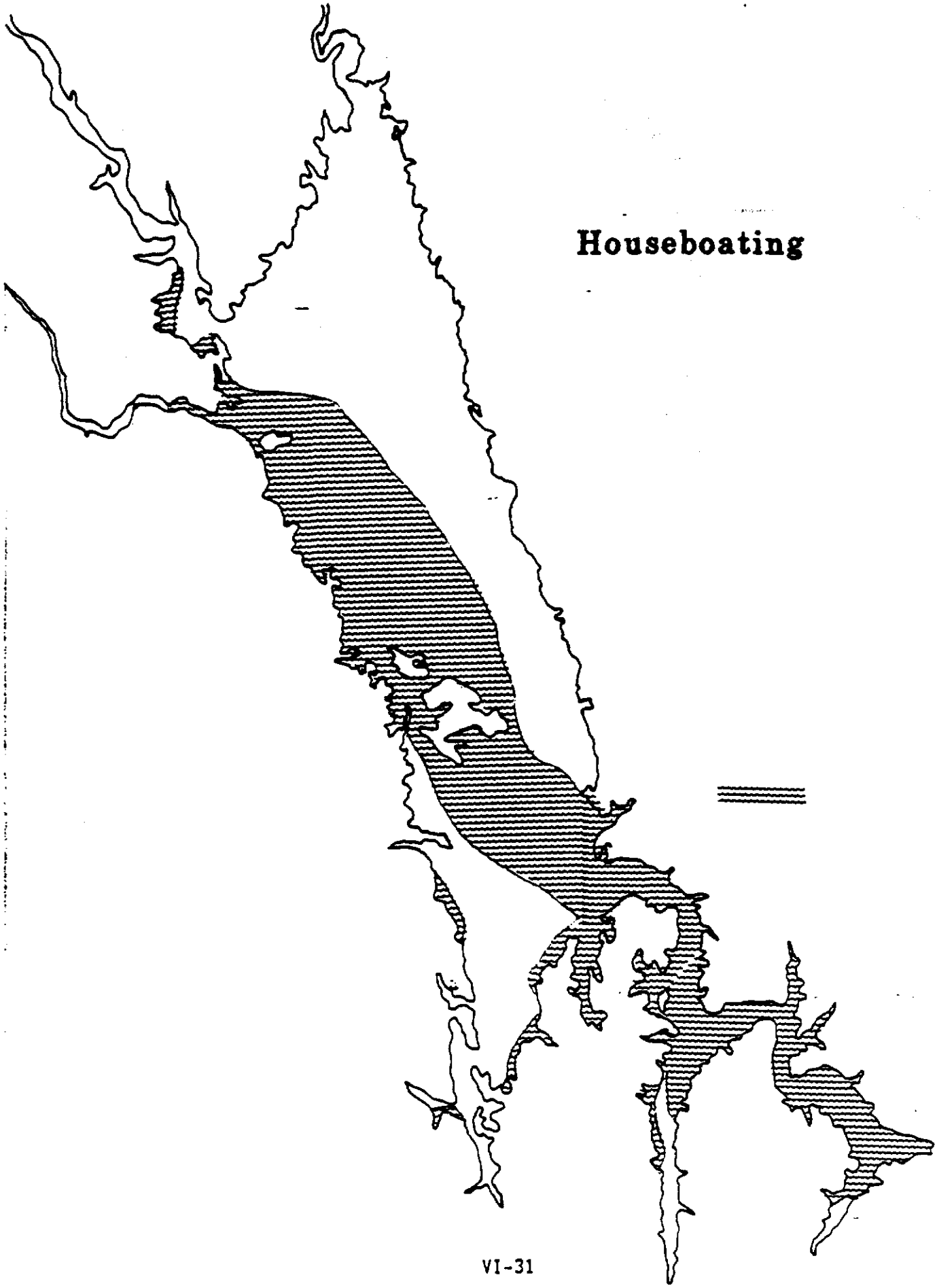


Figure VI-14. - Houseboating

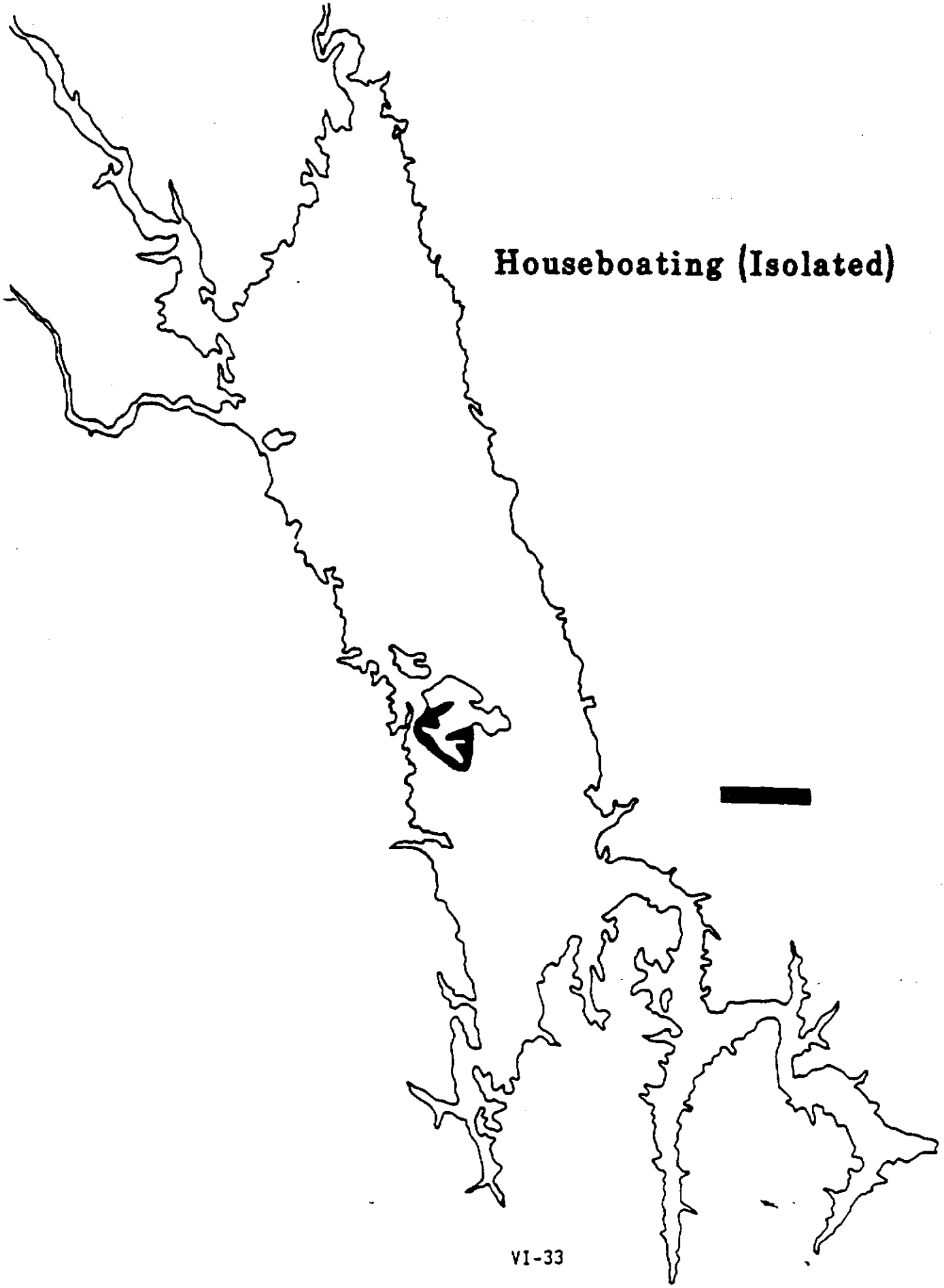

Houseboating

HOUSEBOATING - ISOLATED - EXPERIENCE: Solitary

Activity description. - Houseboats are rented to special interest groups, such as nudists, who prefer to seek privacy in a cove, small canyon, or bay. The activity usually occurs during July. Some sightseeing around the lake may occur. The group socializes within rather than outside of its members. The weather and water are warm enough for the group to swim or participate in other activities such as picnicking close to the houseboat. The activity usually occurs during warm times of the day.

Resource requirements. - There are no standards for this activity. Remote areas away from people are essential. Canyons, coves, or small bays where privacy is available are favored. Voyeurs are a problem. Water temperatures greater than 70 °F are optional for swimming. Warm weather is desirable. This activity usually occurs during the recreation season.

Figure VI-15. - Houseboating/isolated

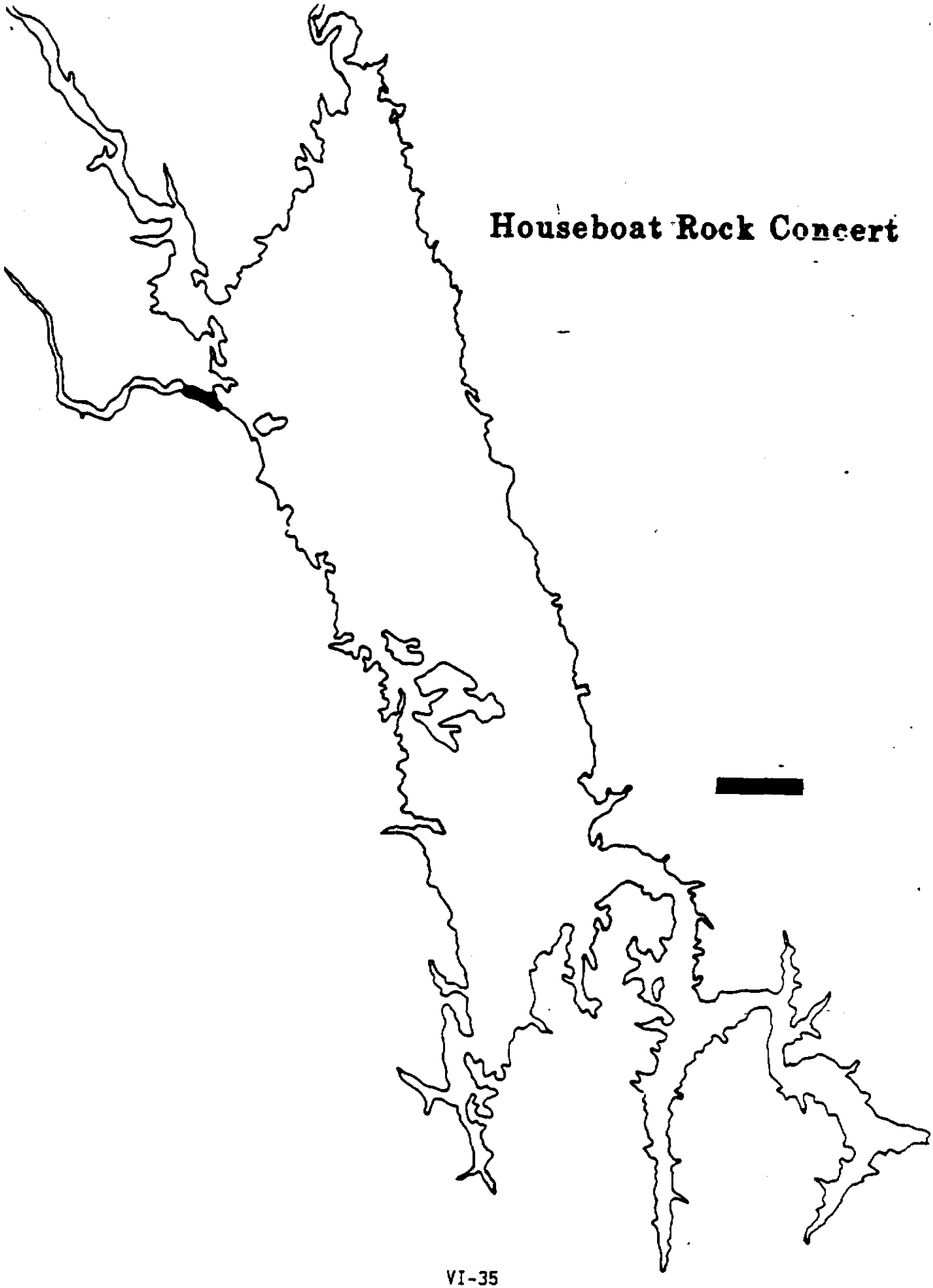

Houseboating (Isolated)

HOUSEBOAT ROCK CONCERT - EXPERIENCE: Social

Activity description. - Groups will rent a houseboat, take it to a place like Pope Creek, drop anchor, and have a musical concert. The band(s) and performers are on the roof of the houseboat. Some of the instruments are electrical and have amplifiers for increased sound. Spectators, both on shore and the water, are attracted by the music. The water spectators come in their boats, jet skis, rubber rafts, air mattresses, and inner tubes and congest the local area while participating in the festivities. The music carries quite a distance. The activity does not occur often.

Resource requirements. - There are no recreation standards for this activity. The requirements for houseboating are basically the same. This activity requires sufficient depth for the houseboat, area for all the spectators and their boats, and sufficient distance from a developed area to avoid disturbing other lake visitors. The activity occurs during warm days of the year beginning in April. The water is generally calm except for boat wakes.

Figure VI-16. - Houseboat rock concert


Houseboat Rock Concert

INNER TUBE FLOATING - EXPERIENCE: Solitary

Activity description. - Inner tube floating is closely associated with swimming. The inner tubes range in size from small (3 feet in diameter after inflation) to large 7 to 8 feet in diameter after inflation). One or more people use the inner tubes for flotation, to recline in, and paddle around with their hands. Horseplay resulting in capsizing the occupant(s) occurs frequently. The activity can occur with other activities any place on the lake during the recreation season. The most common places used for inner tube floating are swim areas and developed shorelines.

Resource requirements. - There are no recreation standards for inner tube floating. Although the activity can occur any place on the lake, the preferred area would be designated swimming areas with depth of 6 feet and less. Sandy lake bottoms on which people can stand are desirable while playing with inner tubes. The water temperature should be 70 °F or greater. Waves can enhance the activity for some. The activity usually occurs during the warm recreation season. Lifeguard presence is desirable but optional.

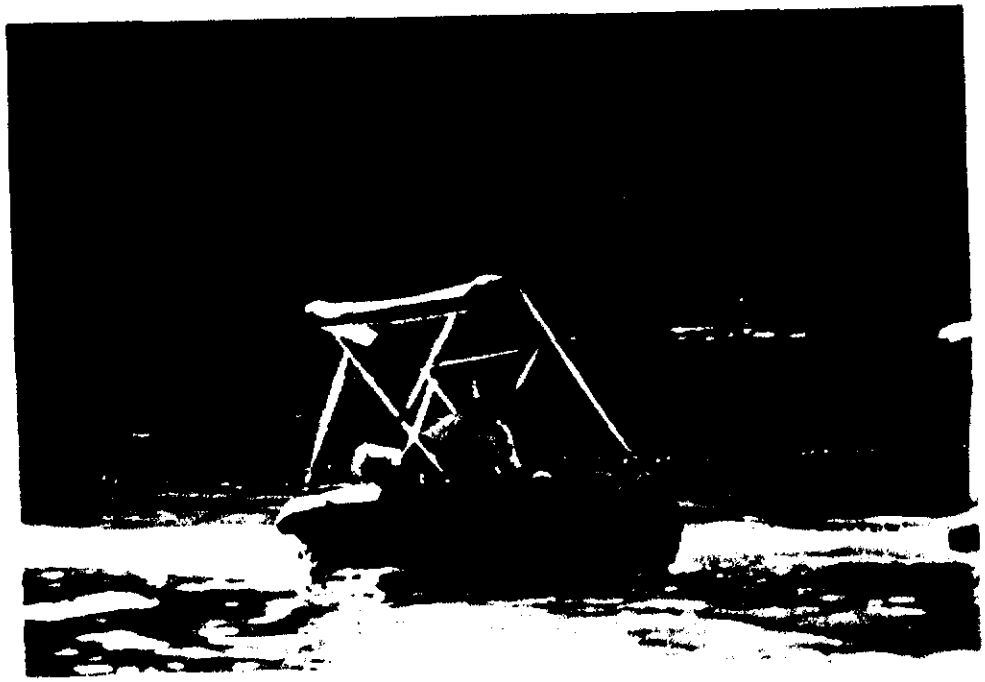
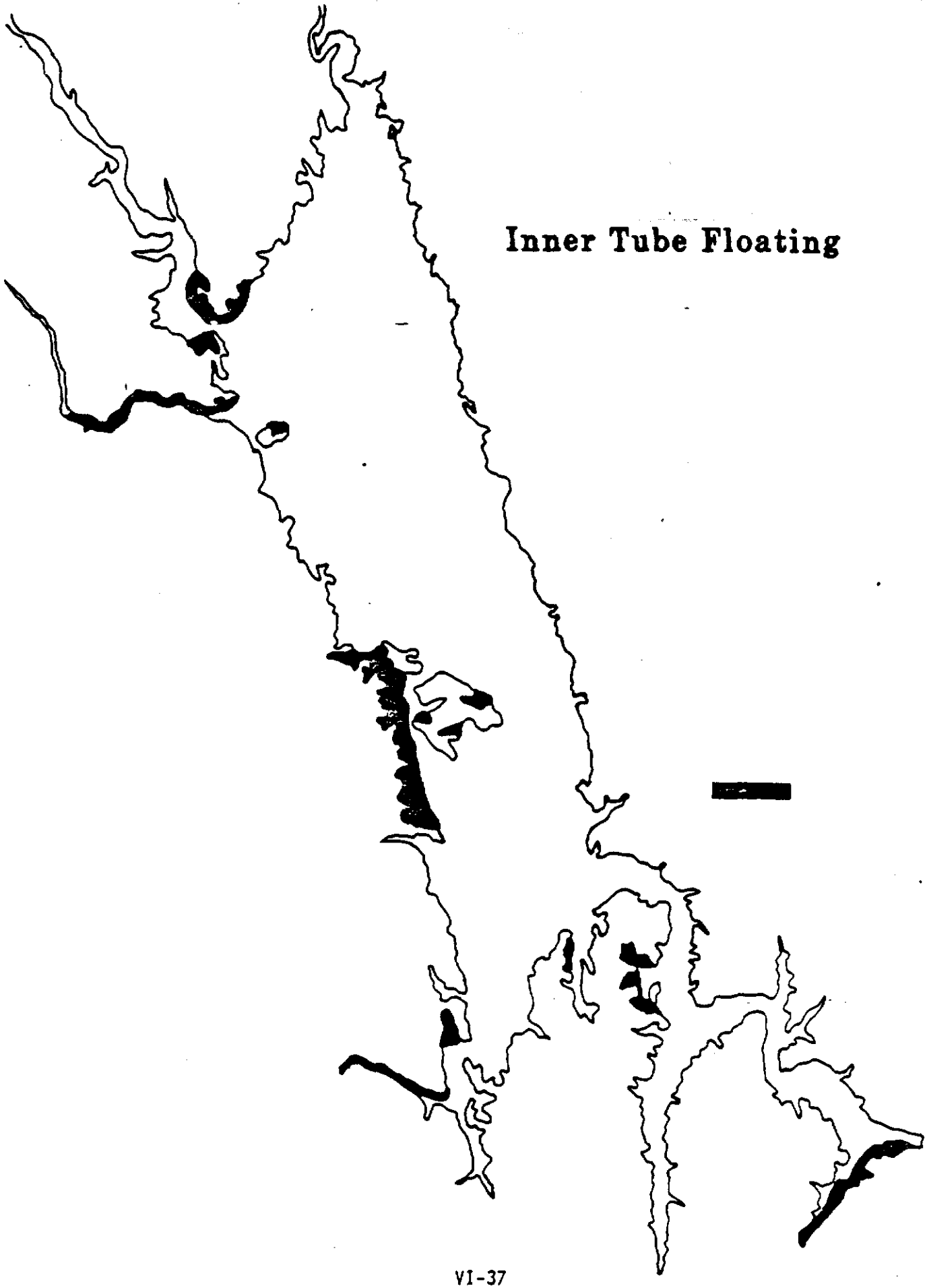


Figure VI-17. - Inner tube floating

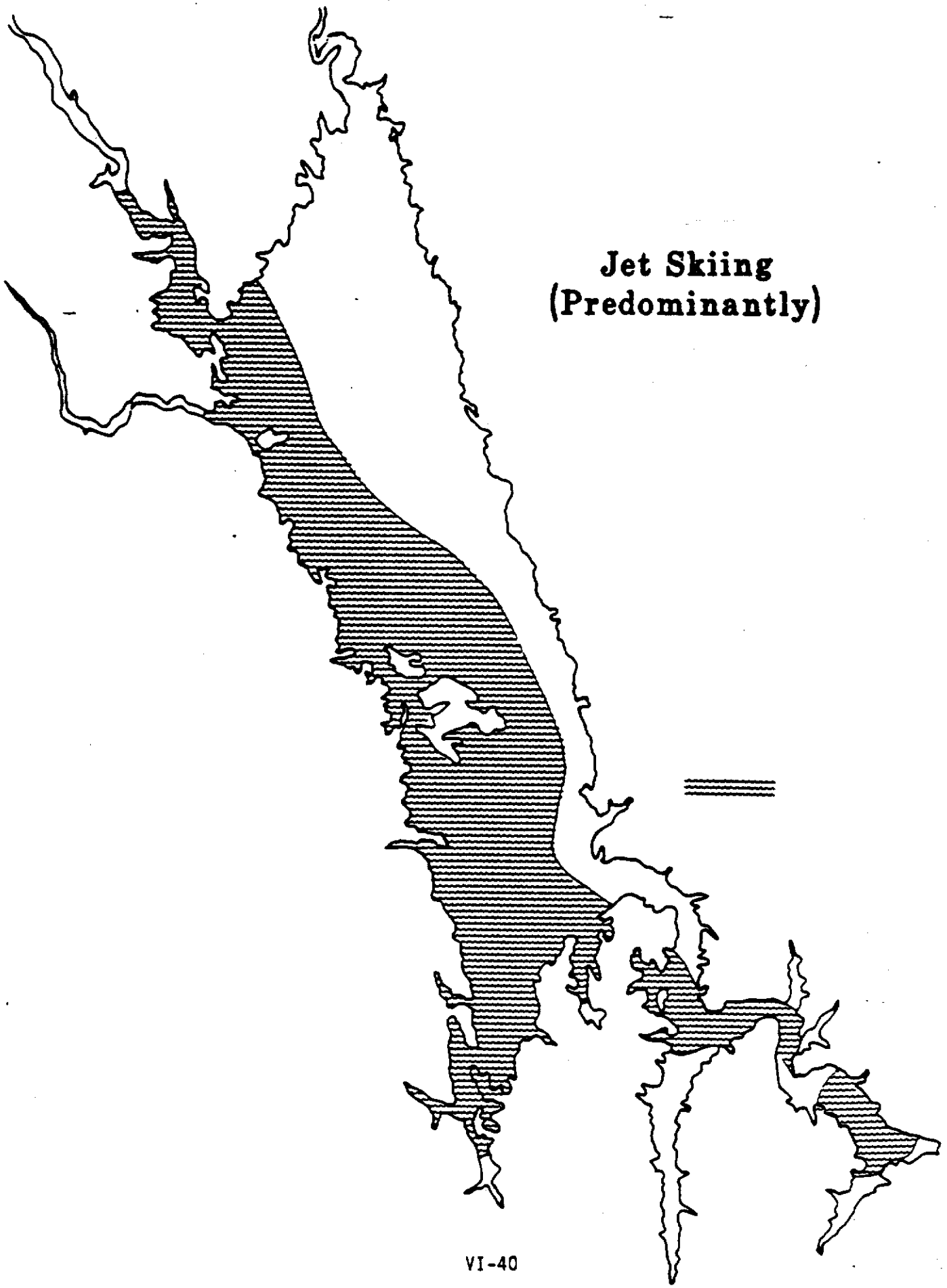

Inner Tube Floating

JET SKIING - EXPERIENCE: Competent

Activity description. - "Jet Ski" is a trade name for a waterborne "scooter" which is a popular recreation technological product introduced on the market about 15 years ago. It is about 6 feet long by 30 inches wide in size, has anywhere from 30 to 70 horsepower, and a 2-gallon gas tank with a range of 15 miles at full throttle. It is designed for one person, but two may ride it. The majority of operators are usually under 30. Jet skis are usually operated near the shore, and those with small engines may attain speeds 35 to 40 mph while those with large engines may go over 50 mph. Popular uses are jumping wakes, racing, and touring. Careless and unskilled operators frequently run into other jet skiers and boats. The jet ski will usually circle a fallen skier or stop running. The activity usually occurs during warm periods of the day.

Resource requirements. - There are no recreation capacity standards for jet skiing. Calm water areas may be used for beginners, and the proficient jet skiers can handle waves up to 4 feet high whether waves are boat wakes or windblown. A minimum depth of 18 inches or greater is required. Safe minimum depths for high speed is 6 feet or greater to cushion a falling operator. Water and air temperature should be greater than 70 °F. The activity can occur almost anywhere on the reservoir during the warm recreation season. Use can be year round with suitable protective devises.

Figure VI-18. - Jet Skiing

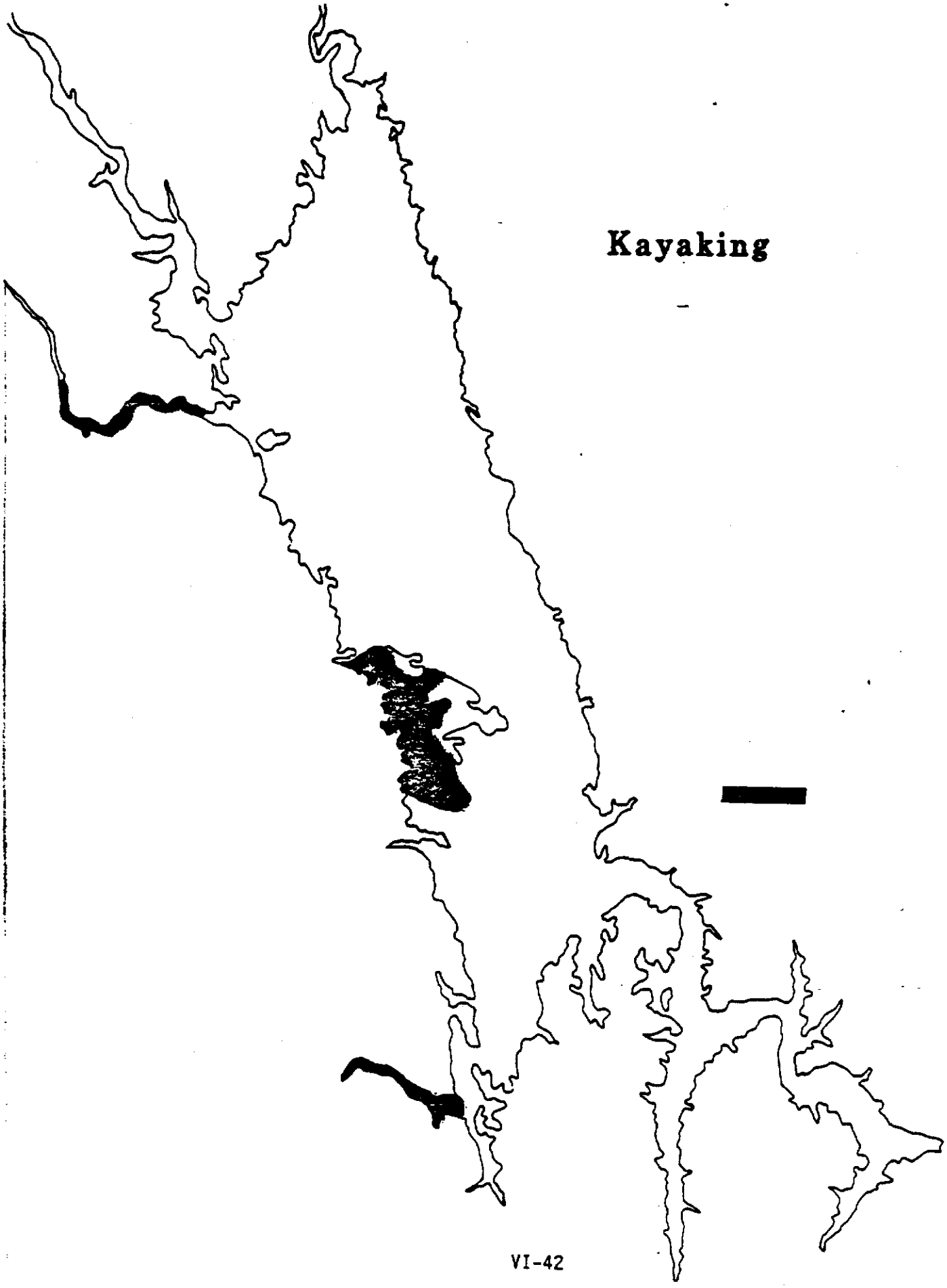

Jet Skiing
(Predominantly)

KAYAKING - EXPERIENCE: Solitary

Activity description. - Kayaks are a watertight canoe having a deck covering that closes around the waist of the paddler. It is lightweight, highly maneuverable, and popular for calm water and river running sports. Most kayaks are designed for one person; some can handle two. Like small canoes, kayaks have a reputation for instability and skilled people can upright a capsized kayak with the use of a two bladed paddle. Kayaks may be used in a controlled group camp situation with water depths relatively shallow. People who want to develop a kayaking proficiency for running rivers will practice in the lake in depths of 5 feet or more. Others will seek solitude experiences on the lake. Kayaks can go any place on the lake depending on the experience people seek. The activity usually occurs in areas protected from the wind.

Resource requirements. - There are no recreation capacity standards for kayaking. Minimal depth for flotation is 1 foot, and a relatively safe wave height is 1 foot or less. Skilled kayakers can handle greater wave heights to 3 or 4 feet. Calm water is preferred. Water temperature is a factor especially if a kayak capsizes. Kayakers can suffer from chills or hypothermia. Kayaking usually occurs during the warm recreation season.

Figure VI-19. - Kayaking

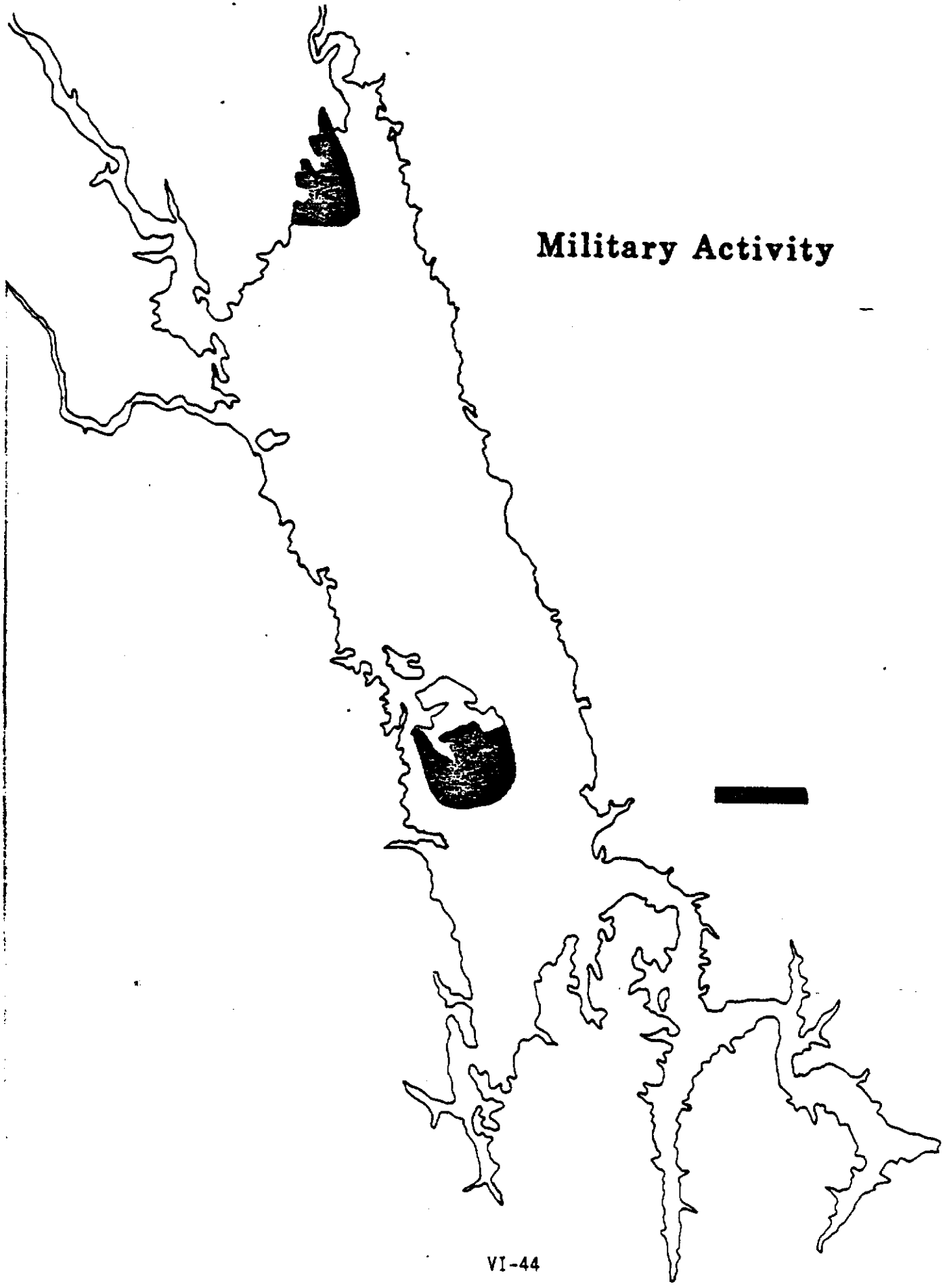

Kayaking

MILITARY ACTIVITIES - EXPERIENCE: Competent

Activity description. - The Army, Navy, Marines, Air Force, and Coast Guard have permits from Reclamation to use Lake Berryessa for dropping personnel into the water from helicopters and fixed wing aircraft. The personnel may also be picked up from the water by aircraft. The exercise is designed to develop competency of personnel during military maneuvers. The activity usually occurs in the midsections of the lake during periods of low recreation use weekdays and seasonally.

Resource requirements. - There are no capacity standards for military activities. Resources are committed for this activity which competes with other recreation activities for use of the lake. Therefore, potential for conflict with other activities and the resource commitment has a bearing on carrying capacity. A large water body under public administration is a prime prerequisite for military activities. The water must physically accommodate the activity and the administration must be willing to let the activity occur. Timing of the activity so it will not conflict with other activities is critical.

Figure VI-20 - Military Activity

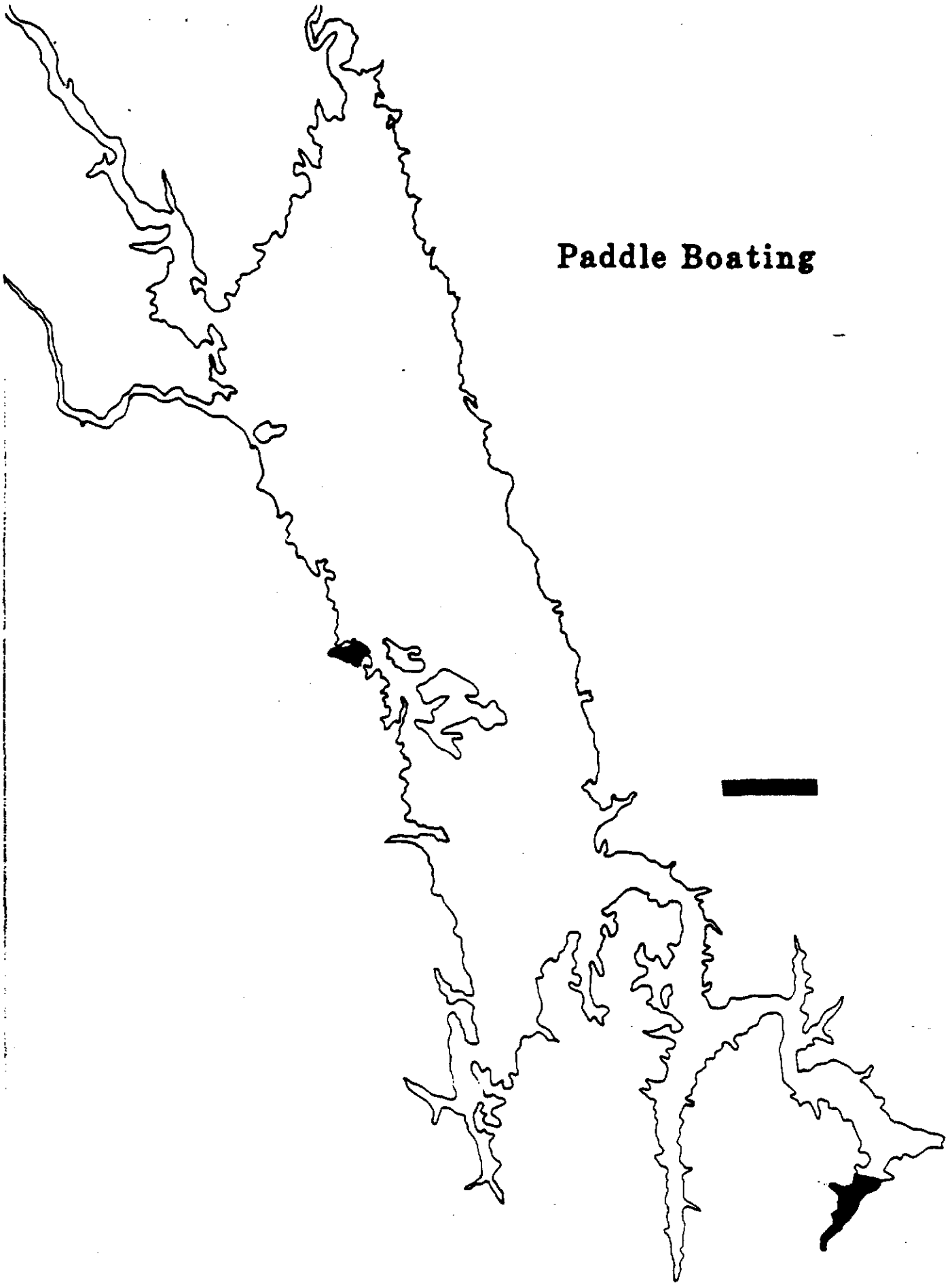

Military Activity

PADDLE BOATING - EXPERIENCE: Solitary

Activity description. - Paddle boats are usually rental devices obtained at a marina or resort operation. Paddle boats are propelled by physical actions similar to bike riding. Most paddle boats are designed for two persons, but one person can operate the them. Some are designed for up to four persons. Paddle boat use is generally short-term (1 to 3 hours) for solitary situations, and limited sightseeing. Use is most common on warm, sunny calm days.

Resource requirements. - There are no recreation standards for paddle boating. Water depths need to exceed 1 foot with greater depths being usable. Slight to nonexistent wind is preferable. Paddle boats can be affected by the wind causing drifting and excessive exhaustion to the user. Water surface has to be nearly calm. Best conditions are in small, protected, and scenic coves near the resort or marina. Other motorized activities in the paddle boating area should be limited. Activities such as canoeing and rowboating are compatible.

Figure VI-21. - Paddle boating


Paddle Boating

PARASAILING - EXPERIENCE: Risk

Activity description. - Parasailing (also known as kite skiing) involves a powerful boat, a 100- to 200-foot-long towrope, and a kite-like glider with a harness to suspend airborne the person who is being towed. Speeds over 40 mph are required to provide uplift and sustain a person in the air to a height of 150 feet above the water or ground. Takeoff can be accomplished from water skis behind the boat or without water skis from a beach. Going into the wind helps uplift. The towboat must make broad, gentle turns to prevent the parasailor from losing uplift. Landing can be in water or on shore, depending on wind conditions and if skis are used. The parasailor must wear a personal flotation device. The towboat requires a driver and an additional person to watch the parasailor. The activity usually occurs during the warmer times of the day.

Resource requirements. - There are no recreation capacity standards for parasailing. Requirements for the activity are diverse. A boat capable of speed in excess of 40 mph is necessary for initial uplift and to sustain a person in the air. A breeze to assist uplift is desirable. A water body should be absent of any over water obstructions such as transmission lines, communications lines, and bridges. Other air related activities such as ultralight aircraft, hot air ballooning, seaplane landings, and military activities cannot be occurring where people are parasailing.

A large water body with a physical shoreline configuration that provides long straight stretches is necessary. There must be ample room for maneuvering and executing broad gradual turns by the towboat. The water depth should be at least 6 feet for the boat and possibly more for the safety of the parasailor.

There are three types of areas for takeoff and landing: (1) The shore takeoff

point. It should be clear of all trees, bushes, and structures within a 150-foot radius. A sandy beach absent of rock outcrops is preferred. The takeoff area may be used for landings, therefore, it must be free of all possible obstructions. A successful landing depends on the skill of both the towboat operator and parasailor. (2) A raft anchored in the open water is another takeoff point. Parasailors land in the water adjacent to the raft. (3) The last takeoff technique is on water skis. Uplift is gradual until the boat gains full speed. Both raft and water ski takeoff parasailors can land in water or on a cleared beach area.

Parasailors need to wear a personal flotation device that will not rip off. The harness for the parasailor must have a device to allow quick release from the parasail. Sudden stops of the towboat must be avoided while a person is airborne.

This activity usually occurs during the warmer recreation season when the air and water temperatures are above 70 °F.

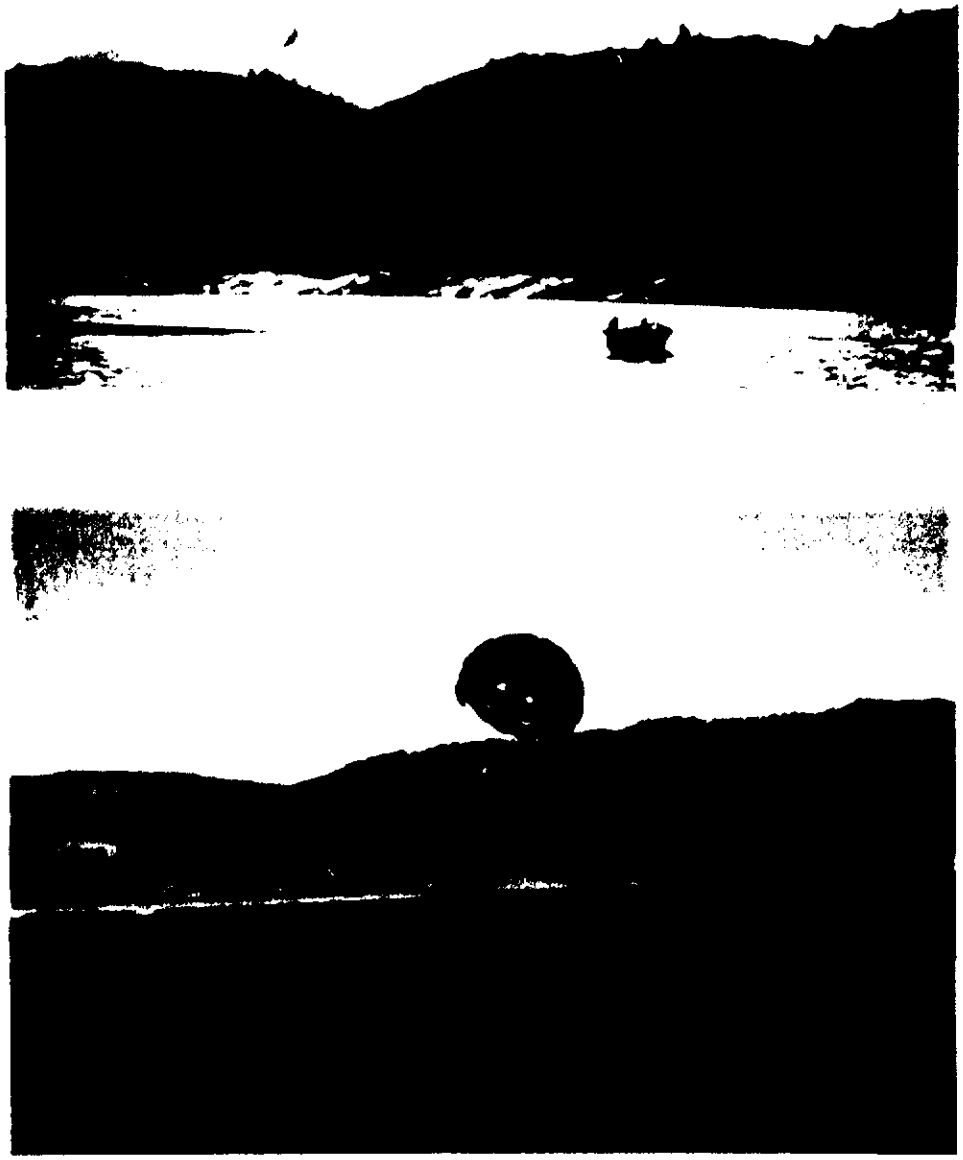
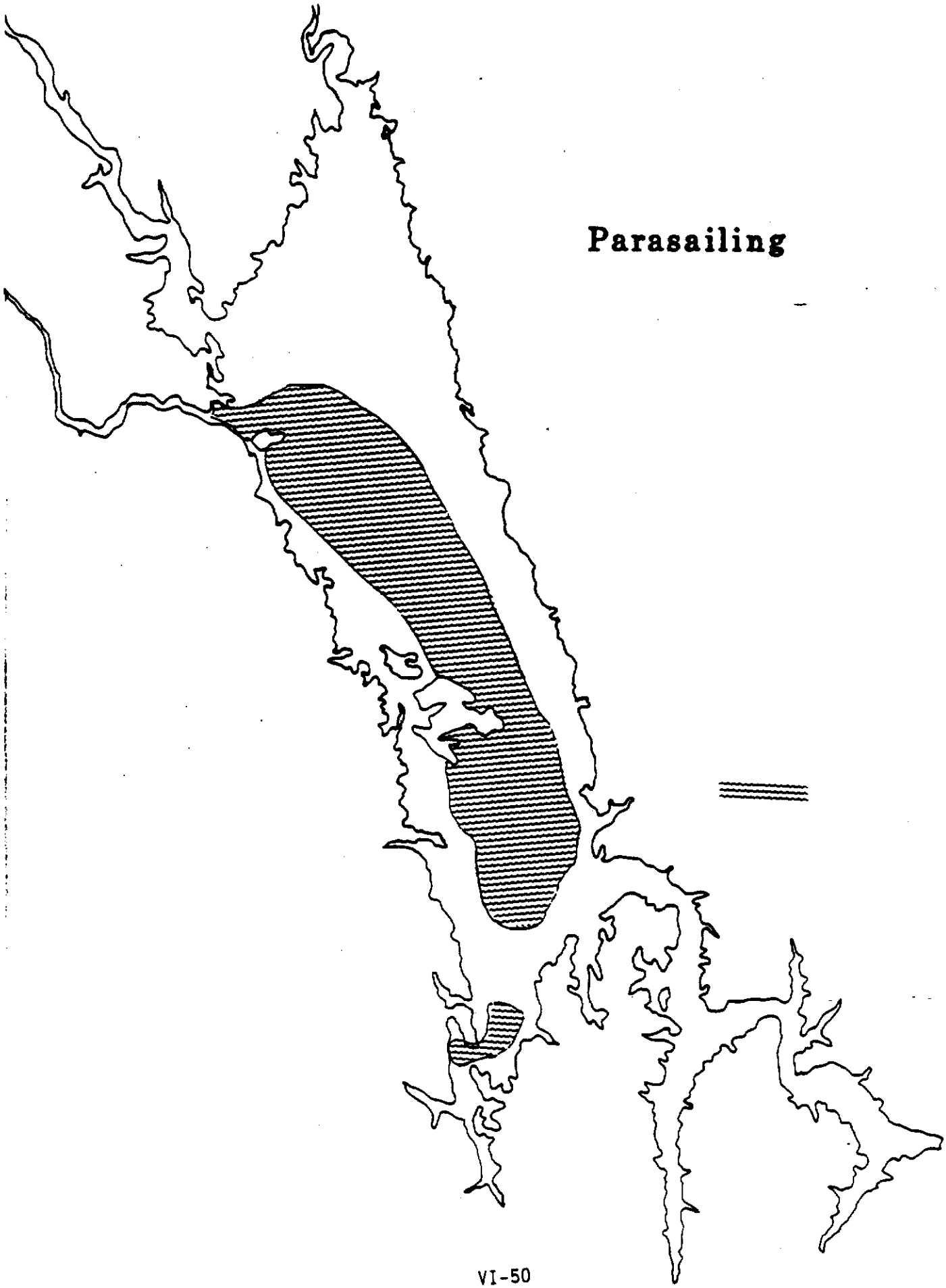


Figure VI-22. - Parasailing

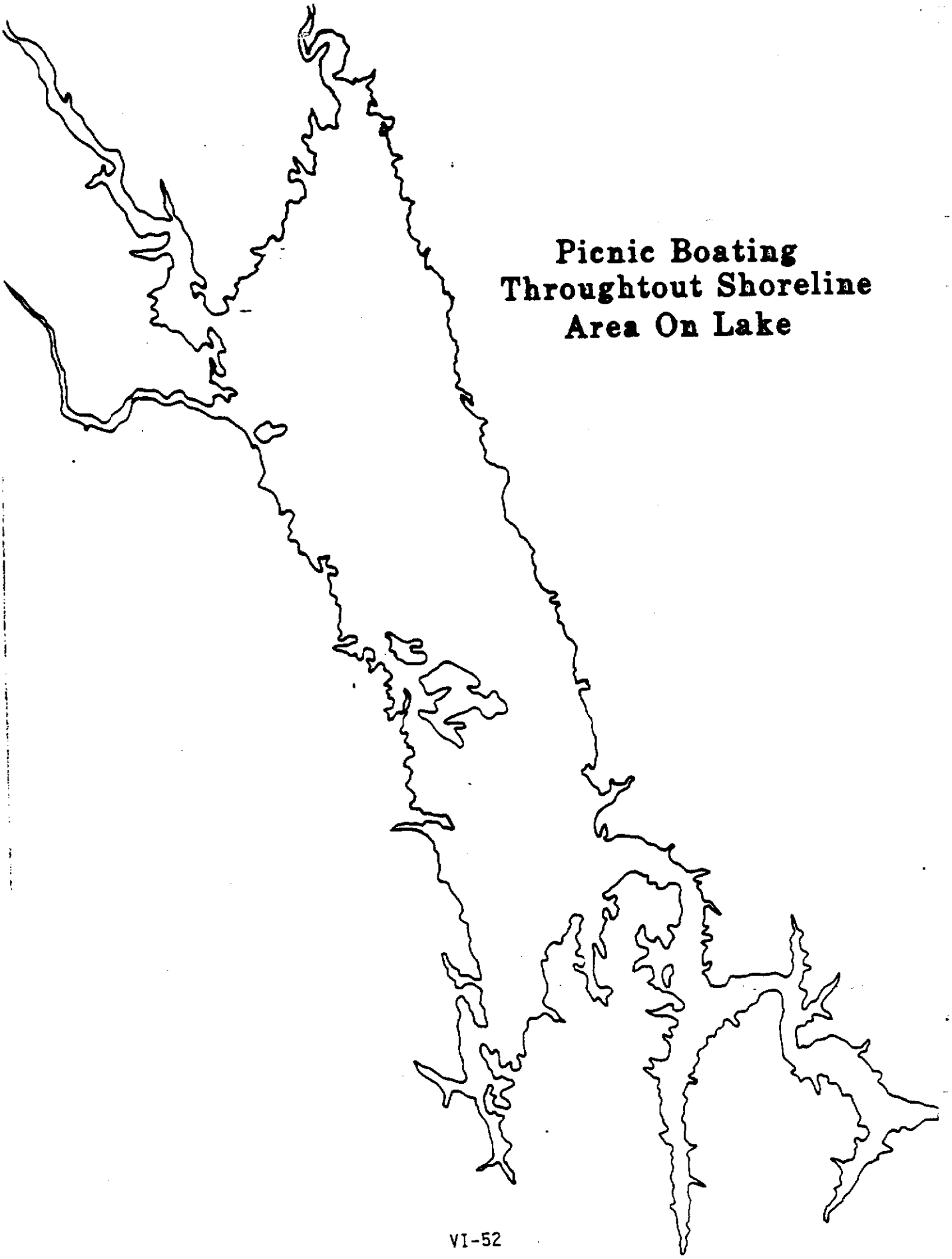

Parasailing

PICNIC BOATING - EXPERIENCE: Solitary

Activity description. - Picnic boating combines two activities. Boating provides the transportation to a remote location on the lake to picnic. Boats also provide the opportunity to participate in other water activities with the picnic site serving as the staging area. Usually, several people participate and it is is assumed they want the solitude away from all the noise and people in developed areas. Primary activity occurs during summer season but can occur yearround.

Resource requirement. - There are no standards for picnic boating. Areas without development are essential for providing solitude. An irregular shoreline can separate users and create the illusion of solitude. A beach to land and unload the boat is desirable. The lake bottom slope should be 10° to 13° so the boat can get close to the shore. Facilities should be limited to an occasional trash can, with no major developments in the area.

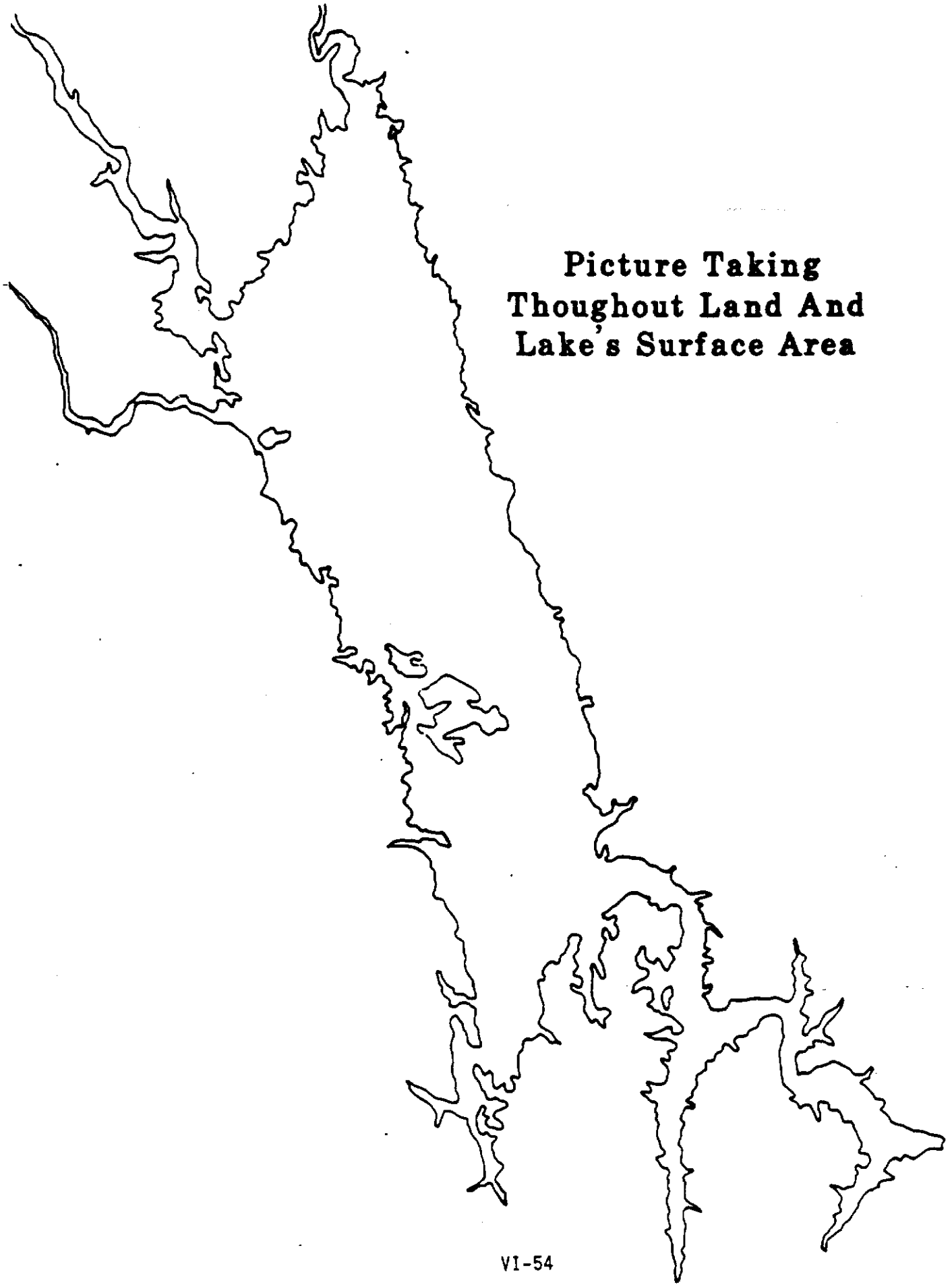
Figure VI-23. - Picnic boating.


Picnic Boating
Throughtout Shoreline
Area On Lake

PICTURE TAKING - EXPERIENCE: Mental

Activity description. - Taking pictures can range from amateur to the professional. The subject can vary from people, scenic and a spectacular event to the unusual or covering of a story. Usually, photography is secondary to some other recreation activity. The activity can occur at any time of the year.

Resource requirements. - The subjects that catch the photographers' eye are the resources. Picture taking is a passive activity and is compatible with most other activities on Lake Berryessa.



Picture Taking Thoughout Land And Lake's Surface Area

POWER SURFBOARDS - EXPERIENCE: Competent

Activity description. - Power surfboards are self-propelled surfboards, utilizing a jet propulsion unit. Depending upon the skill of the user, use might range from the person with little competency laying on the board to a person able to stand up and perform intricate maneuvers. Use generally occurs during the summer months, but can occur yearround. Units weigh under 130 pounds, are considered portable, and are affordable to purchase or to rent. Good balance is needed to direct these units.

Resource requirements. - There are no recreation standards for power surfboarding. Depending upon one's skill, water surface should be flat to waves up to 3 feet. Lake accessibility with good beaches for launching and landing is important. Fairly open, uncongested areas with water depths greater than 3 feet are needed.

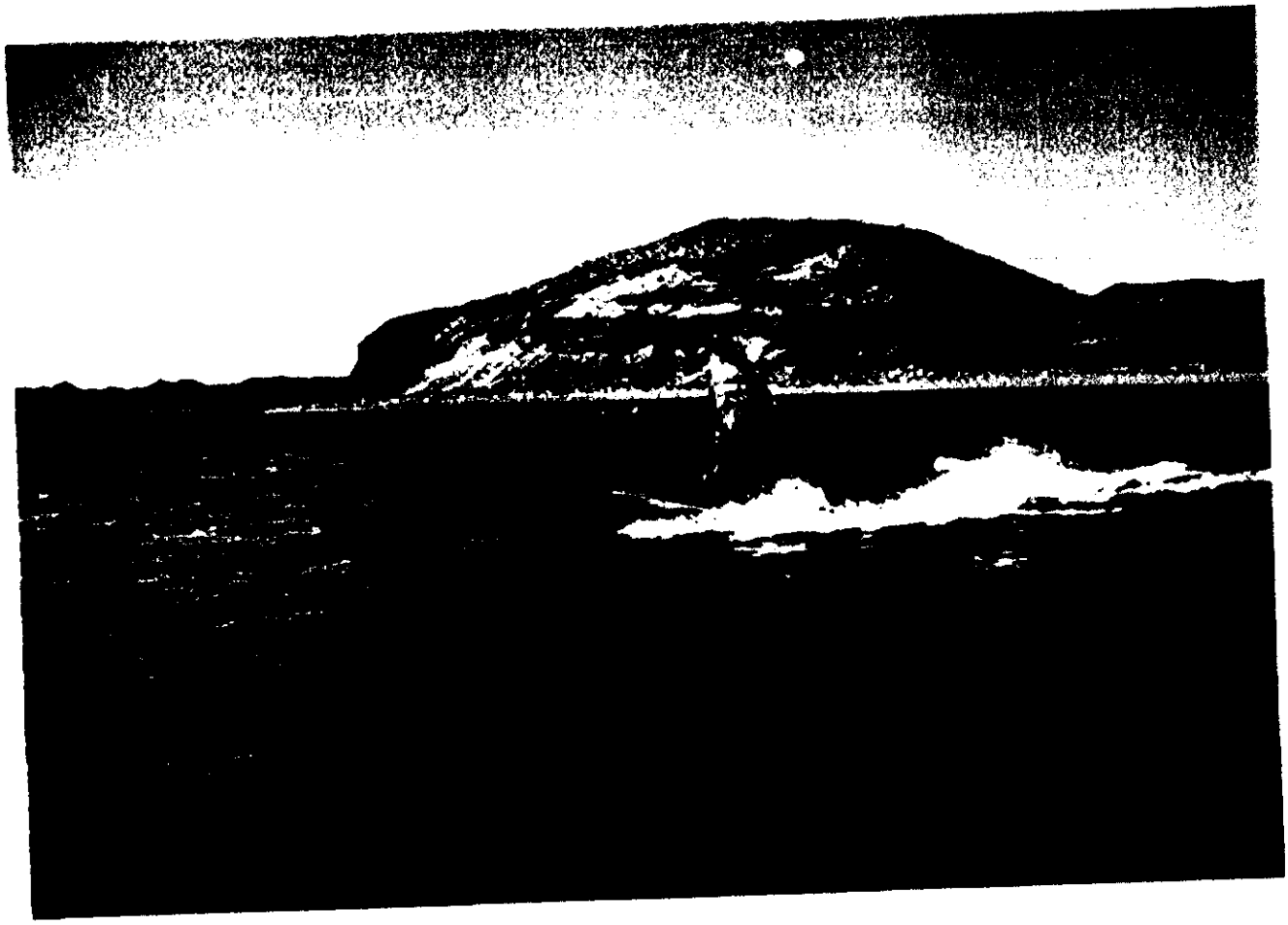
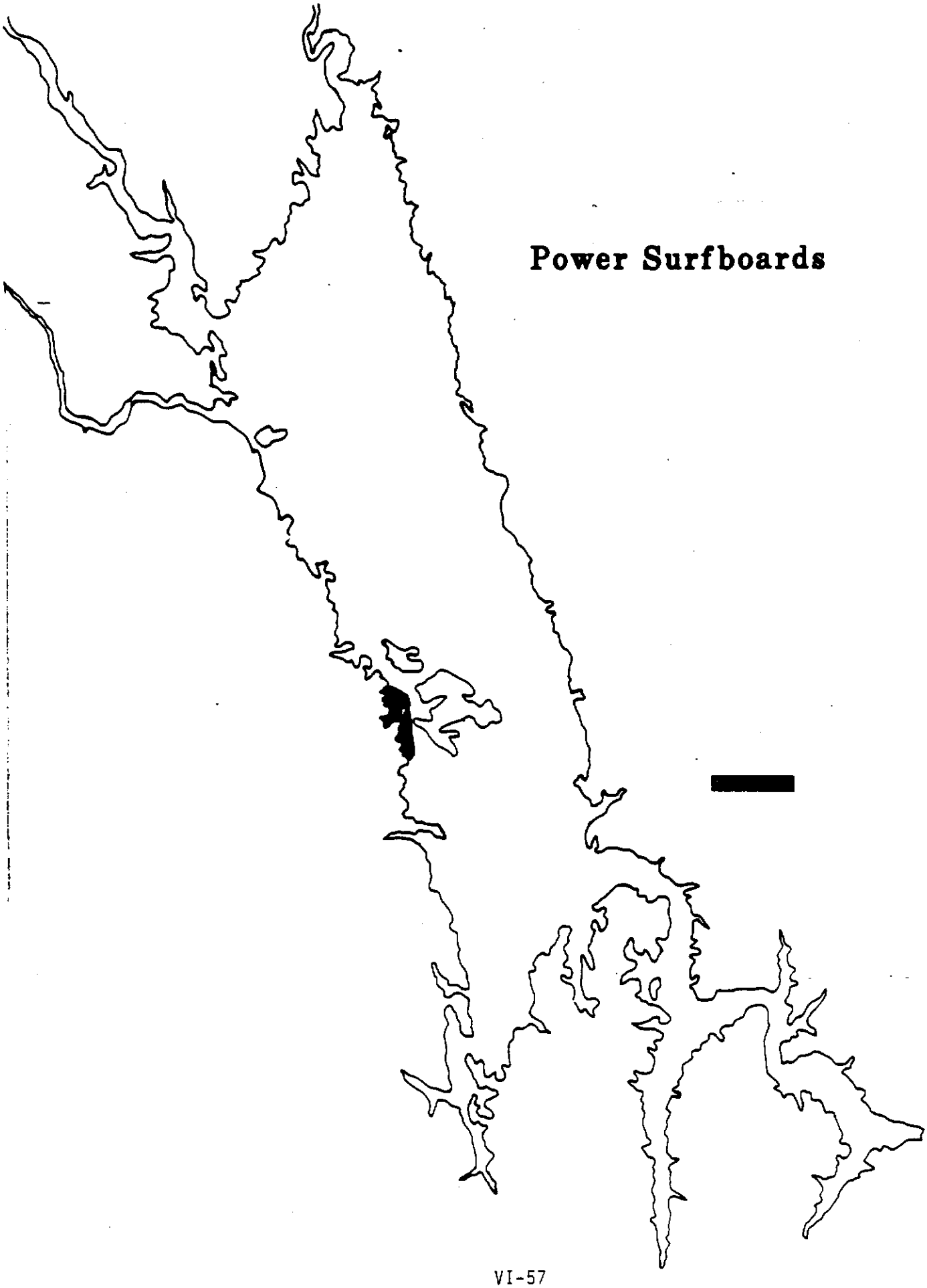


Figure VI-25. - Power surfboards

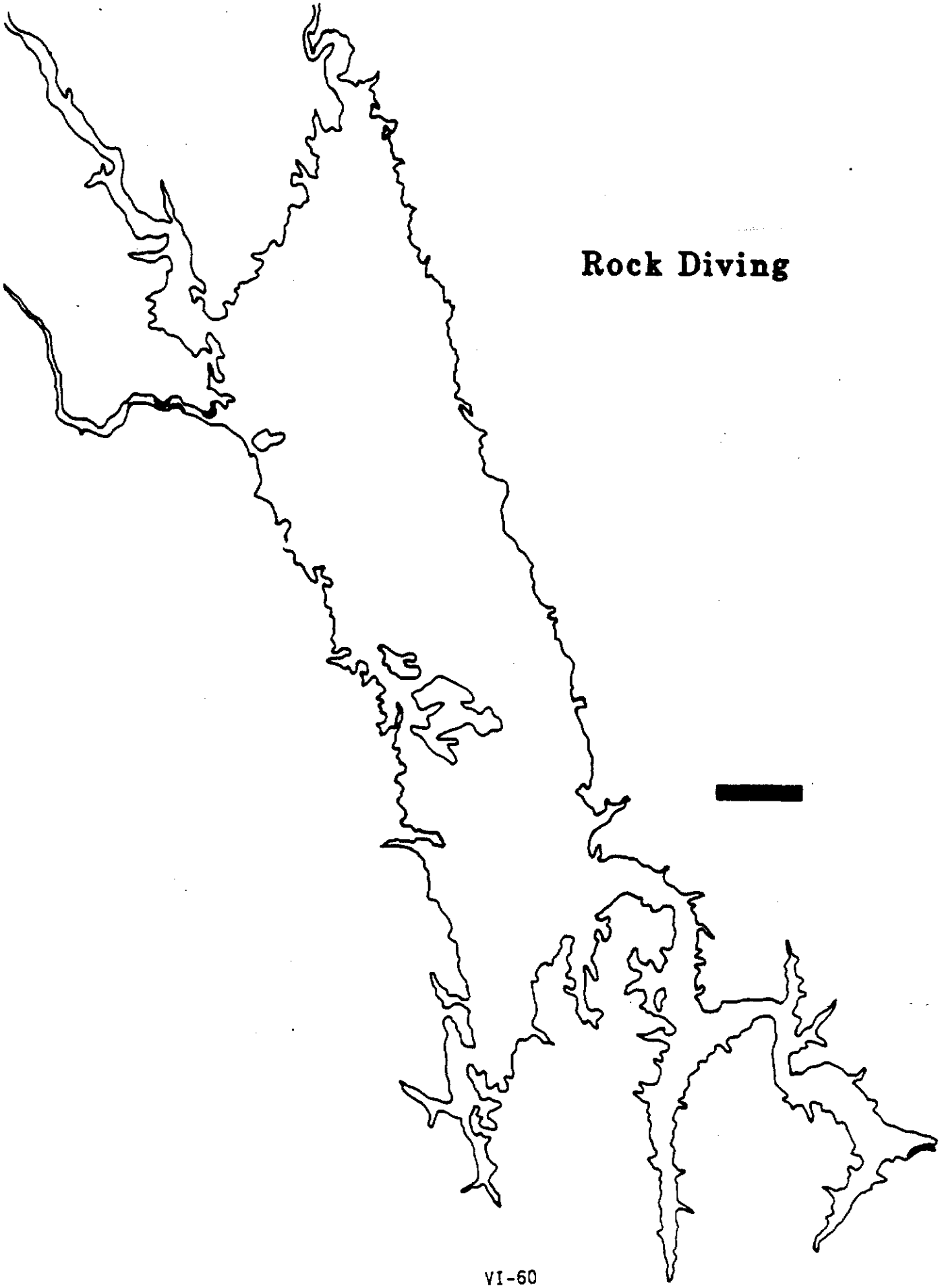

Power Surfboards

ROCK DIVING - EXPERIENCE: Risk

Activity description. - Rock diving usually occurs in the Pope Creek area where a rock outcrop is located near the highway bridge. Another less popular area for rock diving is located upstream from Monticello Dam on the west shore. People, usually in their teens and twenties, either jump or dive from the rocks 30 to 40 feet into the water below. Reclamation does not condone this activity, but it occurs. Why people jump from the rocks is speculative. Challenge, thrill, being a showoff, doing it on a dare are all possible reasons. The water is used to break the fall. This is an individual activity.

Resource requirements. - There are no standards for rock diving. The phenomenon is one of those unique activities inherent in the characteristics of Lake Berryessa. The activity requires water at least 15 to 20 feet deep to safely cushion the diver. A water temperature above 70 °F is desirable to reduce the contact shock to the body. For successful completion of the dive, the water below the rocks must be free of all natural rock and manmade obstructions. Calm water is preferred. This activity usually occurs during the warm recreation season.

Figure VI-26. - Rock diving

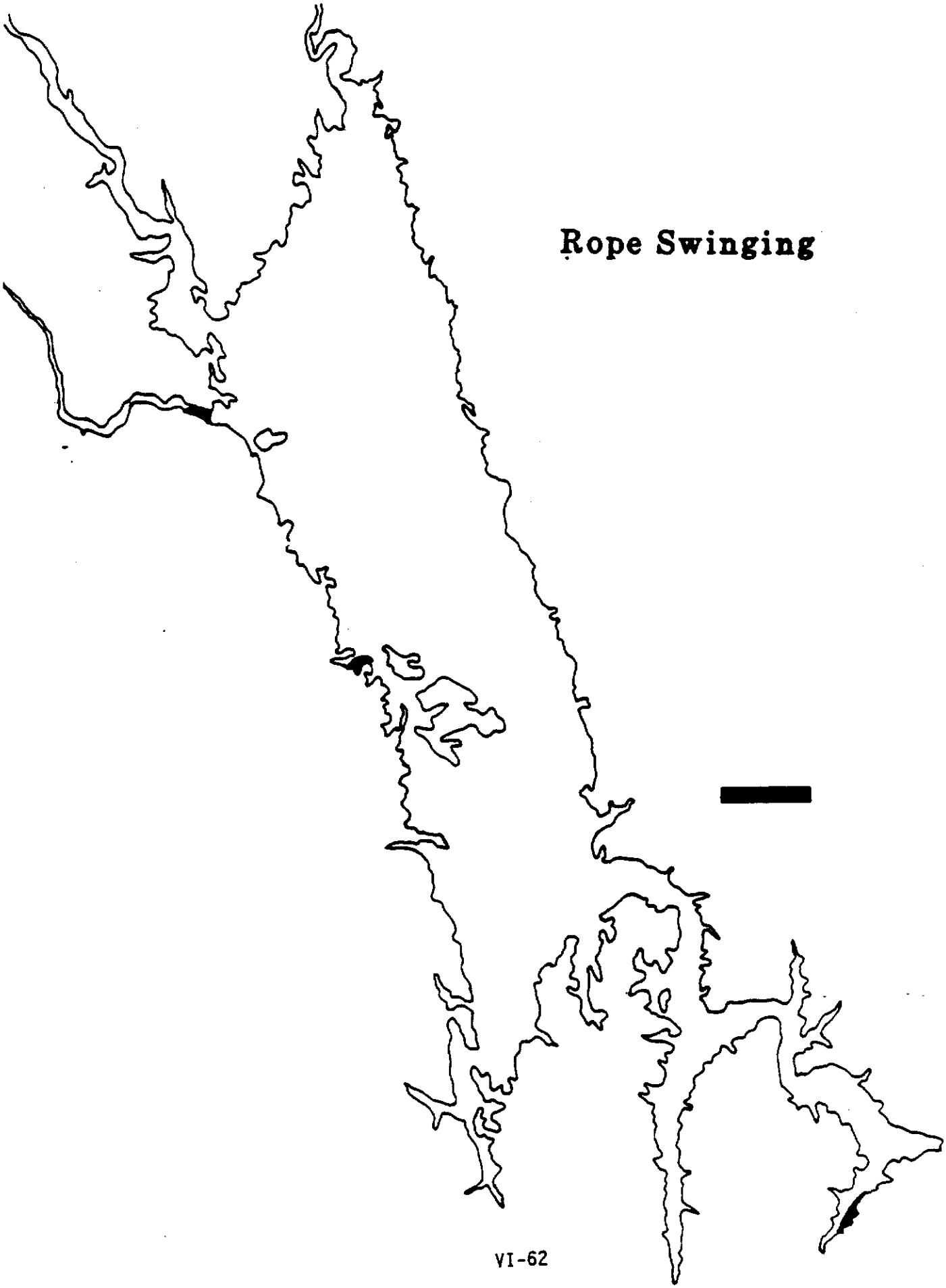

Rock Diving

ROPE SWINGING - EXPERIENCE: Risk

Activity description. - Rope swinging occurs at Pope Creek, Smittle Creek, and Markley Canyon. A rope is tied to a tree limb or to a structure extending over the water. The rope is used by participants who swing over and drop into the water. Reclamation does not condone this activity, but it occurs. Timeliness is required to let go of the rope so one does not drop on shore or in shallow water. This is an individual activity.

Resource requirements. - There are no standards for rope swinging. The phenomenon is not unique nor inherent to Lake Berryessa resources. A tree or a structure, with sufficient strength to support a person, must be over the water and small enough to attach a rope to. The water depth should vary proportionately with the height from which a person drops into the water. A safe water depth would be 15 feet free of all natural and manmade obstructions. Calm water is preferred. The water and air temperature should be above 70 °F. This activity usually occurs during the warm recreation season.

Figure VI-27. - Rope swinging


Rope Swinging

ROWBOATING - EXPERIENCE: Solitary

Activity description. - Rowboating can be participated in by one to four people per boat. A rowboat is a craft up to 15 feet long and propelled by oars. The activity usually occurs close to shore on the west and south portions of the lake. Concentrations occur at Berryessa Marina, Oak Shores Park, Spanish Flat, Capell Cove, and Markley Cove. Rowboating can occur year round; however, it usually occurs during the recreation season and is usually associated with another activity such as fishing.

Resource requirements. - Recreation capacity standards for nonpowered flat water boating range from 0.4 to 3 boats per acre. See Appendix B. Rowboats need at least 1 foot of water depth for flotation. The area should be free of aquatic vegetation to facilitate rowing and minimize boat drag. Rowboating can occur almost anywhere on the lake. Participants prefer calm water, protection from the wind, and waves less than 1 foot high. The range of distance on the water is usually within 2 miles of the site of origin. Air temperatures too hot or cold will discourage rowboating.

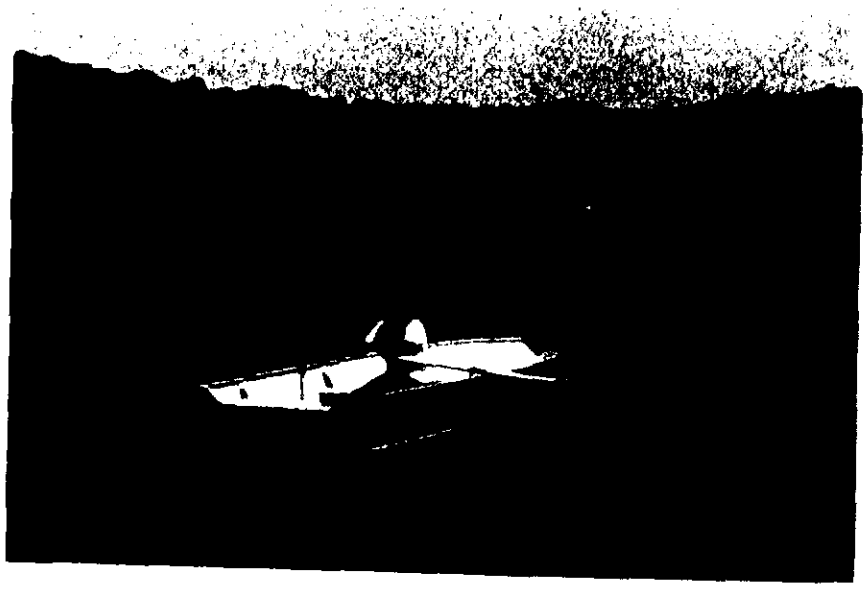
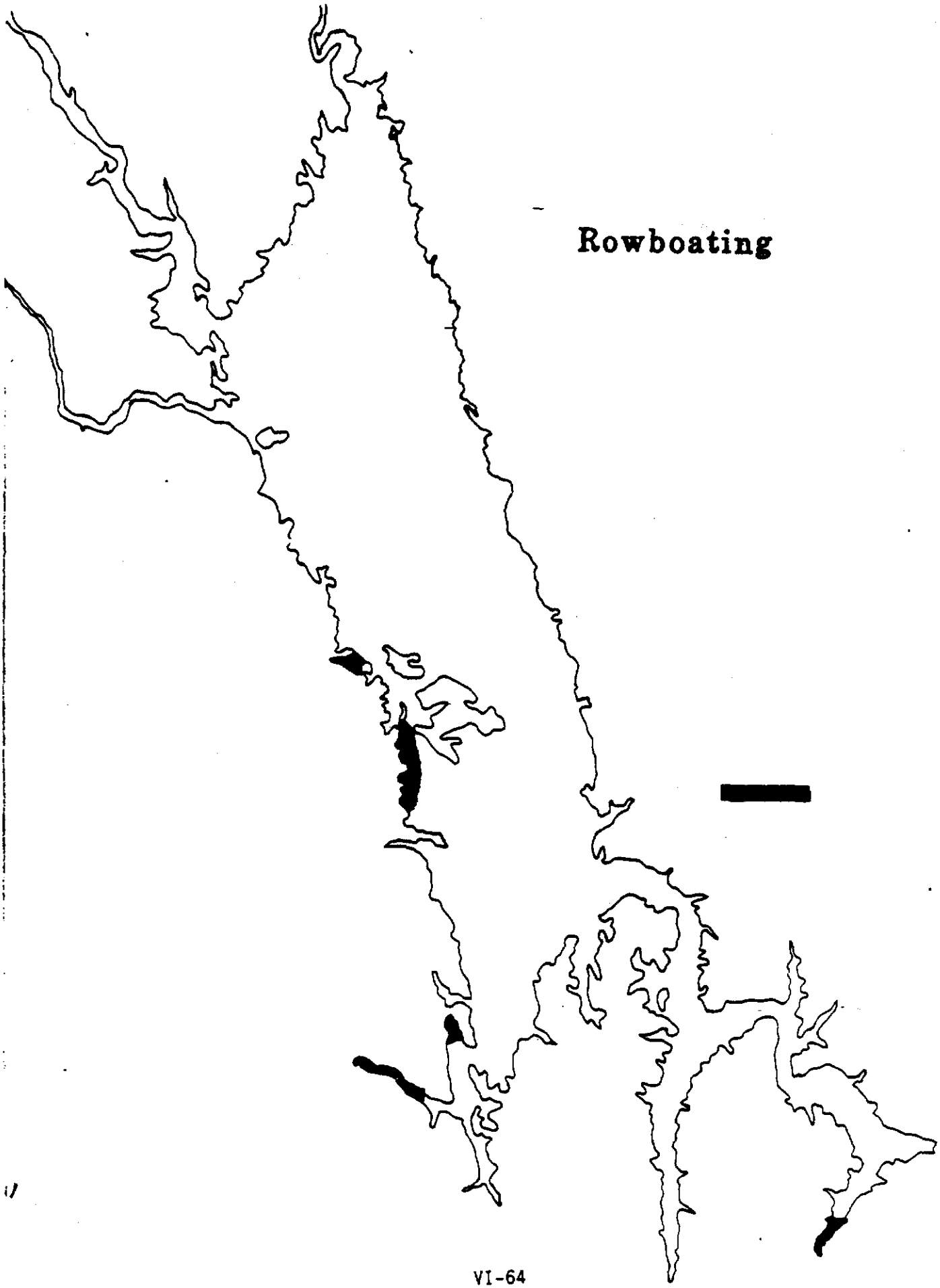


Figure VI- 28. - Rowboating

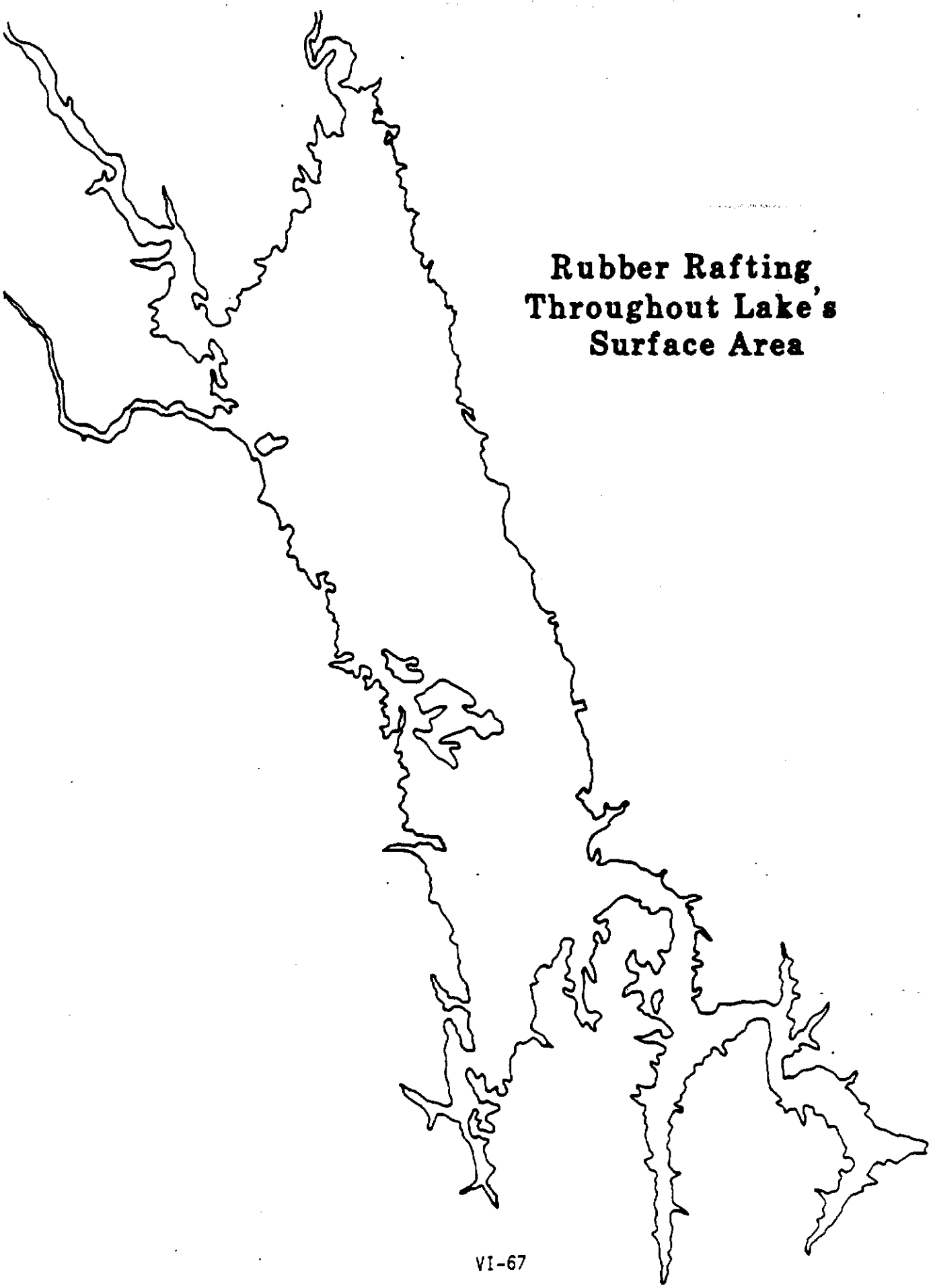

Rowboating

RUBBER RAFTING - EXPERIENCE: Solitary

Activity description. - Rubber rafts can range in size from 7 by 4 foot one-man rafts, to 20 by 8 feet rafts with a six person capacity. Designs vary to accommodate motors oars or paddles. The uses of rubber rafts range from horseplay in swimming areas to passive floating around, fishing, and boating. Rubber rafts can be used in conjunction with other activities such as houseboating, rock concerts, and swimming. The activity occurs almost any place on the lake.

Resource requirements. - There are no recreation standards for rubber rafts per se. Rubber rafts require water depths of 1 foot or greater for flotation. Water temperatures should be greater than 70 °F. Rubber rafting participants prefer areas protected from wind, waves less than 1 foot high to calm, and solitude. In some instances, a greater sense of excitement and risk can be achieved in rougher waters. People rafting in swimming areas prefer sandy bottoms with depths less than 4 feet. The activity occurs primarily during the warm recreation season.

Figure VI-29. - Rubber rafting


Rubber Rafting
Throughout Lake's
Surface Area

SAILBOATING - EXPERIENCE: Competent

Activity description. - Sailboats on Lake Berryessa range from 8 to 23 feet in length. Hull configurations vary from twin pontoon "Hobie Cats," to sleek hulls with keels or sailing dinghys with centerboards. Participants range from one to six people per vessel. Racing, formally or informally, occurs on the lake. Sailboats favor the center portions of the lake and avoid the north and south extremities. Sailing occurs during the warmer times of day.

Resource requirements. - Standards for sailboating are in Appendix B. Three acres of water area per boat is recommended by the Soil Conservation Service. Preferred water depths range from 4 feet for Hobie Cats to 8 feet or more for boats equipped with keels. The availability of wind varies from area to area on Lake Berryessa. Sailboats handle natural wind waves without much problem. Powerboat wakes can interrupt sailing, particularly during racing. This activity usually occurs during the warm recreation season.

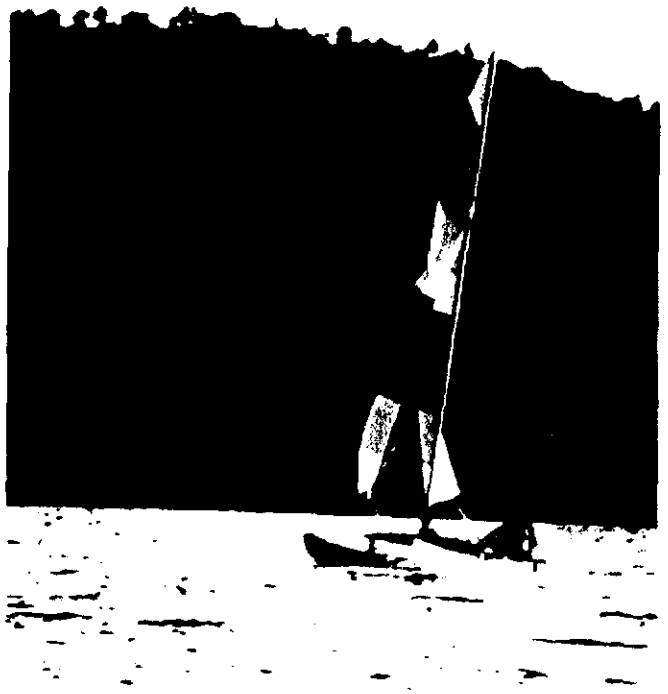
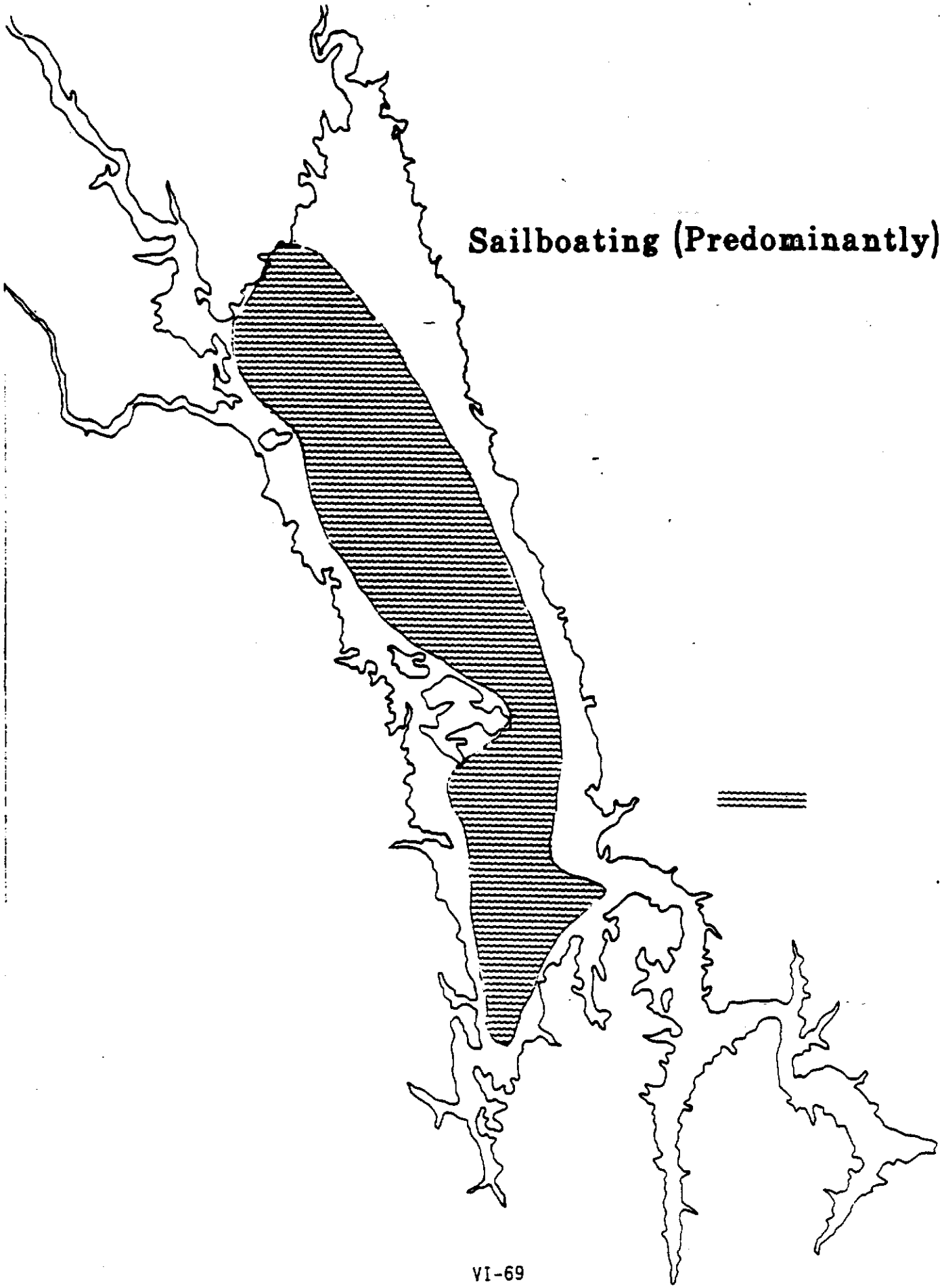


Figure VI-30. - Sailboating

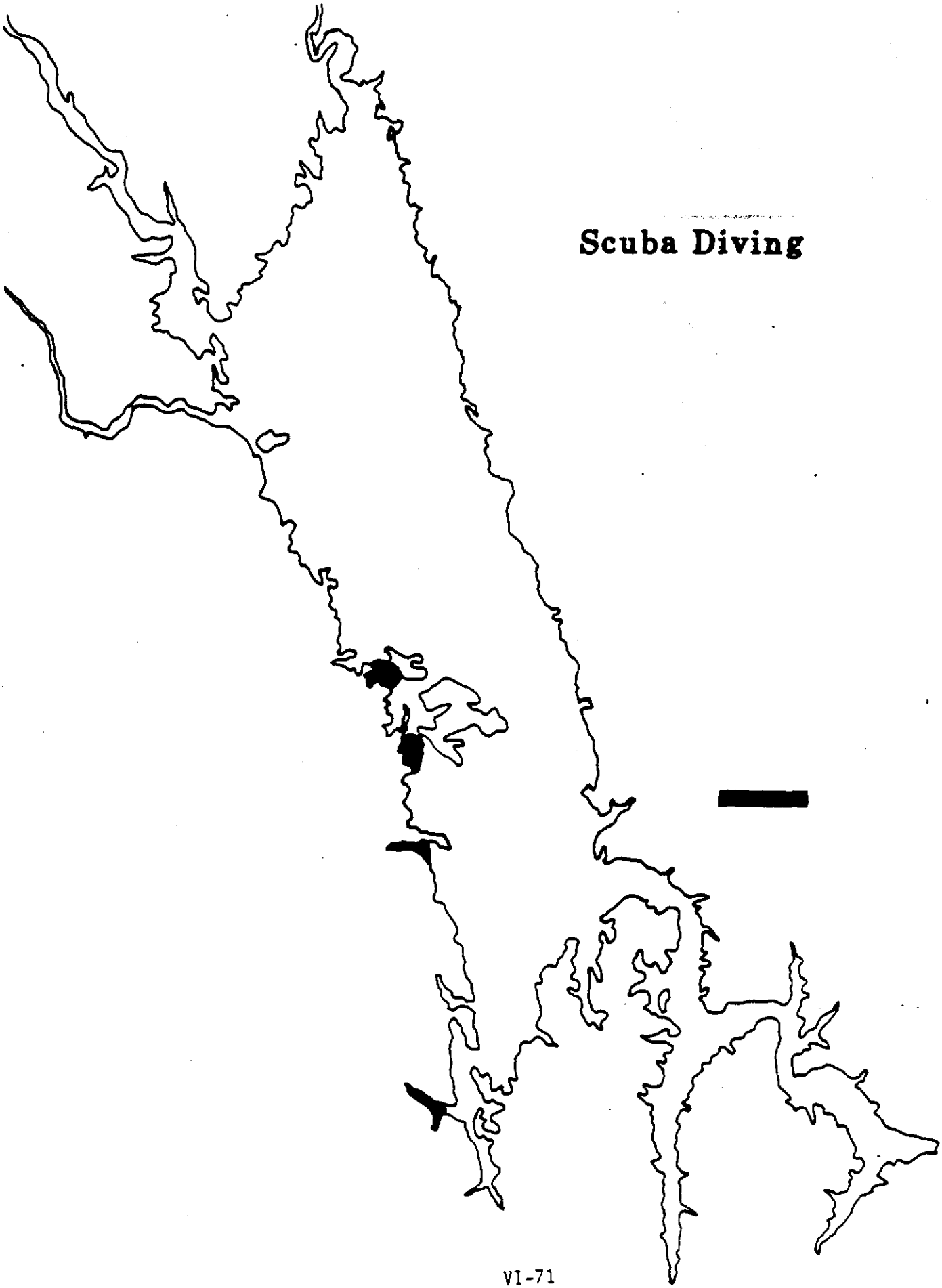

Sailboating (Predominantly)

SCUBA DIVING - EXPERIENCE: Competent

Activity description. - Self-contained underwater breathing apparatus enables participants to stay underwater for long periods of time. The activity is multi-dimensional as each dive develops another degree of competency and confidence. As competency becomes proficiency, divers can explore the lake bottom. If divers find anything interesting, they can extend their proficiency to underwater photography. Smittle Creek, Oak Shores, Park Headquarters, and Capell Cove are the locations generally used by divers. This activity can occur year-round with use of wet and dry suits.

Resource requirements. - There are no recreation capacity standards for diving. State diving regulations require boats to maintain a 100-foot radius from a dive flag which indicates a diver is down. Divers with a wet suit for comfort prefer water temperatures in the 50 and 60 °F range. Air temperatures in the high 70's to low 80's are desirable. Clear water is desirable for visibility - at least 10 feet. Water depths ranging from 4 to 30 feet are the safest for diving. Beyond 15 to 20 feet of depth, the visibility diminishes to a point underwater lights are needed. Divers are difficult to see and unpredictable as to when or where they will surface. A boat free area is necessary for safety.

Figure VI-31. - Scuba diving

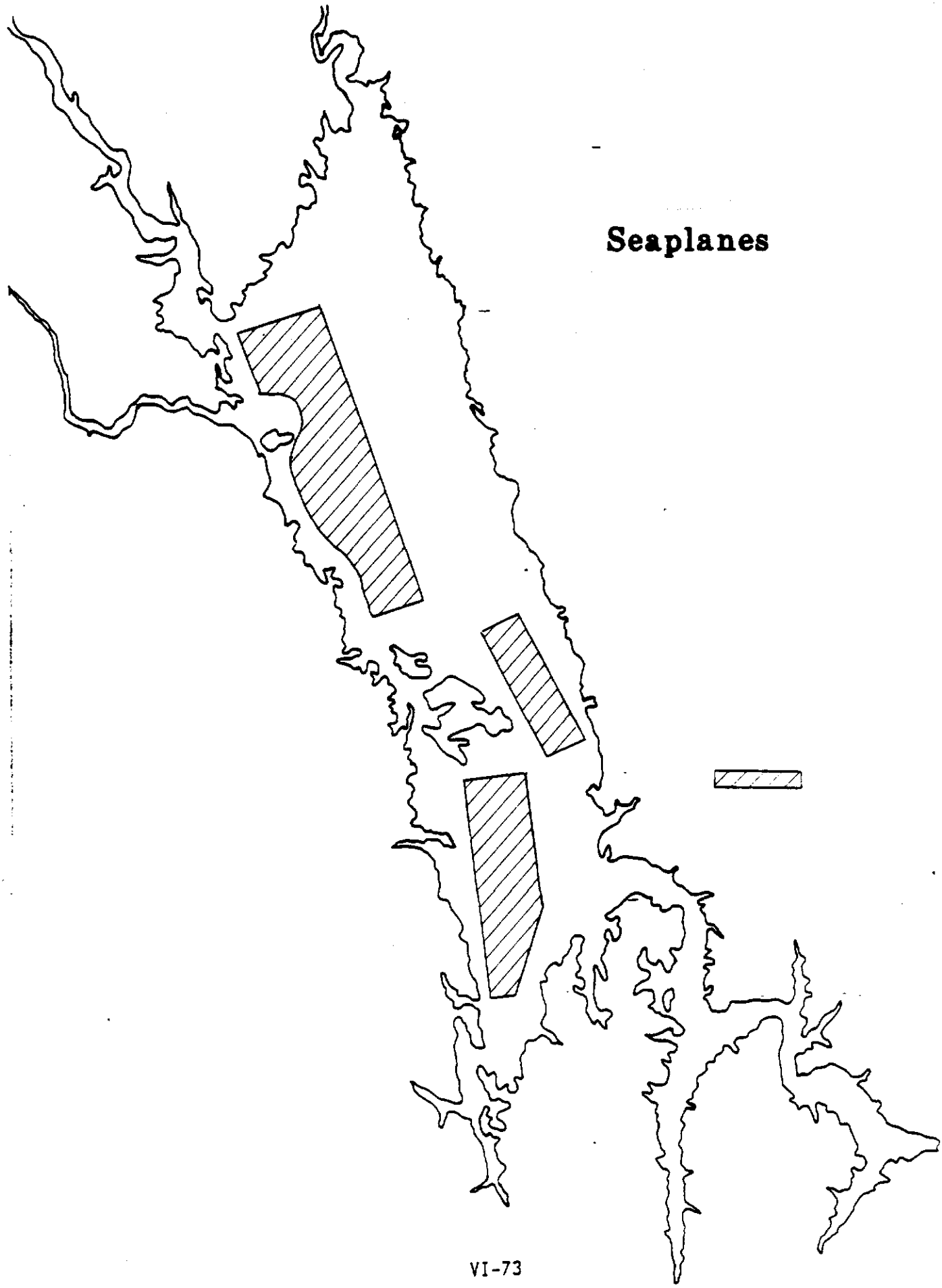

Scuba Diving

SEAPLANES - EXPERIENCE: Competency

Activity description. - Seaplanes have a single engine, pontoons or a fuselage shaped like a boat hull to land on water, and carry up to five passengers. Three designated areas of the lake are used for seaplane landings and takeoffs. Picnicking and overnight camping are part of the seaplane experience. The seaplane taxis to shore for these activities. This activity provides sightseeing from the air and requires a flying skill to land and takeoff on water. Seaplanes use the lake most often during the summer.

Resource requirements. - There are no recreation standards for seaplane use of water bodies. There are aviation standards requiring certain clearances over concentrated populations. It is conceivable some boats could be considered "concentrated populations." The landing flight path is 3°. The combined clearance and angle for landing and takeoff determine the length of area required for the activity. Landings and takeoffs are usually into the wind. Waves less than 2 feet high are required for safe landings and takeoffs. This activity can occur any time of the year when weather exceeding 1,000-foot ceiling and there is a visability of 3 miles.

Figure VI-32. - Seaplane

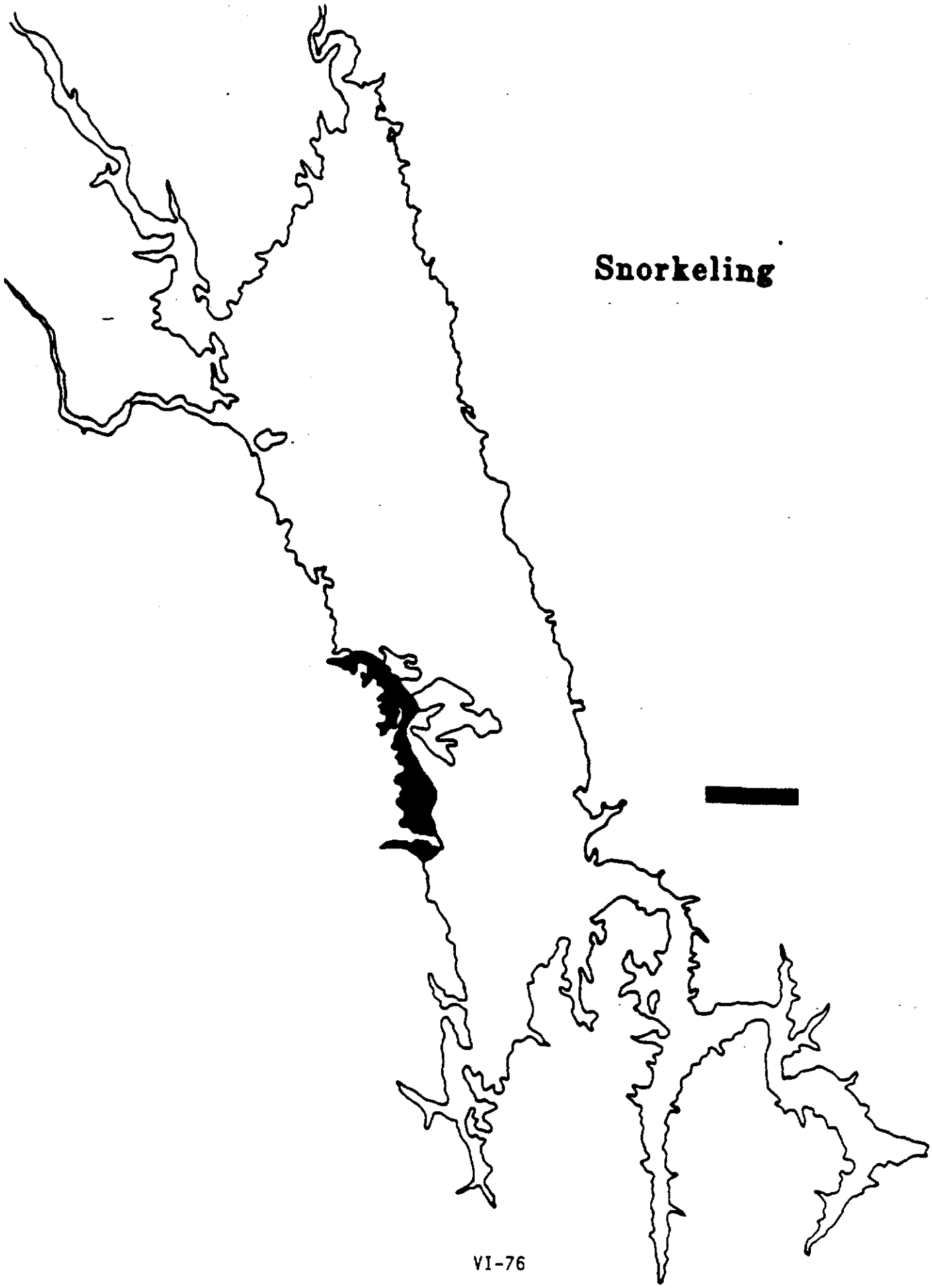

Seaplanes

SNORKELING - EXPERIENCE: Solitary

Activity description. - Snorkeling is swimming at or near the water surface while using a curved 15-inch tube (snorkel) held in the mouth for breathing. Participants usually use a face mask to see underwater and swim fins for added mobility. Some snorkelers can free dive (without scuba gear) to 100 feet and return to the surface for air within 2 to 3 minutes. Most snorkelers at Lake Berryessa mingle with swimmers and stay close to the surface. Lake Berryessa is not conducive to free diving because of low visibility and lack of sights of interest to see.

Resource requirements. - There are no recreation standards for snorkeling. Good, accessible beach area with a 12- to 15-percent gradient is desirable for entering or leaving the water. Calm, clear, fairly warm - (70° F+,) water with 15 feet or more visibility provide the most optimal conditions. The area should be relatively free of aquatic plants, and have subjects of interest to the snorkler. Snorkeling should be conducted in areas of no boating or canoeing. The activity usually occurs in the summer season.

Figure VI-33. - Snorkeling


Snorkeling

CHAPTER VI

ACTIVITY DESCRIPTION

RESOURCE REQUIREMENTS,

AND AREA USED

ACTIVITY DESCRIPTION, RESOURCE REQUIREMENTS, AND AREA USED

This chapter describes each recreation activity and its resource requirements. The leisure profile is used for assessing the experience a participant receives from the activity. An understanding of these elements will facilitate explaining the activity matrix consortium. The information will help identify conflicts and compatibilities of the activities on Lake Berryessa.

Recreation standards appear to apply only to more popular and conventional activities. Standards are presented in Appendix B. There are 33 recreation activities occurring on Lake Berryessa that have no standards and must be recognized as resource users. The standard and nonstandard activities compete with each other for the utilization of water areas. Some understanding of the nonstandard activities and their resource requirements are necessary for the capacity analysis.

The "Leisure Profile" provides an idea why people participate in certain activities on Lake Berryessa. The activity expectation returned to the participant has a bearing on perceived crowding and quality of experience. The profile is useful to explain conflicts, compatibilities, and interrelationships. Table VI-1 provides a leisure profile breakdown for the activities.

Table VI-1. - Leisure profile activity experience

Social	Mental	Risk	Solitary	Competent
Houseboating	Boating-sightseeing less than 15 mi/h	Amphibious ultra light	Air matress floating	Archery fishing
Houseboat rock concert	Fish and wildlife habitat conservation	Boating-speeds up to 50 mi/h	Camp-boating	Jet skiing
Swimming	Picture taking	Bridge diving	Canoeing	Military activities
Swimming devices		Parasailing	Fishing-shore	Power surfboards
		Rock diving	Fishing-boat still	Sailboating
Wet bicycling		Rope swinging	Fishing-boat trolling	Scuba diving
		Surf sailing	Houseboat-isolated	Seaplanes
		Wiener riding	Inner tube floating	Water skiing
			Kayaking	Swimming competition
			Paddle boating	Tournament fishing
			Picnic-boating	Biathlon
			Rowboating	Triathlon
			Rubber rafting	Sailing regatta
			Snorkeling	
			Wading	

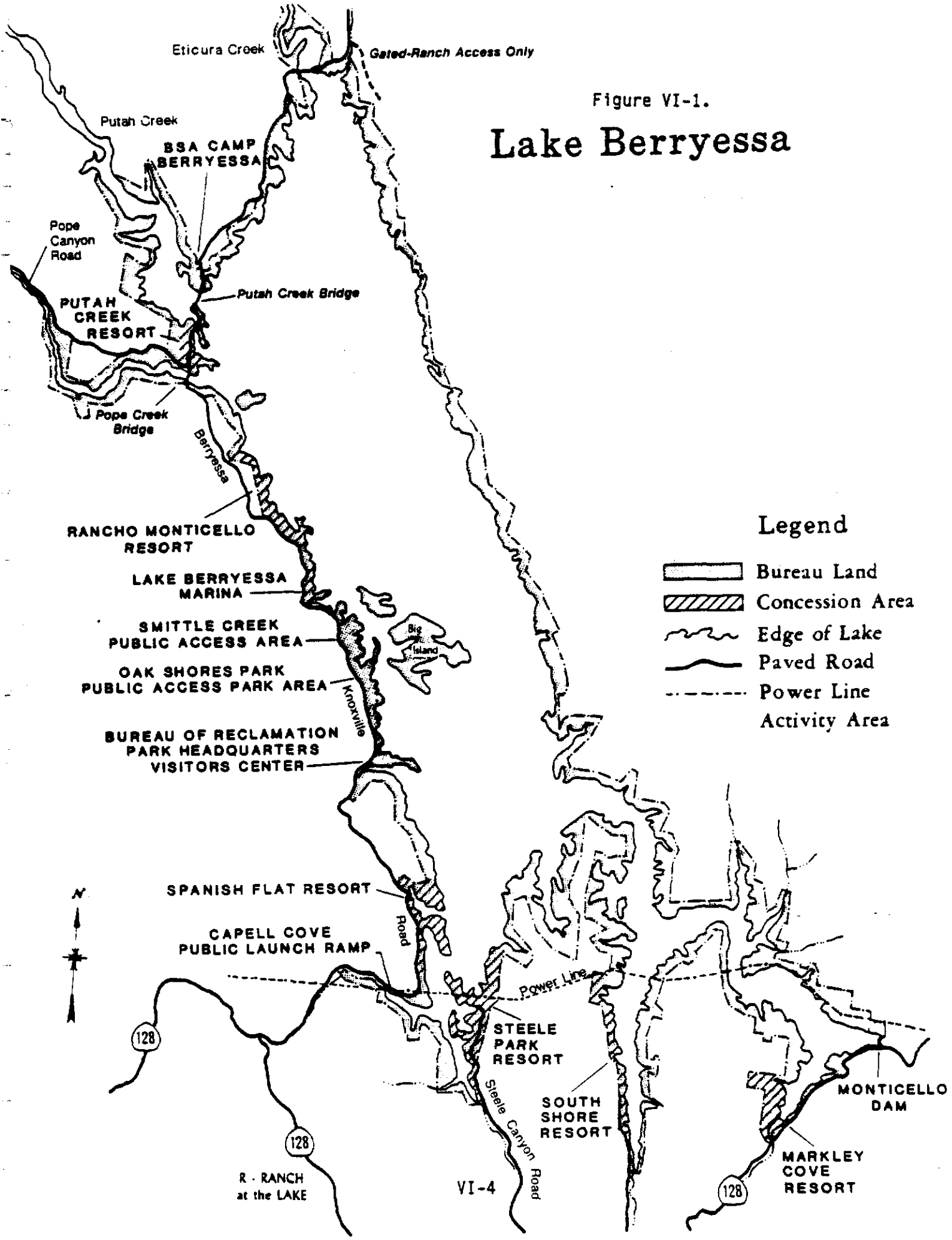
Each activity is designated a leisure profile category as it applies to the experience on Lake Berryessa. Some activities could be assigned more than one category. One category is assigned for each activity to reduce the complexity of the analysis.

Figure VI-1 illustrates the areas occupied by the concessions, roads, Bureau land, and the powerline. Subsequent activity maps can be related to this map.

Photographs were not available for all the activities and the variations within some of the activities. Each figure reference includes (a) photograph(s), and (b) a map showing the usual place of the activity occurrence on Lake Berryessa.

Figure VI-1.

Lake Berryessa



AIR MATTRESS FLOATING - EXPERIENCE: Social

Activity description. - Air mattresses are usually plastic or rubber inflatable flotation devices about 7 to 8 feet long, 2 to 3 feet wide, and up to 8 inches thick. People use the mattress to lie on for sunbathing or passive activity, horseplay and piling on, and for hand paddling around. The activity usually occurs during warmer times of the day.

Resource requirements. - There are no recreation capacity standards for air mattress floating. The activity requires sufficient water for flotation usually in excess of 1 foot deep, water and air temperatures in excess of 70 °F, calm water, and preferably a sandy lake bottom. The activity can occur almost anywhere on the reservoir and can be associated with other activities such as houseboating and swimming. This activity usually occurs during the warm recreation season.

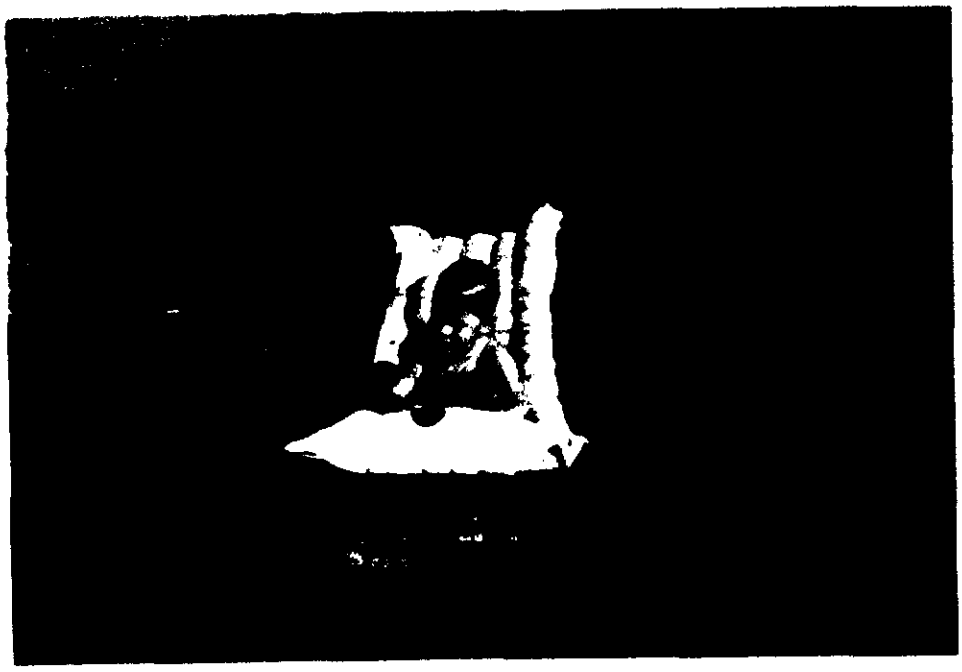
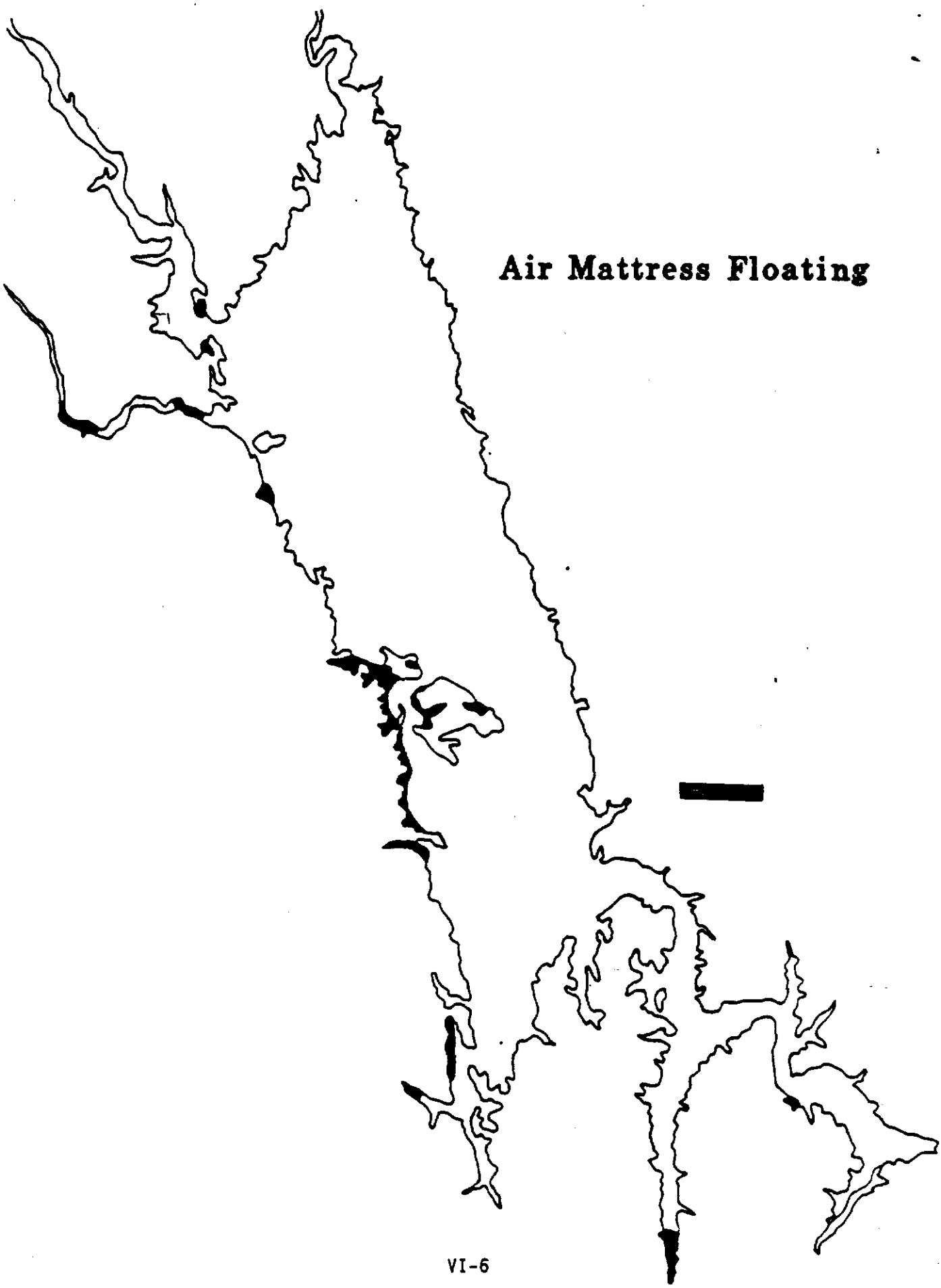


Figure VI-2. - Air mattress floating

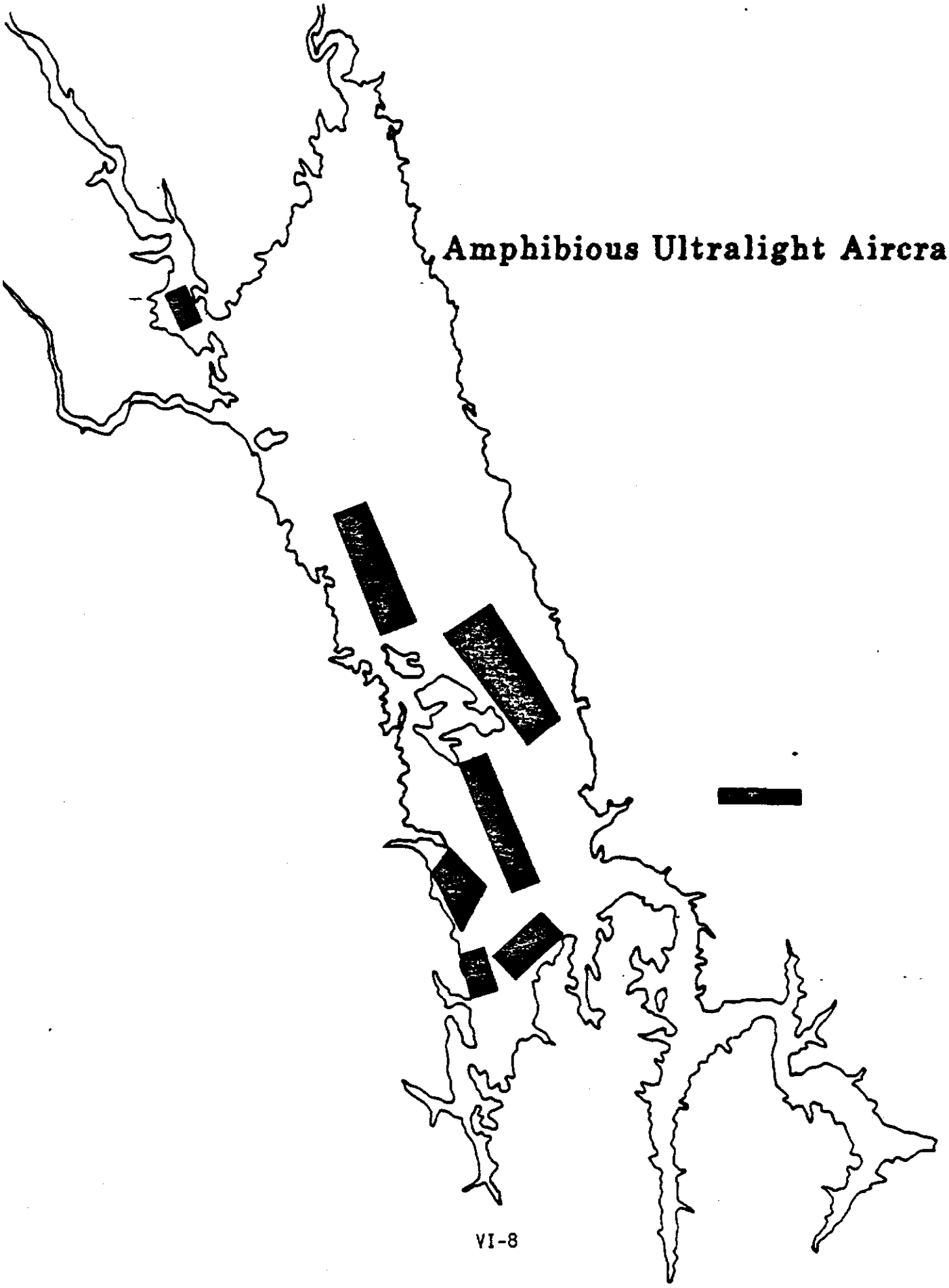

Air Mattress Floating

AMPHIBIOUS ULTRALIGHT AIRCRAFT - EXPERIENCE: Risk

Activity description. - Ultralight aircraft are single-person lightweight airplanes equipped with pontoons to land on water. They weigh less than 254 pounds, have a fuel capacity not exceeding 5 gallons, and are incapable of more than a 55-knot maximum air speed. They periodically fly over and land on Lake Berryessa. People experience a challenge and a thrill to be suspended in air with a minimum of protection. Sightseeing is a part of the experience. Occasionally, some individuals fish from the aircraft.

Resource requirements. - There are no recreation capacity standards for amphibious ultralight aircraft. The activity requires relatively calm water with waves less than 1 foot high for landing and taking off. The landing flight path is 3° and the Federal Aviation Administration forbids flight over any "congested areas." Landing is usually into the wind and requires at least one-quarter mile. Taking off is usually into the wind and requires less than one-quarter mile. This activity can occur any time of the year in good weather.

Figure VI-3. - Amphibious ultralight aircraft


Amphibious Ultralight Aircraft

ARCHERY FISHING - EXPERIENCE: Competent

Activity description. - Archery fishing is simply bow and arrow fishing, usually from the shore. A fishing arrow has a takeup wheel, or reel and line. The most common fish species pursued is carp which come close to the surface in shallow areas while feeding. The carp size makes them easy targets. A heavyweight light line is usually attached to the arrow to retrieve the fish struck by the arrow. Usually the shooting distance is within 50 feet. The activity occurs between sunrise and sunset and requires skill and expertise.

Resource requirements. - There are no recreation capacity standards for archery fishing. Archery fishing usually occurs in shallow, still water areas 3 feet and less in depth, and can be participated in from a boat or shore. The shore should provide elevation above the water for visibility into the water. An embankment up to 8 feet high adjacent to the water where fish usually feed is desirable. Carp are usually the target fish. No other recreation developments or activities should be in the vicinity of archery fishermen. This activity can occur year round during the designated fishing seasons; however, it is more common during the spring breeding season.

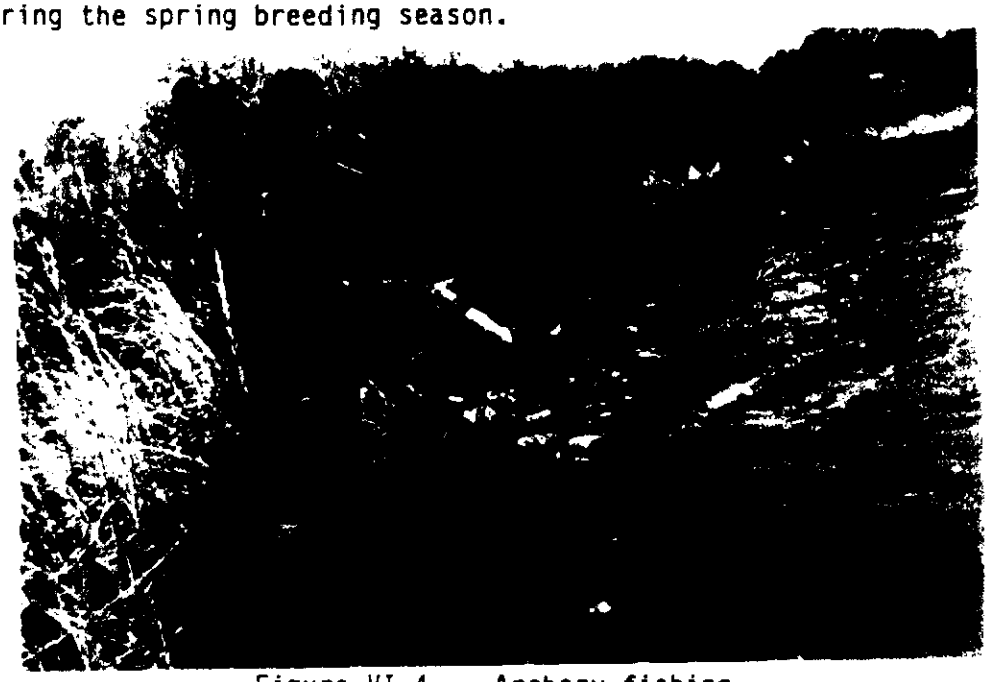
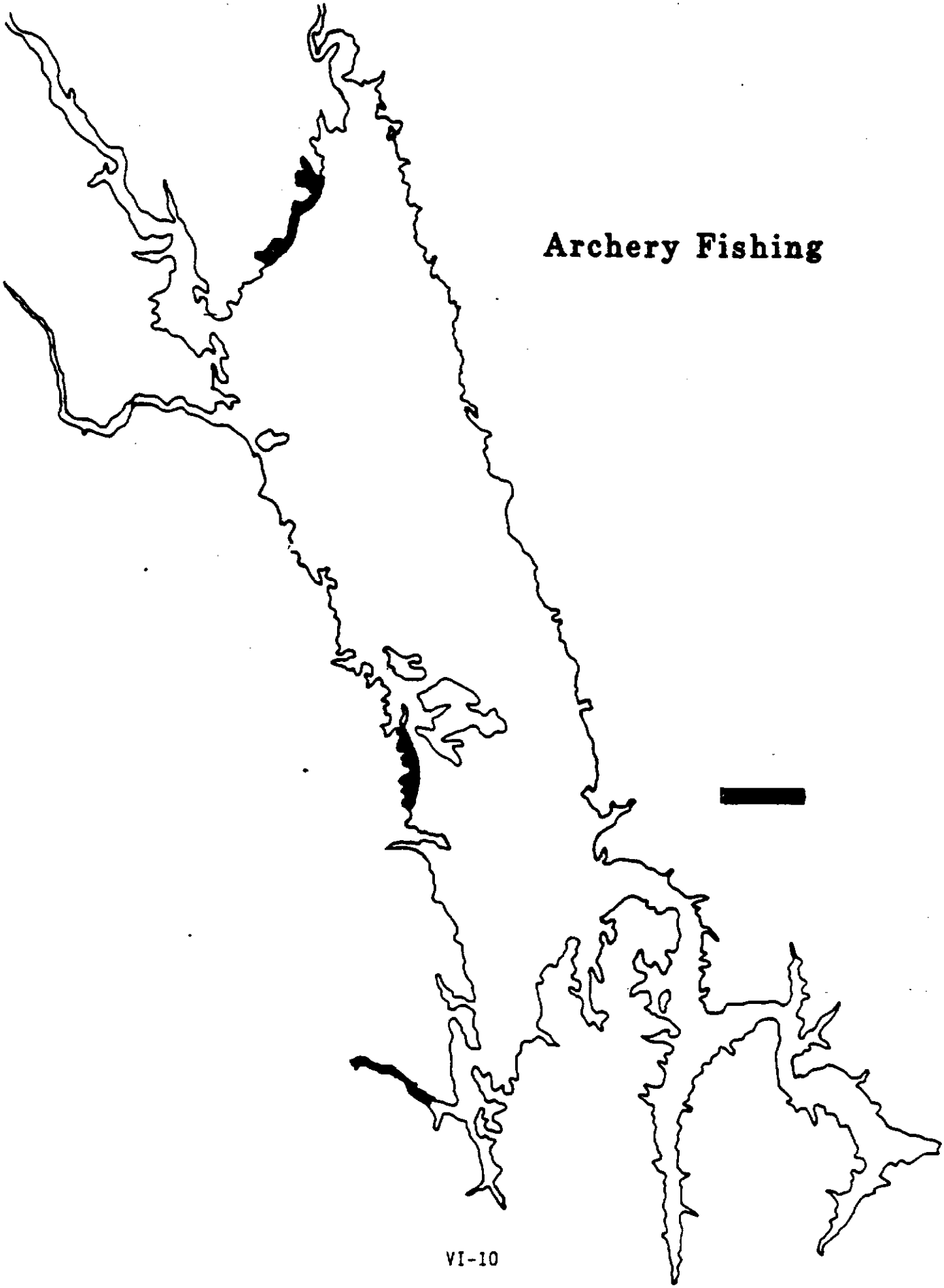


Figure VI-4. - Archery fishing


Archery Fishing

LITERATURE REVIEW

Recreation carrying capacity literature is extensive. As early as 1969, Ditton (1969) reviewed 900 pieces of pertinent literature dealing with the recreation aspects of water resource use. Since then, numerous articles have been written and research conducted on recreation carrying capacity.

This review selectively draws upon literature which applies to the analysis of the recreation carrying capacity of Lake Berryessa. This review addresses: (1) the definition of carrying capacity, (2) the types of capacities, (3) capacity observations, (4) the leisure profiles, and (5) an application of ecological principles. References are alphabetically listed in the Bibliography.

Carrying Capacity Defined

The *American Heritage Dictionary* (1976) defines "capacity" as: "1) the ability to receive, hold, or absorb, 2) a measure of this ability, 3) the maximum amount that can be contained." "Carry" is "to hold or be capable of holding, to support or sustain the responsibility of." Carrying capacity is biologically defined as, "the population (as of one species of animal) that a given area (as of water or pasture) will support without undergoing deterioration." In general, recreation researchers agree with Chubb and Ashton's (1969) definition that, "Outdoor recreation annual carrying capacity is the number of user-unit

use periods that the recreation site can provide in an average year without permanent biological or physical deteriorations of the site's ability to support recreation or appreciable impairment of the recreational experience."

According to Suhm (1969), "outdoor recreation planning is plagued by the lack of standardized nomenclature and units of measurement. Anyone trying to determine carrying capacity of recreation areas, or finding agreement in space standards or planning for recreation needs of the future is well aware of the chaos in our profession." This continues to be a truism today.

Chubb and Ashton (1969) list 16 different "capacities" based on entirely different concepts emanating from state and federal agencies. This is primarily because there are many professions and disciplines involved in a "recreation capacity".

Ditton's (1969) literature review found capacity is what the user considers desirable in recreation, the threshold levels of satisfaction within and between user groups, and a level of use which management can manipulate for achieving optimum user satisfaction.

Hammon et. al. (1974) indicate capacity connotes capability, maximum safe level of use, and a saturation point. It implies that something can receive and contain a certain quantity and no more. If the quantity is exceeded, something must break down.

In recreation, the breakdowns are thought of as resource degradation, diminishing satisfaction of recreation participants, and diluted quality of the recreation experience due to crowding and friction. Natural and physical scientists tend to develop their resource planning and development methods in a vacuum that fails to consider human ecological relationships and attitudinal and

behavioral patterns of recreation participants (Ditton, 1969). On the other hand, planners, sociologists, psychologists, and economists have developed comprehensive methods of analyzing and allocating resources which reflect minimal environmental understanding. Each discipline has its own threshold of capacity; and, when it is breached by some increment of visitation, a breakdown occurs and problems of health, safety, and resource integrity, user dissatisfaction, and experience quality may develop.

Wagar (1964) has defined carrying capacity on an annual basis as:

"... the number of user-unit use periods that the recreation site can provide in an average year without permanent biological or physical deterioration of the site's ability to support recreation or appreciable impairment of the recreation experience." In considering this definition of carrying capacity, two effects are identified: the effect on the user and the effect on the resource. However, resource deterioration itself is primarily significant because of its impact on people. Wagar emphasizes this point in the following way:

> "Even severe abuse of land and other resources is not wrong from the standpoint of the resources themselves, but because of the impact that deteriorating resources have on the fulfillment of human needs and on the sustained welfare of society. For evaluating recreational carrying capacity, comparing alternative uses of land, or for making other land use decisions, human needs and desires provide the primary criteria for judgment."

Capacity is related to human behavior and expressed attitudes under different intensities of recreational use. These are the factors which contribute to the establishment of tolerance thresholds.

Types of Capacities

Carrying capacity is complex and dynamic due to the numerous interacting factors which influence people in a recreation environment. Crysdale (1973) grouped the factors into five categories: 1) administrative, 2) biological, 3) physical, 4) social, and 5) temporal. A synopsis of each factor follows.

Administrative: Other literature recognized resource deterioration and dissatisfaction of recreators as integral parts of carrying capacity. None of the literature sets forth unacceptable levels of deterioration or user dissatisfaction. Ditton indicates levels of user satisfaction depend on management manipulation; and Wagar (1964) indicates recreational capacity must be of an administrative nature.

Administrators determine how much accessibility there is to a water body through the acquisition of land encompassing that water and through the extent facilities are provided to enable access to the water. A Michigan Department of Commerce Report (1966) indicates "Resource availability and not capacity controls participation in outdoor recreation."

Administrators influence the amount and kind of facilities the public uses for obtaining access to water for recreation activities. Reid (1963) found the lack of facilities and overcrowding were major reasons of dissatisfaction of users who motorboated. Other concerns were inadequate provisions for visiting boaters, improper location and design of launching ramps, and inadequate parking space for boat trailers.

Zapata (1980) studied crowding in recreational boating at Lake Tyler and Lake Palestine, Texas. He found that "crowding was felt to be more intense on shore (at parking areas and launch ramps) than on the water surface." Six

variables were significantly related to crowding experiences on the water surface: "1) the number of boating activities engaged in, 2) the boating activity engaged in most of the time, 3) length of boating experiences, 4) type of use encountered, 5) horsepower of the boat used, and 6) the type of boat used."

Paulson (1965) indicates there are three common controls administration uses around the country for recreation use of water bodies: 1) alternate time periods for each sport, 2) limits on speed and power of boats, and 3) zoned areas for each activity. Zoning reduces interspecific competition of recreation activities. However, Crysdale (1973) indicates the activity competition becomes intraspecific as more people seek more activities on a limited water surface area.

Biological: Disease, pollutants, aquatic growth, and pests directly and indirectly influence the degree and types of recreation use water bodies receive. These four factors usurp the recreation carrying capacity of any water body if they reach problem proportions in occurrence. Swimming and water skiing demand the highest water quality because of high occurrence of body contact with water. Ditton (1969) indicates recreation use is discouraged by ill-tasting and malodorous water; transmission of waterborne diseases hazardous to man; impairment of water quality by color and turbidity; and toxicity to fish, wildlife, plants, and aquatic insects.

Pollution problems at Lake Berryessa presently have not reached a critical point that would prevent any recreation activities from occurring. Suffice it to just recognize the biological factors related to carrying capacity.

Physical: Recreation carrying capacity is generally expressed as a physical ceiling or limitation of an area to accommodate a number of participants in various recreation activities. Physical features have dimensions both in numbers such as people, boats, or whatever; and in units of acres, miles, meters, hours, day, or horsepower. Dimensions can be measured.

Peterson (1968) indicates existing standards for water-based recreation activities leave a wide range of area-requirement elasticity and are limited to two dimensions without specifying minimum lengths and widths. The literature reveals six dimensions associated with water-based recreation: length, width, depth, height, time, and speed. Present two-dimensional surface area dimensions expressed in surface acres do not consider the morphology of a water body. A water body may have all the necessary surface area for activities; however, the shoreline configuration may pre-empt any use of the area for the recreation activity in question.

Ashton (1968) indicates a large reservoir more than a few miles across will have substantial unusable area in the center and a smaller percentage of its total water surface will be used by the recreationist.

The depth of water can have a great influence on boating. Lakes with frequent shoal or other obstructions may have a low spatial capacity resulting in a low annual carrying capacity. Anderson (1968) feels 5 feet of water depth for adults in inland lakes is a safe minimum limit for accommodating all types of boats engaged in various waterborne activities. Scuba diving and sailing would be excluded. In general, shallow areas are preferred for fishing and swimming.

The availability of height between the water surface and over-water obstacles is frequently overlooked as a consideration for capacity. Bridges, powerlines, and other low objects reduce the area available for some recreation activities and preclude the participation in other activities. Kite skiing (parasailing), for example, requires heights ranging from 20 to 120 feet in the air depending on the speed of the towboat (Anderson 1968).

The height of waves from wind or motor-boating can curtail or completely discourage recreation activity on a water body. Water skiing should be in the calmest part of the water and water skiers are encouraged to avoid heavy wave action. Boat wakes disturb sailboaters, canoers, fishermen, and pleasure boaters; and all appear to compete with each other for the use of calm water (Crysdale 1973). Such competition leads to crowding and inter-and intraactivity conflicts.

Hall (1962) cites the Oxford dictionary for relating space not to an "area" in the first definition, but to "time." Time is common to everyone. Suhm (1969) indicates time can be used to describe how we exist in, move around in, and occupy space which is also common to everyone.

Speed is the rate other dimensions are exploited in utilizing water resources for recreation. Threinen (1964) says, "space consumption on water is directly proportionate to speed." Van Doren and Lentnek (1969) observed people owning small motors are precluded from high-speed activities such as water skiing. On the other hand, fishing may be associated with any size engine.

Weather and water temperatures are other significant physical factors. Dowell (1970) cites Haugen's boating study on four Iowa lakes and indicates

wind direction and velocity were the most important variables in the recreation utilization of the lakes. About 90 percent of boat launchings occurred on days with a mean temperature range between 56 and 86 °F. Stott (1967) recommends the most suitable water temperatures for swimming range from 68 to 75° F. The quality of the activity diminishes above and below that range.

Social: Hopkins (1967) stated "The recreation ceiling or limit to our area may more often be social rather than physical." Underlying the social behavioral patterns of humans is the acceptance of them being a part of nature and subject to natural laws.

Hammon et. al. (1974) observed water bodies may provide a good opportunity for individuals to purge their suppressed impulses. However, when many people people are recreating on the same water body at the same time, there appears to be a sense of territoriality influencing each individual's behavior while participating in his respective activity. As more people use a lake for recreation and the surface area reaches a user saturation point, some will move to other areas of the lake or get off the lake to avoid a perceived crowd. This behavior is an individual's means to seek a balance between the advantages of aggregation on one hand and isolation or "territoriality" on the other. The crowding reaches the individual's psychological tolerance level for withstanding the presence of others.

O'Brien (1969) makes the distinction between apparent and perceived crowding in recreation areas:

> "Apparent crowding should be reduced. Crowding is going to lessen most people's recreational experience. However, crowding is not

> necessarily a given number of people in a given acreage because different areas, by design and purpose, have vastly differing capacities to accommodate people before crowding becomes evident."

Whether a recreation area is apparently crowded or perceptually crowded depends upon physical factors and attitudes of people (Lucas 1964). An increase in visits may be accompanied by crowding and, therefore, by a reduction in quality.

Threinen (1964) noticed that fishermen will not space themselves near the 75-foot distance they can cast:

> "Most fishermen will be intolerant of one another at much greater densities. For example, aerial counts of fishermen have shown few densities greater than one boat per 10 acres on lakes. Although lakes may have space to fish and under-utilized stock of fish, intolerance may prevent more fishing."

Klopfer (1962) has observed that where the spatial organization is a function of the possession of individual territories, the mean distance between individuals will remain reasonably constant. He further agrees that a given spatial pattern results from territorial behavior and that this pattern is relatively independent of the abundance of the species. The territory size may remain constant even in the face of a rising density of individuals without territory. For example, Threinen (1964) observed that most fishermen will be intolerant of one another if the density exceeds one boat per 10 acres on lakes and that water skiing seldom builds up to more than one boat per 20 acres of water. He hypothesized that as the number of boats increased on a lake, an element of fear sets in. The downed water skier is not a very secure person as boats speed around him. Therefore, Threinen

feels water skiing is density dependent and, when pursued to excess, it limits the number of participants.

Crowding and competition can reduce the utility or value of the recreation experience to individual recreationists. However, the value received by a user will depend largely on his training, experience, and alternative experiences (Dice 1955).

Dice suggests that the actual density of population that any region can support may be assumed to be controlled by the interaction of the 1) heredity of the people, 2) their type of culture, 3) their standard of living, and 4) the resources available in their habitat. Hall (1962) quotes Lasswell, author of Power and Personality:

> "People group themselves in space according to the values they demand, the expectations they entertain about the outcome and their identification."

Hopkins (1967) illustrates the segregation and clustering phenomena by activity:

> "Campers and other visitors tend to segregate themselves into specific activity groups such as fishing, nature study, swimming, or water skiing. Often the requirements of one group are incompatible with those of another. Unplanned or forced intrusion of one activity on another can alter the complexion of use, the demand on the site, and levels of satisfaction. Water skiers seem to like lots of company near their camps, if the company is that of fellow skiers."

Territoriality is a social phenomena as it relates to recreation. This is illustrated by the following Outboard Industry Association (1962) research conclusion:

> Boat owners see themselves as average people who have attained a degree of financial security. They are by their own admission an "in-group" and are inclined to reject non-owners, yet will accept other boat owners. They have a possessive attitude toward boats and the water, feeling that it is their sacred right to be there, and their right alone, whether they use their boats for fishing, cruising, water skiing, or whatever. They resent the public infringing on their rights by such statements as, "the water is too crowded," or "getting on the water now is like driving on the highway, bumper to bumper," etc.

When talking of an organism's response to space over a period of time, we are in reality referring to an intricately balanced system of internal and external feedback mechanisms that are brought into play prior to the point that population growth is self-limiting and self-regulating. Ardrey (1970) endorses J. J. Christina's hypothesis that the building up of a population is a time of increasing stress. They suggest that the increasing number of young, the increasing competition of adults, the increasing number of strangers in a massive, increasingly disorganized population at last brings on a state of exhaustion both psychological and physiological. Human populations can endure heavy crowding for a short time, but they do not then thrive best (Dice 1955). With too much pressure from one's surroundings, it is natural to seek escape.

The conditions and behavior just described have been observed under a variety of situations where human or animal populations densities have been high and where little individual choice was available as far as altering the situation. There seems to be applications of these principles to recreational behavior even though personal choice plays a very large role in such behavior. Hammon et. al. (1974) observed as densities and intensities of recreation activity on a water surface increase, it is expected that stress will increase on the users to the point that they will migrate to less dense

areas or will go to the shore and, in some cases, will even leave the lake altogether.

The ability to migrate within a water recreation system appears to be partially dependent upon horsepower. For example, Van Doren's observation that large engines can be used for a greater variety of activities than can small engines. The engine size has migration implications. Small engines are usually used for more specialized purposes and can be viewed as less competitive than large horsepowered units. Those users which are least competitive are also least able to utilize this mode of migration.

Alihan (1938) notes that three characteristics: competition, freedom, and mobility (the condition of distribution) are the basic features of natural systems.

> "Mobility, a term used by ecologists as equivalent to physical movement of all kinds, is apparently regarded as one of the primary means of survival and hence becomes not only a condition but a concomitant of the process of competition. It is assumed that through change of location organisms are better able to seek more favorable conditions for survival, so that mobility in this case determines success in competition and implies freedom of selection within the limits of the environment. In fact, the degree of freedom of movement is related to the degree of freedom of competition. Freedom of competition means freedom of movement and vice versa."

In summary, the literature in this area suggests that a recreation saturation point is reached as an increasing number of strangers in an increasingly disorganized population brings on a state of psychological and physiological exhaustion. Human populations can endure heavy crowding and its associated stress for a short time. With too much pressure from one's surroundings, it is natural to seek escape.

Escape is usually in the form of migrating, mutating, or completely avoiding return to the recreation area or activity. Migration is avoiding crowds by moving to another less crowded area on the lake, changing from one recreation activity to another, or waiting for the water activity to decrease and then resuming participation in the desired activity. The change in activity or waiting can be on land or water.

Mutation is usually the temporary tolerance of an unsatisfactory recreation experience. However, mutation can also be in a physical form such as using a larger boat and/or motor to effectively compete with other users of a water body. Generally, larger boats tend to withstand waves better than small boats, and larger motors provide greater capability for migrating. Safety and recreation satisfaction can be enhanced by this type of mutation.

If lakes are commonly crowded, some people will avoid using them and drive to another less crowded lake that may be farther from their home. If no other lake is available, then people may refrain entirely from participating in the desired recreation activity.

Crowding on a water body, whether it is apparent or perceived, contributes to stress which triggers a need to escape. The satisfaction derived from water-oriented recreation is heavily dependent on the degree of freedom which the water body and the pursued activity offer. The degree of movement freedom is related to the degree of freedom from competition with other recreationists.

Temporal: Time is manipulated by administration and management to regulate, by lengthening or shortening time periods, and the utilization periods of water resources for recreation whithin seasonal and diurnal limitations. Restrictions can reduce the amount of time a water body can be used for

recreation. The carrying capacity potential of a water body cannot be realized if time restrictions are imposed on all activities at the same time. The amount of time a participant devotes to an activity will vary depending on his physical condition and the degree of physical activity involved. For example, Van Doren and Lentnek found few individuals devote more than 69 percent of their boating time to water skiing. The remaining time usually is spent pleasure cruising. Other research by Urban Research and Development Corporation (1977) found proximity of picnic facilities would contribute to water skiers pleasant experience. In other words, water skiing, pleasure boating, and picnicking are alternated with each other.

Capacity Observations

This section describes research observations of capacity on other water bodies and capacity observations on Lake Berryessa.

Other Water Bodies: Threinen (1961) observed the shallows of a lake are a zone of intense activity in which all activities are concentrated. When activities such as motorboating and water skiing with high space consumption transgress on activities with low space consumption, which includes most of the other activities, zoning for certain uses is justified. The number of boats on a lake is related to the amount of shore and that a high shore/area ratio results in high concentrations (Threinen 1964). As a result, small lakes have greater densities than large lakes, and the number of boats in use for fishing or boating of any kind is much lower than the number present on the lake, and a common level of use at the peak activity period is 10 percent of the boats present (Threinen 1964). The pressure of the growing numbers of water recreationists threaten to extinguish the very values sought.

Lucas (1964) in "The Recreation Capacity of the Quetico-Superior Area" study observed the type of craft used seemed to condition strongly the perception of crowding.

The Urban Research and Development Corporation (1977) did research on the "optimum recreation carrying capacity." The study treats optimum capacity in terms of "instant capacity" - the capacity of a given resource area at any single point in time. The study:

> "basically looks at each recreation activity as functioning independently and not inter-mixed with others, the study does recognize the importance of considering "compatibility" or "incompatibility" of an activity related to other activities in the park. The possible combinations of activities are much too extensive for this study to determine the specific capacity of various activities when combined with other activities. Capacities regarding recreation activity combinations are best left to the experience of park managers and their effective, practical use of the capacity guidelines in this report until such time that a separate capacity study can be devoted to various recreation activity combinations."

The study also indicates consideration of management objectives is most essential in making the final determination of a site's specific optimum carrying capacity from a management perspective. Recreation activities must be well defined with regard to: 1) the characteristics of different subtypes within one type, 2) the natural resource requirements of the activity, 3) the facilities and equipment required, 4) the goals of the participants, and 5) various unique aspects of the activity which affect participant experience and optimum carrying capacity.

Cordell et. al. (1975) in a recreation capacity study of Lake Burlington in North Carolina observed potential use conflicts should be identified. Lake area zoning or permissible use period zoning are possible means for accommodating

incompatible uses. "Aside from setting upper use limits or restricting types of use for purposes of protecting the resource, setting capacity limits may, in fact, limit rather than maximize water recreation satisfaction." In regard to personal benefit-cost evaluation of the experience, Cordell explains each recreationist is maximizing his own satisfaction. This produces an overall satisfaction maximizing effect for all users. Because of this characteristic, human behavior manager's actions to restrict use to the calculated capacity may, in effect, reduce the total recreational benefit rather than enhance it. Artificially establishing an overall upper limit on number of boats allowed into a lake system seems to be a counterproductive effort. If not set by management, use limits appear to be automatically determined by the users, and the result seems to be satisfaction maximization. A study conclusion reached was "that capacity may not be a valid concept for management of reservoirs for recreational use." It is believed that capacity limits should not be a concern of the lake managers.

Zapata (1980) found, "no significant relationship between crowding and levels of satisfaction reported for boating experiences. Although crowding affected boat owners negatively as evidence by behavior responses, this effect was not evident when measured in terms of satisfaction."

Gold (1980) describes an "Activity Quality Scale" assuming the more an individual puts into an activity, the greater satisfaction or quality of the activity for the individual. There is a value judgment and weighing which ranks "creativity" highest and "killing time" the lowest. See figure V-1. An activity quality method divides all activities into (1) activities the agency now provides, and (2) activities not provided, but should be provided as determined by surveys.

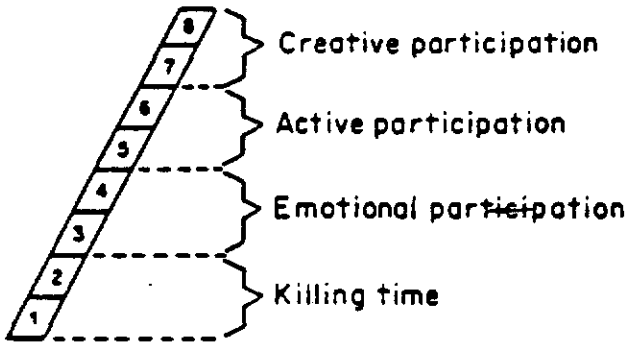


Figure V-1. - Activity quality scale.

The Glovers (1986) report the U.S. Forest Service found the capacity approach did not work in the Bob Marshall Wilderness, Montana, because it never lived up to expectations and there are simply too many variables. Instead of focusing on numbers of users, attention is on specific kinds of resource degradation and user experience impacts. Users would have choice of several types of wilderness experience based on plans jointly developed by the users and the U.S. Forest Service. The U.S. Forest Service is using education, which is better than eliminating use.

Lake Berryessa: Bigler and McCallum (1959) of the National Park Service studied Lake Berryessa recreation development before and during construction of Monticello Dam. The report said, "With full development, and at optimum water surface elevation, it is estimated the reservoir should accommodate 3,000 boats, needing approximately 125 launching ramps. A minimum of 8,000 picnic sites and 800 campsites should be provided."

Scullin (1987), a 9-year Lake Berryessa Ranger for the Bureau of Reclamation, regularly patrols the lake on the water and from an airplane during the peak recreation season. During some of his patrols, surveys were conducted. The

surveys were divided into the lake surface and the shoreline. The tallying of watercraft included all powerboats, rowboats, houseboats, jet skies, etc., with sailboats being counted by themselves. Shoreline use was obtained by counting all the vessels (in the same manner as noted above) tied up to shore, beached, or moored in a marina. On May 22, 1984, the peak use rose to 3,660 boats on the lake at one time. See table V-1. Based on the flyover data in the table, the total number of boats went over 3,000 once since the flyover patrols were initiated in 1980. Boats under the covered portions of marina floating docks could not be counted during the aerial survey.

Leisure Profile

Reference is made to Lasswell's Power and Personality that states people group themselves in space according to the values they demand, the expectations they entertain about the outcome, and their identification. People have numerous expectations of the outcome of their recreation experience. The outcome is basically why people recreate in various activities. People expect to gain something from the experience. The expectations can be synonymous with "needs" which are displayed in the broad categories of the leisure profile in figure V-2.

Table V-1. - Fly-over data for Lake Berryessa

Date	Total Other	Total Sail	Total Other	Total Sail	% On Shore	Total Boats	Comments
5/25/80	482	12	153	1	24%	648	Mem/Day
6/19/80	87	07	25	0	21%	119	Thursday
7/05/80	506	07	207	8	29%	728	Sat. Hot
8/31/80	654	00	326	12	34%	992	
5/24/81	907	45	396	12	30%	1360	cldy.wrm
6/21/81	466	51	128	7	21%	652	Clr.Hot
7/05/81	682	29	375	9	35%	1095	Lt. Rain
8/02/81	317	12	127	1	28%	457	Clr.Warm
8/31/81	105	05	41	1	28	152	hot
5/31/82	513	53	334	12	38	912	cldy.cool
6/20/82	757	118	613	17	42	1505	clear
7/04/82	1238	64	969	50	44	2321	clds.wrm
8/01/82	713	75	614	21	45	1423	
5/30/82	147	01	112	1	43	261	clr.wrm
5/22/84	2290	80	1290	0	35	3660	me m.d.ht
6/18/84	126	07	112	0	46	245	clr.wrm
7/01/84	795	356	377	0	31	1207	hot
8/06/84	118	06	418	0	77	542	clr.hot
9/02/84	1101	28	825	0	42	1954	warm
5/26/85	403	09	693	18	63	1123	cldy.rain
7/04/85	840	39	872	11	50	1762	hot
8/04/85	538	14	342	0	38	894	warm
5/26/86	1172	59	1083	0	47	2314	hot
6/07/86	945	14	568	0	37	1527	warm
6/17/86	109	03	318	0	74	430	wrm.wind
6/29/86	1473	24	916	0	38	2413	clr.warm
7/04/86	1410	13	1428	0	50	2851	clr.warm
8/09/86	1316	17	1258	2	49	2593	clr.warm
9/01/86	1489	07	1270	3	46	2772	clr.hot
5/25/87	440	08	284	5	40	737	mem.day
6/14/87	658	16	326	2	33	1002	strwinds
6/18/87	118	03	216	0	64	337	ltwinds
6/28/87	931	11	417	0	31	1359	warm
7/04/87	1041	09	745	0	42	1795	warm
7/22/87	242	03	355	3	60	600	85°
8/01/87	1328	40	650	0	32	2018	98°
8/15/87	533	10	446	0	45	989	85°
8/29/87	592	05	706	0	54	1303	90°
9/06/87	1136	10	1385	0	55	2531	80°
9/19/87	404	02	539	0	57	945	80°
10/10/87	257	04	649	0	71	910	72°
11/7/87	269	02	339	0	55	610	78°
11/14/87	235	03	299	0	56	537	68° windy
8/17/86	1285	07	970	0	43	2262	clr.warm
Totals	31,168	970	24,516	196	44% average	56,850	

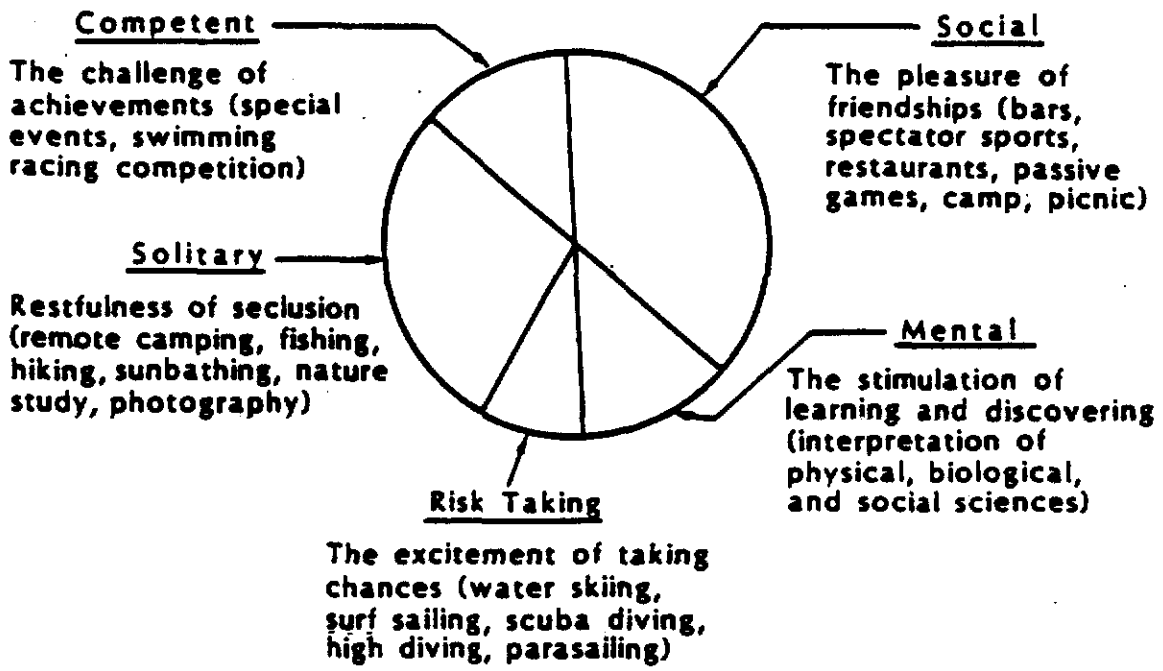


Figure V-2. - Leisure profile*.

* This leisure profile was displayed by an exhibitor at the 1986 National Recreation and Parks Congress in Anaheim, California.

Almost all recreation activities fit into one or more of the five categories. It is assumed Lake Berryessa satisfied a diversity of the profile needs for whatever reason people use the water.

Crysdale (1987) describes each of the categories. "Social" is basically the development of friendships and sharing common leisure experiences. There is a certain inherent excitement when one human being comes into the immediate presence of other human beings and interacts with them (Lagemann, 1967). Lake Berryessa's recreation land, water, and facilities foster these moments of friendship and socializing.

"Mental" refreshment is stimulation through discovery and learning. People enjoy learning new things and sharing that knowledge. They learn through interpretation programs about the biological and cultural resources, and obtain firsthand experiences with studying the Lake Berryessa environment. The experiences range from knowing how to be a successful fishermen, to wildlife habitat conservation, to understanding the area history, and the operation of the dam.

"Risk" is the rush of excitement experienced because the activity engaged in is outside of one's comfort zone. As people participate in risk activities, they experience the development of self-confidence and the satisfaction of acquiring new skills. They establish a new dimension in their personality because of successfully meeting new physical and mental challenges. Their means of enjoyment is expanded.

"Solitary" experience is the need to be alone and away from people. It is the purging of societal stress and an opportunity for healing within. It is avoiding all forms of competition in a world that demands incessant competition.

It is the solitude needed to successfully pursue fishing and wildlife interests. It is the need for privacy in an outdoor setting.

"Competent" is the challenge of achieving and testing one's skills whether this occurs in contests with others or with oneself. It is experiencing the thrill of victory and the agony of defeat. Lake Berryessa offers formal and informal opportunities to pursue this profile dimension.

There undoubtedly are other leisure categories why people recreate on water and specifically on Lake Berryessa. The profile provides an insight and some understanding why people--over 1 million of them in 5 of the last 9 years--choose Lake Berryessa for satisfying their leisure pursuits.

Application of Ecology

Ecology is defined as the study of the relation of organisms or groups of organisms to their environment, or the science of the interrelationships between living organisms and their environment (Odum, 1971).

Several researchers recognized ecology as a means to explain, in part, the degree of recreation use water bodies receive. Overpopulation and underpopulation on a water body must be expressed in relative terms (Hammon et. al. 1974). No estimate of the maximum limit of density for any human population can have meaning unless the limiting factors of resources, technology, and standard of living are specified (Dice, 1955). For estimating the carrying capacity of water resources, the limiting "factors" have been categorized as administrative, biological, physical, social, and temporal, together with their interacting subfactors.

Crysdale (1973) indicates the degree of recreation utilization a water body is receiving at any particular moment in time is a reflection of an equilibrium between all the factors influencing that amount of use. These factors are dynamic, and one which may be the limiting factor of use at one time may not be limiting use at another moment in time.

Ditton (1969) applied Liebig's Law of the Minimum, a basic law of ecology, to define the means by which this equilibrium is established. This law states the occurrence and functioning of an organism is limited by that essential environmental factor, or combination of factors, which is present to the least favorable extent (Odum, 1962). In Ditton's view:

> "The recreational use of water primarily depends upon these factors: (1) existence of required amounts of water at a specific point in time, (2) physical, chemical, biological, and esthetic qualities of the water, (3) the extent of compatibility between recreation and other multiple-purpose uses, and (4) legal implications involved in determining public rights and access to use available water (Hammon, et. al., 1974).

Ditton further observes that the application of the law of minimum implies that recreation resource development, planning, and use involve a system of interdependent physical, ecological, chemical, biological, hydrological, esthetic, social, physiological, economic, historic, and political inputs. Optimum planning, development, and use depends upon an understanding of this interrelated system.

Crowding, which has a negative value for water-oriented recreation, can occur on land, in the use of facilities, or on the water. If the land and facilities are adequate, then the crowding may occur on water. It is at the point of reaching saturation on the recreation use of water that Shelford's Law of Tolerance appears to apply causing the population to become self-limiting.

Odum (1962) quotes Shelford as follows:

> "The presence and success of an organism depends upon the completeness of a complex of conditions. Absence or failure of an organism can be controlled by the qualitative or quantitative deficiency or excess with respect to any one of several factors which may approach the limits of tolerance for that organism."

Crysdale (1973), Ditton (1969), and Hammon (1974) acknowledge an application of ecological laws and principles may contribute to a greater understanding of the nature of the supply (the water resource) and the nature of demand (the recreation participant) being accommodated. An understanding of the supply and nature of demand, their relationships, with the help of ecological laws and principles may provide guidelines and means for recognizing the critical state of people first and the resource second.

An indefinite number of "capacities" may be breached before a people or resource problem becomes acute.

Summary

In summary, resource administrators will frequently have the final word for determining the carrying capacity of the water body, especially Government built water projects which involve public access to lands and water. Administrators determine what is acceptable resource use and degradation, and the degree of user satisfaction.

Recreationists heavily depend on freedom an experience offers to purge their suppressed frustrations. Low-density water-based recreation offers opportunities for much of that freedom. However, restrictions and poor planning of resource utilization often impede the freedom recreationists seek. When

water-based opportunities are scarce, more restrictions are necessary for obtaining efficient utilization of water resources. Efficiency considerations must include regional opportunities for pursuing a variety of recreation activities with a high probability of the recreationists receiving a satisfactory experience. This requirement is beyond mathematically calculating how many people and activities a water body can accommodate. New leisure technologies and activities add to the complexity of managing public reservoirs.

The recreation carrying capacity of water resources is an artificial concept. It is also the only concept available; therefore, it must be used with caution for water resources planning, development, and management.

CHAPTER VII

RECREATION ACTIVITY MATRIX

RECREATION ACTIVITY MATRIX

Matrix Premise

Ditton, Hammon, and Crysdale acknowledge the plausibility of using ecological laws and principles to understand the recreation carrying capacity phenomena. The ecological species consortium approach is selected to help understand the interaction of recreation activities on Lake Berryessa. Odum's (1974) discussion on principles and concepts pertaining to organization at population levels provides an interaction table. This table is an analysis of how populations of two species may interact with each other. Table VII-1 displays the consortium and a recreation adaptation of it. For purpose of this analysis, the words "recreation activity" are inserted in lieu of "species."

Table VII-1. - Analysis of interactions between two recreation activities

0 INDICATES NO SIGNIFICANT INTERACTION
+ INDICATES GROWTH, SURVIVAL, OR OTHER POPULATION ATTRIBUTE BENEFITTED (POSITIVE TERM ADDED TO GROWTH EQUATION)
- INDICATES POPULATION GROWTH OR OTHER ATTRIBUTE INHIBITED (NEGATIVE TERM ADDED TO GROWTH EQUATION)

	(Recreation Activities)		
Types of interaction*	1	2	General nature of interaction
1. Neutralism	0	0	Neither population affects the other
2. Competion: Direct interference type	-	-	Direct inhibition of each species (activity) by the other
3. Competion: Resource use type	-	-	Indirect inhibition when common resource is in short supply
4. Amensalism	-	0	Population 1 inhibited, 2 not affected
5. Parasitism	+	-	Population 1, the parasite, generally smaller than 2, the host
6. Predation	+	-	Population 1, the predator, generally larger than 2, the prey
7. Commensalism	+	0	Population 1, the commensal, benefits while 2, the host, is not affected
8. Protocooperation	+	+	Interaction favorable to both but not obligatory
9. Mutualism	+	+	Interaction favorable to both and obligatory

*Types 2 through 4 can be classed as "negative interactions," types 7 through 9 as "positive interaction," and 5 and 6 as both.

Criteria for Matrix Analysis

1. Activity 1 (vertical axis) can interface with Activity 2 (horizontal axis).

2. The interaction of Activity 1 with Activity 2 is:

Influence On

Activity		Activity
1	——— Left Column ———→	2
1	←——— Right Column ———	2

A. Compatible (+)
B. Incompatible (-)
C. Neutral (no affect) (0)

The procedure is Activity 1 impact on Activity 2 (LEFT MARGIN); and Activity 2 impact on Activity 1 (RIGHT MARGIN). Any possible conflict is a "-" minus.

The leisure profile is used in the analyses and tables.

3. The interaction of an activity with itself on the matrix is evaluated on the possibility of "intraspecific competition" with participants who use the same resource or area. Intraspecific competition is within the same activity and is noted by an asterisk(*). Activities are analyzed and catagorized as nonmotorized or motorized.

4. All activities are separate and apart from one another. The activity interface is one participant vs. another participant. The participants do not know each other, they are not part of the same social group and are not familiar with each other's skills, capabilities, or intentions why the activity is being participated in.

5. Activity 2 cannot be a part of Activity 1, and vice versa. For example, swimming from a houseboat is part of the houseboat experience and should not

enter into consideration. The analysis must be the houseboat activity bearing down on the swimmer activity when using the same space. How does the swimmer feel? How does the houseboat operator feel?

6. The activity occurring may be legal or prohibited; it is not the intent to judge right or wrong. It is the interaction of the activity that is analyzed. Examples are bridge diving and rock diving at Pope Creek Bridge. Neither activity is condoned, but both occur despite managerial efforts to discourage them.

7. Military activities are not recreation per se, but resource commitments are made on Lake Berryessa to accommodate parachuting into the water. The military activities compete with other recreation uses of the Lake.

Matrix Procedures

1. The matrix will be independently completed by Lake Berryessa ranger personnel who are familiar with the recreation use of the water, recreation planning personnel, and a recreation carrying capacity specialist who is familiar with the lake.

2. The activity evaluation above will be compared for consistency and differences will be jointly resolved.

3. The vertical axis evaluation will be compared and checked with the horizontal axis for accuracy. Each activity has a transparent map showing where that activity usually occurs on Lake Berryessa. The transparencies of each activity are overlaid upon each other to obtain a geographical understanding of the activity relationships.

4. The "-" (minus's) will be totaled in the vertical column for each activity. The sum will be divided by 88 which is derived from 44 activities times 2 entries per activity. The quotient represents the degree of potential conflict with other recreation activities on the reservoir. The activities will be ranked from "greatest potential" to "least potential."

5. The "0" (neutrals) will be totaled in the vertical column for each activity. The sum will be divided by 88. The quotient represents the degree of neutrality or no interaction an activity has with other activities. The activities neutrality will be ranked from "most neutral" to "least" interactions.

6. The "+" (pluses) will be totaled in the vertical column for each activity. The sum will be divided by 88. The quotient represents the degree of compatiblity an activity has with other activities. The activities will be ranked "most compatible" to "least compatible."

7. The incompatible activities will be appropriately separated into two categories to understand the nature of the conflict. The two categories are: (a) direct inhibition of each activity by the other, and (b) indirect inhibition when a common resource is in short supply.

8. Activity occurrentces will be catagorized and analyzed on a seasonal, nonseasonal, and diurnal basis.

9. Recreation standards are not used in the analyses. Thirty-three of the 44 activities do not have standards. Those activities with standards should not be compared to activities without standards for analysis purposes. Those activities without standards should not be ignored. Also, those standards for certain activities are elastic, based on limited research; are limited on

CHAPTER VIII

MATRIX ANALYSIS

MATRIX ANALYSIS

The matrix facilitates an understanding of recreation activity interactions. The potential conflicts, compatibilities, and neutral relationships are analyzed to sort out problems related to competition and resource use. The leisure profile provides an additional dimension of understanding the activity interactions. The analysis provides a basis to examine interactions and develop management options.

General Analysis

The recreation use of Lake Berryessa is diversified. Forty-four activities that use the water surface are identified. Five of the activities are organized competition which require intensive management for intensive use for a short period of time in a relatively small area. The remaining 39 activities are informal, disorganized, and randomly occur on the water surface. These 39 activities are the most difficult to manage on a day-to-day basis. Only picture taking is not a resource consumer. Most of the remaining activities compete with each other to a point of direct interference with each other and indirect competition when a common resource is in short supply.

Threinen (1964) observed the number of boats on a lake is related to the amount of shore and that a high shore/area ratio results in high concentrations. This observation appears to apply to Lake Berryessa. The boats and water surface users on the lake are not evenly distributed. The shoreline (165 miles) to area (20,700) surface acres ratio for Lake Berryessa is 1:125. The activity maps in the Activity Description chapter show pockets of concentrated use along the west shore south of Putah Creek, and concentrated use into the southern portions of the lake. The pockets of use coincide with proximity to public and concession access areas.

The lake area north of Putah Creek along the northern and eastern portions are remote from existing access areas and relatively unused. There are several possible reasons for the light use of the northeastern portion of the lake. They are:

1. The geographic distance is too far from the access areas which are also used for staging activities. People will link their water activities to land activities and take turns going out on the water. The rest of the people stay on land until it is their turn.

2. The fluctuating water levels create unpredictable subsurface hazards in the upstream portions of a reservoir. Activities involving high speeds tend to avoid areas which may be shallow, be partially cleared of trees and shrubs before inundation, and pose real or imagined hazards due to water withdrawals and lower levels.

3. Prevailing winds may cause excessive wave action. Therefore, the participants in activities that require calm water will tend to use the leeward shore or seek protection in coves, bays, or use access areas until the wind and waves subside.

4. The resource conditions may not be favorable for the activity as those conditions in the southern and western portions of the lake.

Fishing, for example, is influenced by water temperatures. The fish will tend to occupy areas where the temperature is favorable for their needs. During the summer, the shallow waters at the northern part of the lake may be too warm and the best seasonal fishing would be in the south.

The "Fly-over Data for Lake Berryessa" table in Chapter V indicates 3,660 boats were observed actively using the water surface on May 22, 1984. This number is almost equal to the total possible number of boats (3,685) from existing launch parking facilities (2,074 units), boat slips (1,507 units), and rental boats (104 units). It is reasonable to assume not every car in a car-only parking unit (362 Bureau, 538 concession, total 900) at a launch site carried a boat which was launched on the lake. It is also reasonable to assume not every marina boat slip (1,507 total) was vacant, and every occupant boat was actively using the water surface. If these assumptions are reasonable, there is a disproportionately greater number of boats on the water compared to the available facilities to accommodate the 3,660 boats.

There are several possible reasons for the difference between the facility capacity to handle boats, and the number of boats occurring on the water. First, many long-term lessees keep boats and trailers outside their trailer homes at some concessions. Those parking facilities are not included in the statistics above. Second, many Lake Berryessa visitors will park on the shoulders of the Berryessa-Knoxville Road after launching their boats if all the parking facilities are full. This happens frequently during heavy use periods. The road shoulders become overflow parking facilities. Third, and last, are the dynamics of recreation use of people coming and going on the water surface. It is difficult to separate all the activities from an airplane and determine what stage of activity participation each boat may be involved in.

The count of 3,660 boats is indicative that the water surface has a saturation point greater than 3,000 boats mentioned in the Monticello Dam Recreation Planning Report. It also suggests the pockets of concentrated use, as observed

by Threinen (1964), is a valid phenomenon at Lake Berryessa. Only once did the aerial count exceed 3,000 boats; the rest of the observations were much less.

Conflict Analysis

Table VIII-1 "Potential Conflict" describes, in descending order, those activities having the greatest potential to conflict with other activities and those activities having the least potential to conflict. Those activities with the greatest potential to conflict are also the greatest potential source of complaints to management. The participants may also have the greatest concern for crowding - both actual and perceptual - on the water surface.

All the activities have a potential to conflict with other activities and, to some degree, within each activity. Even picture taking, rated least potential in conflict, can offend some people. For example, some nudists would be offended by having their picture taken by strangers. Of the top 22 activities having the greatest potential to conflict, solitude may be a primary reason for conflict. Table VIII-2 indicates "Solitary" is 45 percent (10 activities) and "Competent" is 32 percent (7 activities). This suggests solitude is an experience value which is the most sensitive activity interaction of all the leisure profile categories. It is also interesting to notice the "solitary" activities are relatively passive and do not involve much use of high-powered motors. These activities cannot effectively compete with other activities involving greater boat and motor size, especially if they interact with each other for a common resource in short supply. Calm water use in areas of depths greater than 5 feet would be an example of a resource in short supply. Mixing passive and active activities in a common area inhibits the experience quality of both.

Table VIII-1. - Potential Conflict

Rank	Intra-specific compe-tition	Leisure profile	Activity	Number of -'s divided by 88	Number of -'s
1	*	Solitary	Fishing - still boat	943	83
2	*	Mental	Boat - sightsee <15 mph	909	80
3	*	Social	Houseboating	886	78
4	*	Solitary	Fishing - boat trolling	875	77
5	*	Risk	Boating - up to 50 mph	829	73
6	*	Solitary	Canoeing	829	73
7	*	Competent	Water skiing	818	72
8		Competent	Military activity	806	71
9	*	Solitary	Rubber rafting	806	71
10	*	Competent	Jet skiing	795	70
11		Solitary	Rowboating	784	69
12		Competent	Seaplanes	772	68
13		Solitary	Air mattress floating	761	67
14	*	Solitary	Fishing - shore	761	67
15		Solitary	Kayaking	761	67
16		Risk	Amphibious ultralight aircraft	735	65
17	*	Competent	Surf sailing	727	64
18		Solitary	Paddle boating	715	63
19	*	Competent	Archery fishing	704	62
20		Solitary	Inner tube floating	704	62
21	*	Risk	Parasailing	704	62
22		Competent	Power surf boards	704	62
23	*	Competent	Sailboating	681	60
24		Solitary	Snorkeling	681	60
25	*	Social	Swim devices	681	60
26	*	Social	Swimming	659	58
27		Social	Wet bicycling	647	57
28		Risk	Wiener riding	636	57
29		Competent	Biathlon	636	56
30		Competent	Scuba diving	579	51
31	*	Competition	Swim competition	568	50
32		Risk	Bridge diving	477	42
33		Solitary	Houseboat isolated	454	40
34	*	Solitary	Picnic/boat	443	39
35	*	Solitary	Camp/boat	420	37
36		Competent	Sailing regatta	409	36
37		Mental	Fish and wildlife habitat conservation	363	32
38	*	Risk	Rock dive	352	31
39	*	Risk	Rope swing	295	26
40	*	Competent	Tournament fish	272	24
41		Solitary	Wading	159	14
42		Social	Houseboat rock concert	136	12
43		Competent	Triathlon	136	12
44	*	Mental	Picture taking	0.034	3

GREATEST

POTENTIAL CONFLICT

LEAST

Table VIII-2. Top 22 activities with greatest potential to conflict - leisure profiles

Social	Mental	Risk	Solitary	Competent
Houseboating	Boat - sightsee	Boat - up to 50 mph	Fish - still boat	Waterskiing
		Amphibian ultra air	Fish - trolling	Military activity
		Parasailing	Canoeing	Jet skiing
			Rubber raft	Seaplanes
			Rowboating	Surf sailing
			Air mattress	Archery fish
			Fishing - shore	Power surfboard
			Kayaking	
			Paddle boating	
			Inner tube floating	

Zoning the lake by area and time would be a means to separate conflicting activities and establish competition on a more equal basis, i.e., small boats and motors with the same, and large boats and motors with the same. An objective of zoning would also be a management commitment to provide opportunities for a solitude experience on a water body. A solitude experience on water is rare, especially with two major metropolitan areas within an hour drive of a major water recreation resource.

Management, with the public input, should determine the desirability of providing solitude opportunities through the use of zoning, to establish a paddlecraft/ motorless area. The northern part of the lake from Putah Creek and Putah Creek itself have potential for such zoning. The area(s) could be zoned during the recreation season and optionally opened during the off-season.

The 10 activities identified as having the greatest potential to conflict also have intraspecific competition designations. The probability of conflicting within each activity is high. Only military activity has no intraspecific

designation because management and the military schedule the times and places where parachutists are dropped.

Seven of the top 10 activities are somewhat passive and do not involve high speed. Only boating up to 50 mph, water skiing, and jet skiing involve high speeds. Four of the 10 activities are categorized as "solitary" which suggests a degree of territorial sensitivity as a cause for the high rating for potential conflict.

It is interesting to notice "Fishing - Still Boat" has the greatest potential for conflict according to the matrix analysis (94.3 percent). Possible reasons for conflict are: (1) there are proportionately more fishermen still-boat fishing than other activities, thereby increasing the probability of interacting with other activities, (2) fishing from a still boat occurs all over the lake, thereby increasing the probability of interacting with other activities, (3) fishermen's space bubble (territory) is greater than the recreation standards indicate, and more sensitive to penetration by other activities or fishermen, especially if solitude is a prime experience benefit, and (4) intrusion by others into a fisherman's space bubble is perceived as interfering with fishing success. All these factors could reduce the quality of experience which is perhaps a reason fishing from a still boat occurs yearround. The most territorial sensitive fishermen avoid the heavy use season and prefer the off-season low use periods. During the offseason there is less interference from other activities and less competition for successful fishing areas. The same rationale applies to fishing - trolling.

Boats that cruise between 5 to 15 mph tend to create a large wake depending on the hull configuration, motor, and weight distribution in the boat. The wakes tend to alarm others who want calm water.

Lucas (1964) observed the type of craft used seemed to condition strongly the perception of crowding. The larger cruisers and houseboats may cause people in smaller boats to perceive crowding. Large wakes would tend to annoy people in small boats, and possibly cause concern of capsizing, disrupting their activity, or damaging their boats.

Intraspecific Analysis

Of the 44 identified activities occurring on the water, 23 (52 percent) are identified as experiencing intraspecific competition. These activities are listed below in two groups: nonmotorized and motorized.

Table VIII-3. - Intraspecific competition

Nonmotorized activity	Motorized activity
5 Archery fishing	2 Boating - sightseeing <15 mph
4 Camp/boating	3 Boating - speed up to 50 mph
4 Canoeing	4 Fishing - boat trolling
4 Fishing - shore	1 Houseboating
4 Fishing - still boat	5 Jet skiing
4 Picnic/boating	3 Parasailing
2 Picture taking	5 Waterskiing
3 Rock diving	
3 Rope swinging	
4 Rubber rafting	
5 Sail boating	
5 Surf sailing	
1 Swimming	
1 Swimming devices	
5 Swim competition a/	
5 Tournament fishing a/	

Leisure profile designations: 1 = Social 2 = Mental 3 = Risk 4 = Solitary 5 = Competent

a/ Organized activities.

Nonmotorized activities. - Sixteen of the 23 intraspecific activities are nonmotorized. Motors are incidental and not the prime part of the experience

for camp/boating, fishing-still boat, and tournament fishing. Of significance are the activities identified as being "solitary." Six activities (38 percent) camp/boating, canoeing, fishing-shore, fishing-boat still, picnic/boating, and rubber rafting are seeking solitude. These participants are attempting to experience low density and low intensity-of-use areas. Their occurrence would tend to be in clusters as opposed to even distribution around the lake surface. Their "space bubbles" tend to be greater in size and very delicate in terms of penetration by others who participate in the same activity or other activities. These participants would tend to be easily displaced as water surface use increases, especially during the recreation season. Exceptionally space sensitive participants will tend to use the lake during the off-seasons of fall, winter, and spring.

Apparently, there are limited ideal resources available for archery fishing, resulting in intraspecific competition by the few who participate. The limitations are the shoreline slope and water interface, i.e., proper depth and clarity, and the frequency of carp occurring in the desirable areas. Safety, because of the use of a lethal object, i.e., bow and arrow, requires a buffer between participants and observers.

Surf sailors and sail boaters seek the wind wherever it occurs. Surf sailors do not have the maneuvering latitude or range of area for participating. They tend to have a similar pattern of participation in a limited area of ideal conditions.

The organized swim competition and tournament fishing forces a competition for space and resources to occur. The occurrence is temporary and only during the event. The lack of space in swim competition usually occurs at the beginning of the event. Tournament fishermen have favorite areas for

which they compete during certain time periods. The resource shortage is temporary.

Only picture taking, a mental activity, does not require allocated resources for occurrence. Competition of picture taking usually occurs with organized events or photographing a significant event or person. The competition is short-term and is not considered critical in this analysis.

Motorized activities. - Four of the seven motorized activities involve high speed. Speed boating (up to 50 mph or greater), jet skiing, parasailing, and waterskiing consume space at a rapid rate. The activities occur randomly, are disorganized, occur at the same time of year (June through September), and at the same time of day (6:00 a.m. to 9:00 p.m.). Waterskiing recreation standards indicate a range up to 60 surface acres per unit (Peterson, 1968). Parasailors require more area than water skiers because of the greater speed needed for uplift, remaining in the air, and descending. The towboat needs the greatest degree of noninterference from other activities because abrupt stops or turns could cause the parasailor to drop from the air. Jet skiers can exceed 50 mph and experienced jet skiers will seek boat wakes for jumping. Many speed boats can exceed 50 mph.

Researchers observed and agree the more speed acquired, the more space required for the activity. Furthermore, when the use is disorganized, as opposed to organized, even more space is needed for the activity.

Organization builds in an element of predictable behavior of participants, thereby reducing the space needed for participants to feel comfortable. However, the participants may only tolerate smaller activity space and shorten their length of time spent on the activity.

In terms of resource requirements, high-speed activities require a water depth of 5 feet or more, calm water with waves less than 1 foot high and adequate surface for broad turns. Peak periods of activity during the day may result in "capacities" voluntarily reached by the participants at instantaneous moments. Those who are uncomfortable with the experience will shorten their participation time or move to another area.

Houseboats usually compete with other houseboats for coves, bays, beaches, and private places to beach overnight or to play in a private surrounding. Space on the open water is not much of a problem since the size of the houseboats enables them to handle large waves and effectively compete for space with other boats of all kinds.

Boating at 15 mph or less is usually a mental or curiosity type of activity "to see what's going on." Therefore, the intraspecific competition usually occurs in water surface pockets adjacent to land developments. The competition is intermittent and vanishes as fast as it develops. Participants are temporarily inconvenienced or uncomfortable because of too many other boats being too close.

Fishing from a trolling boat involves large sensitive solitary space bubbles. The participants are competing for common areas with common resources. The fisherman competes for "hot spots" where the fishing success may be greater. If fishing success is distributed evenly among the area users, the competition is not as intense or sensitive. Poor fishing success can give participants the perception of "crowding" a favorite fishing area.

Compatibility Analysis

Picture taking in Table VIII-4 is the most compatible activity with an 81-percent rating from the matrix. This is not surprising since the activity is passive, has no resource requirements, and there is very little competition among participants engaged in photography and other activities. Conflicts occur when some people feel their privacy is being invaded by photographers.

Compatible activities rapidly decline to 24 percent for houseboat rock concert and 13 percent for fish and wildlife habitat conservation. Jet skiing, ranking eighth in compatibility, is the first active high-speed activity. The compatibility percentage is 7 which is consistent with the 79 percent on the "Potential Conflict" table. Jet skiing has a more significant potential to conflict with other activities than being compatible.

The houseboat rock concert is ranked second (24 percent) in compatibility. There are several possible reasons: (1) the activity occurs one to three times a year for several hours, (2) it is a social activity specifically dependent on an audience, (3) it attracts all kinds of motorized and nonmotorized watercraft and concentrates them in one relatively small water area, and (4) the concentration of numerous watercraft in one small area frees up the main body of Lake Berryessa for all other recreation uses relatively free of competition. This is very desirable from a water surface management point-of-view.

The "Potential Compatibility" table which summarizes the pluses (+) in the matrix basically indicates there is limited compatibility of the activities in interfacing situations. The quality of activity experience depends on the frequency and nature of the interface of each activity to another. Each unfavorable interface causes a decline in experience quality. The participant

Table VIII-4. - Potential Compatibility

Rank	Intra-specific compe-tition	Leisure profile	Activity	Number of +'s divided by 88	Number of +'s	
1	*	Mental	Picture taking	818	72	GREATEST
2		Social	Houseboat rock concert	248	25	
3		Mental	Fish and wildlife habitat conservation	136	12	
4		Solitary	Air mattress floating	136	12	
5		Solitary	Inner tube floating	125	11	
6	*	Social	Swimming	125	11	
7	*	Competent	Jet skiing	079	7	
9		Solitary	Paddle boating	068	6	
10		Solitary	Kayaking	056	5	
11	*	Solitary	Rubber rafting	056	5	
12		Solitary	Rowboating	056	5	
13		Competent	Snorkeling	056	4	
14	*	Competent	Swim competition	045	4	POTENTIAL COMPATIBILITY
15		Competent	Power surfboards	045	4	
16	*	Competent	Tournament fishing	045	4	
17	*	Solitary	Fishing - shore	034	3	
18	*	Solitary	Fishing - still boat	034	3	
19	*	Competent	Sailboating	034	3	
20		Competent	Scuba diving	034	3	
21	*	Competent	Archery fishing	022	2	
22		Risk	Bridge diving	022	2	
23	*	Solitary	Canoeing	022	2	
24	*	Social	Houseboating	022	2	
25	*	Risk	Parasailing	022	2	
26	*	Risk	Rock diving	022	2	
27	*	Risk	Rope swinging	022	2	
28	*	Competent	Surf sailing	022	2	
29	*	Competent	Water skiing	022	2	
30		Risk	Wiener riding	022	2	
31		Social	Wet bicycling	022	2	
32		Competent	Biathlon	022	2	
33		Competent	Triathlon	022	2	LEAST
34		Competent	Sailing regatta	022	2	
35		Risk	Amphibious ultralight aircraft	0	0	
36	*	Mental	Boat - sightsee <15 mph	0	0	
37	*	Risk	Boat - speed up to 50 mph	0	0	
38	*	Solitary	Camp boating	0	0	
39	*	Solitary	Fishing - trolling	0	0	
40		Solitary	Houseboating - isolated	0	0	
41		Competent	Military activities	0	0	
42	*	Solitary	Picnic boating	0	0	
43		Competent	Seaplanes	0	0	
44		Solitary	Wading	0	0	

makes the final judgment when he has enough close calls and moves to a different area, changes activity, leaves the water, or leaves the recreation area.

Neutral Analysis

The activities (Table VIII-5) having the least effect on other activities tend to be organized, passive, limited in number of participants, and/or isolated in occurrence either by space or time. Triathlons (84 percent) are organized, occur once during November between 7:00 a.m. and 2:00 p.m. in a small designated area. Only 14 (32 percent) of the 44 identified activities occur during November, and the number of participants in the activities occurring would not be as great as those participating during the peak recreation season. All the factors above indicate the probability of the triathlon interacting with other activities is very low.

The majority of the more neutral activities occurring during the recreation season are isolated by space. These activities include rope swinging, rock diving, houseboat rock concert, houseboat isolated, bridge diving, scuba diving, and archery fishing.

The activities having limited participants include rope swinging, rock diving, houseboat isolated, bridge diving, scuba diving, wiener riding, wet bicycling, archery fishing, amphibious ultralight aircraft, and seaplanes.

Temporal Perspective

The prime recreation season at Lake Berryessa is April 1 through October 15; that is 198 days or 54 percent of a year. Most of the activities occur during this period. See Table VIII-6 "Monthly Recreation Use of Lake Berryessa By Activity." Table VIII-7 provides a percentage breakdown of the occurrence of

Table VIII-5. Neutrality

Rank	Intra-specific compe-tition	Leisure profile	Activity	Number of 0's divided by 88	Number of 0's	
1		Competent	Triathlon	840	74	GREATEST
2		Solitary	Wading	795	70	
3	*	Risk	Rope swinging	681	60	
4	*	Competent	Tournament fishing	691	60	
5	*	Risk	Rock diving	613	54	
6		Social	Houseboat rock concert	579	51	
7		Competent	Sail regatta	568	50	
8	*	Solitary	Camp/boating	556	49	
9	*	Solitary	Picnic/boating	545	48	
10		Solitary	Houseboating - isolated	522	46	
11		Risk	Bridge - diving	500	44	
12		Mental	Fish and wildlife habitat conservation	500	44	
13		Competent	Scuba diving	386	34	
14	*	Competent	Swim competition	386	34	
15		Competent	Biathlon	340	30	
16		Risk	Wiener riding	340	30	
17		Social	Wet bicycling	329	29	
18	*	Competent	Sailboating	284	25	NEUTRALITY
19	*	Competent	Archery fishing	272	24	
20	*	Risk	Parasailing	272	24	
21	*	Mental	Picture taking	261	23	
22	*	Competent	Surf sailing	250	22	
23		Risk	Amphibous ultralight aircraft	238	21	
24		Competent	Power surfboard	238	21	
25		Solitary	Snorkeling	238	21	
26	*	Social	Swimming devices	227	20	
27		Solitary	Paddle boating	215	19	
28		Competent	Seaplanes	215	19	
29	*	Social	Swimming	215	19	
30	*	Solitary	Fishing - shore	204	18	
31		Solitary	Kayaking	181	16	
32		Solitary	Inner tube floating	170	15	LEAST
33		Competent	Military activities	170	15	
34		Solitary	Rowboating	159	14	
35	*	Competent	Waterskiing	159	14	
36	*	Risk	Boating - speed up to 50 mph	147	13	
37	*	Solitary	Canoeing	136	12	
38	*	Competent	Jet skiing	125	11	
39	*	Solitary	Fishing - trolling	113	10	
40		Solitary	Air mattress floating	113	10	
41	*	Social	Rubber rafting	113	10	
42	*	Social	Houseboating	0.079	7	
43	*	Mental	Boating - sightsee <15 mi/h	0.045	4	
44	*	Solitary	Fishing - still boat	0.022	2	

activities by month. Only the tournament fishing and triathlon do not occur during the prime season.

Table VIII-7. - Activities by month

Month	Percent
January	25
February	27
March	38
April	66
May	73
June	84
July	86
August	82
September	86
October	57
November	32
December	23

Ten of the activities occur year-round. They are divided into motorized and nonmotorized in table VIII-8.

Table VIII-8. - Year-round activities

Motorized	Nonmotorized
Boating - sightsee <15 mph	Fishing - shore
Boating - speed up to 50 mph	Fishing - still boat
Military activities	Picture taking
Seaplane	
Water skiing	
Houseboating	
Fishing - boat trolling	

There are seven activities that occur on a "spot" basis timewise. The length of time ranges from 1 to 90 days. The formal organized competition activities - swim competition, biathlon, triathlon, and sailing regattas - occur only for

1 or 2 days a year. Tournament fishing occurs for 3 months during the first part of the year when between 25 and 38 percent of the activities occur.

The houseboat isolated experience lasts several days during the peak season use of July. Ironically, this is a solitude/private type of experience that Lake Berryessa is apparently capable of satisfactorily providing during the peak season. The participants are repeat visitors.

Houseboat rock concerts usually are a 1 day occurrence during the holidays of May, July, and September. The experience is a social phenomenon, lasting most of the day in the same place - Pope Creek - outside of the mainstream of use on the lake. Other visitors are attracted by the excitement generated by the rock concert. The rock concert may be relieving boating use on the reservoir open water by attracting many boats to the Pope Creek area. If that is true, the rock concert complements all other activities on the main part of Lake Berryessa by leaving more space for other activities to occur during the holiday peak period.

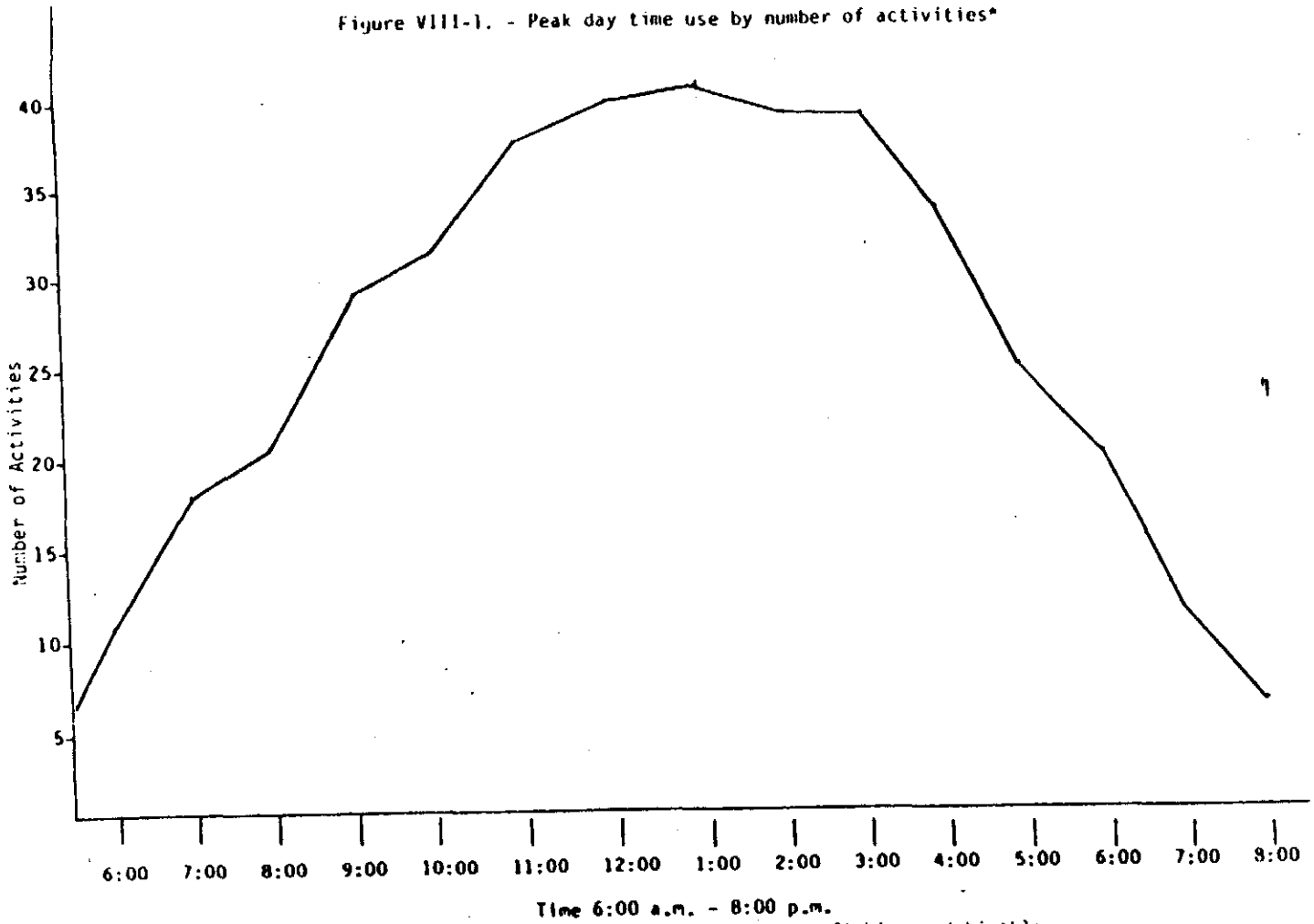
On a diurnal basis, four activities use the water surface 24 hours a day. The activities are camp-boating, houseboating, houseboating - isolated, and military activities. Only the military activities are scheduled with management. Camp-boating competes with the houseboating activities for a limited resource supply of beaching areas which are somewhat private and protected from night winds. If the competition for resource supply becomes intense, management may need to designate specific sites and establish a reservation system for both houseboats and camp-boaters. Uncontrolled litter, fire, and defecation loom as future problems around the shoreline unless management establishes a designation-reservation program that includes education of users.

Figure VIII-1 "Peak Daytime Use By Number of Activities" illustrates potential daily use of the water surface. Conceivably, as many as 39 different water activities could be occurring simultaneously during the midday peak use. During peak periods, the diversity of activities and versatility of each activity could reach momentary dangerous levels, particularly with high-speed activities. See Table VIII-9 "Activity By Time of Day."

A permit system could be a means to sort out the occurrences of these activities so they can be separated by space or time. Management also has the ultimate option to restrict or disallow certain activities. As use of the water surface increases, a permit system will become a management necessity.

Instant capacity of a given resource area at a single point in time is related to various recreation activity combinations. It is also related to the number of participants and the number of "close calls" of conflict. Conflicts can cause a perception of capacity whether that "capacity" is actual or only a perception of that instant phenomenon. If the participant feels uncomfortable about his activity on water, he can "migrate" away from the water and pursue another activity on land. He may need facilities for that land activity until he is ready to return to the water activities. The question is, "What facilities are needed on land" so the participant is not "killing time."

Figure VIII-1. - Peak day time use by number of activities*



* Excludes off-season activities of tournament fishing and biathlon

B

RECREATION STANDARDS

Recreation Standard Sources

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BUREAU OF OUTDOOR RECREATION. 1970. Outdoor Recreation Space Standards. U.S. Government Printing Office, Washington, D.C.

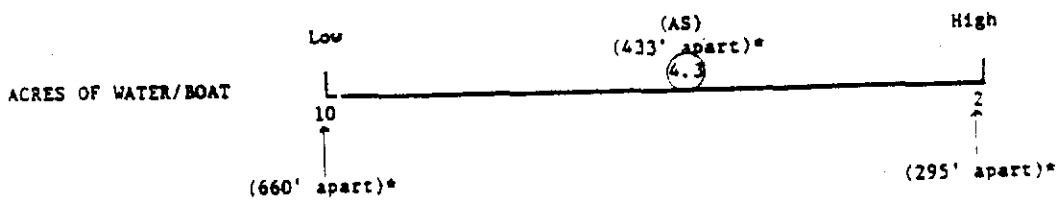
BOATING, LIMITED POWER

Park Administrator/Planner Responses

Of the five administrators/planners interviewed for this activity, three disagreed with the SCORP average of 4.3 acres per boat. They all, however, did agree with the following additional SCORP averages: 2.4 persons per boat; and a turnover of 2.2 per day (an average length of stay of 3.4 hours on the basis of an eight hour day).

Most administrator/planners indicated that the following are important factors affecting optimum carrying capacity for limited power boating: tolerance of aquatic life; location of water body (urban or remote); multiple use of the water area; depth of water; rate at which the water is circulated through the system; shoreline configuration; and the degree of policing.

Summary of Results



BOATING, UNLIMITED POWER

Participant Responses

Participant responses regarding preferred distances from other boaters range from a low of 25 feet to a high of 900 feet, averaging 314 feet between boats or approximately 2.3 acres per boat if boats are evenly spaced. About 60 percent of the respondents preferred a distance of from 200 to 500 feet between boats. The average from the SCORP Survey suggests a spacing of approximately 600 feet between boats; about twice the distance suggested by the average participant from survey results. It is noteworthy that many of the boaters who indicated a preferred spacing of 100 feet or less between boats were also engaged in other activities, such a picnicking.

Many of the participants interviewed cited one or more of the following reasons for the pleasantness of their recreation experience: large body of water; scenic views and natural features; friendliness of other boaters; location of picnic facilities near edge of lake; clean lake, and well-maintained facilities. Some boaters expressed the following complaints: boat ramps are too narrow; some boaters do not know the rules of boating; parking areas sometimes congested or filled; swimmers in the boating area; and very high speed boats.

Park Administrator/Planner Responses

The four administrators who were interviewed for this activity all agreed that the SCORP average of 9 acres per boat (a distance of 620 feet between boats if evenly spaced) probably represents an acceptable optimum capacity standard for unlimited power boating. They also believed the following two SCORP averages could be used to estimate daily carrying capacity: (1) 2.75 persons per boat; and (2) a turnover rate of 2.5 (assumes an average length of stay of 3.2 hours on the basis of an eight hour day).

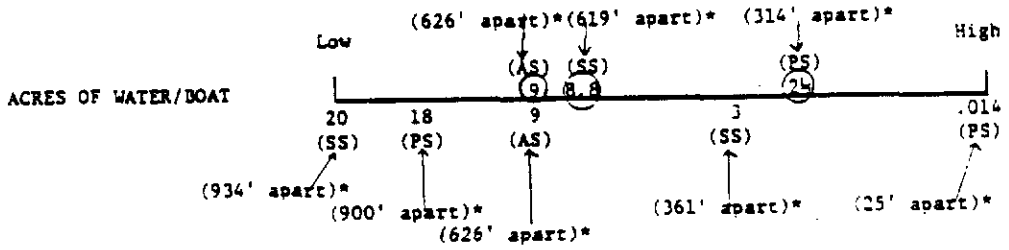
Most of the administrators agreed that the following variable factors should be considered when establishing optimum carrying capacities: tolerance of aquatic life; location of the water body (urban or remote); multiple use of the water area; depth of water; the rate at which water is circulated through system; shoreline configuration; and degree of policing.

One administrator noted that "more space per boat is required if water skiing is a primary activity". A park ranger also stated "when water activities are controlled, through designated swimming and water-skiing areas, and policed, the carrying capacity of the resource can be increased".

Surveyor Observations

- If other activities such as swimming, waterskiing or sailing are also allowed in the boating area, the recreation carrying capacity level should be lower.
- Boaters also engaged in other activities such as picnicking, at least on the basis of the interviews, appear to be more willing to accept a closer space between boats.

Summary of Results



BOATING, CANOEING, AND WATER SKIING

Reference	Facility	Standard
(97) Nevada Department of Conservation and Natural Resources	trailered boats	Average party of 3 persons. 40 units accommodate 120 persons on one acre. Turnover rate is one. One 12 ft. wide ramp accommodates 40 boats per day.
	moors or slips	Average party of 3 persons. 40 units accommodate 120 persons on .5 acre.
(135) Comprehensive Plan for Wisconsin, Outdoor Recreation. pp. G-10, G-11	water skiing	One person per 13.3 acres of water. Estimate 3 persons per boat, 20 acres per boat may be adequate, but 40 acres per boat is more desirable.
	boating	One person per 8 acres of water surface. Estimating 2.5 persons per boat, or 20 acres per boat. Small lakes with restricted motor sizes could support more than one boat per 20 acres.
	canoeing	One person per 1/4 mile of stream. Estimating 2 persons per canoe or 1/2 mile of stream per canoe. Larger streams probably could handle one canoe per 1/4 mile of stream or more.
(28) Connecticut Department of Agriculture and Natural Resources, p. 41	boating	Instant capacity of 1% of state population at state or other public boating access areas and on available freshwater and saltwater bodies.
(45) Federal Power Commission, p. 2	boat launch ramp	At least one ramp is provided for federal power projects having 5000 to 40,000 annual visitors; or at any one area with 40 boat launchings projected per peak-day. Ramps have an optimum width of 12 ft. with the vertical limits from the elevation of the 5-year flood frequency elevation or 3 ft. above the normal operating pool, whichever is higher, to at least 4 ft. below the permanent pool.

BOATING, CANOEING, AND WATER SKIING

Reference	Facility	Standard
(31) Corps of Engineers, Grand Chariton and Little Chariton Report, p. 1	boating and water skiing	1 acre of water per boat, 4 people per boat.
	boat ramp	40 boats per lane of launching ramps. Parking area for 40 cars.
(32) Corps of Engineers Manual, p. 3	boat ramp	Minimum of 1 ramp per project with 5000 to 40,000 annual visitors; or 1 per 40,000 annual visitors or at any one area with 40 boat launchings per peak-day; or the number of ramps required to prevent not more than 1 hour's delay in launching.
(110) Placer County, Calif. Recreation Commission, pp. 7-9	boat launching lane	5 acres of water surface per boat. One lane per 25 boats.
(119) Soil Conservation Service, Recreation Memorandum-3, Supplement-3, p. 1	anchored fishing boats	4 to 7 boats per acre of water area.
	trolling fishery boats	2 to 4 boats per acre of water area.
	power and sail boats	3 acres of water area per boat.*
	water skiing	5 acres of water area per boat.* *(these figures exclude the 300-foot strip around the shores zoned against these uses except at access points)
(106) Recreation and Open Space in the Onondaga-Syracuse Area	boating	1/4 acre of water for every 1000 persons. Boating area located in a county park that allows 12 acres for every 1000 population.

BOATING, CANOEING, AND WATER SKIING

Reference	Facility	Standard
(134) Recreation in Wisconsin, p. 48	trip canoeing	Average number of canoes a day is 6, with 2 men per canoe. Average daily trip distance is 15 miles. Streams must have an average flow of 100 cubic feet a second in order to be generally suitable for canoeing.
(132) Outdoor Recreation Plan for the State of Vermont, p. 93	boating	Access to a lake of 100 acres or more within 1/2 hour's drive of every family.
(10) Statewide Comprehensive Outdoor Recreation Plan for Arkansas	boating	One launching ramp for each 150 acres of water.
(88) National Recreation and Park Association, Bulletin no. 54, pp. 6-9	marinas	The main difference in marina designs will be governed by the size and design of boats using the area. The Outboard Boating Club of America states that optimum size for marina development ranges upward from 25 acres. Generally, the ideal land area required for marinas is the same as that for mooring boats or 1-1/4 times that size.
(16) BOR, Water-Oriented Outdoor Recreation: Lake Erie, p. D-9	boating	1633 sq. ft. parking per car and trailer including ramp facilities. Turnover factor of 2. Three people per car and boat.
(103) G. Nez, Urban Land, p. 4	major boating activities	100 acres for every 50,000 population. Ideal size of 100 acres and over. May be located within a district park, regional park or reservation.
	row boating and canoeing	1 lake or lagoon for every 25,000 people. Ideal size of 20 acres of water area. May be located in a community park or special regional reservations.

BOATING, CANOEING, AND WATER SKIING

Reference	Facility	Standard
		Ramps generally service 160 surface acres of water available for boating. Each ramp has at least one 75-foot vehicular turn-around.
(15) Bureau of Reclamation, p. 27	boat access	Two dual launching ramps per 40 boats, 40 boat trailers, auto parking spaces and buffer strip.
(63) Louisiana Parks and Recreation Commission, p. 3.0.15	boat ramp	A boat ramp occupies one acre of ground space and can accommodate launching and retrieving of about 40 boats per day per launching lane. 50 cars with boat trailers can be parked in area.
	motor boat area	It takes 20 acres of water to support one power boat. 13 boats in the water would require 260 surface acres of open water to support a ramp. With 2.5 persons per boat, an optimum day with 40 launchings would produce 100 user days per ramp or 100 user days per acre of land and .385 user days per acre of water. This amounts to .01 acre of land and 2.6 acres of water per user day.
	canoe area	Estimating 2 persons per canoe per 1/2 mile of stream. Larger streams could probably handle one canoe per 1/4 mile of stream.
	water skiing area	One ski boat requires 40 acres of water, therefore, 13 ski boats would require 520 acres of water to support one ski boat ramp. With an average of three persons per ski boat, a ramp would produce 120 activity days during an optimum day use, or 120 user days per acre of land and .23 user days per acre of water. This amounts to .0083 acres of land and 4.33 acres of water per user day.

BOATING, NON-POWER FLAT WATER

Participant Responses

Participant responses regarding preferred distances from other boats ranged from a low of 50 feet to a high of 600 feet, averaging 260 feet between boats or approximately 1.5 acres per boat. Over 60 percent of the respondents indicated preferred distances of 100-300 feet between their boat and other boats. A few of the respondents pointed out that certain types of boats (e.g., sail boats) require more space for maneuvering than others (e.g., canoes), suggesting a need for different capacity levels for different kinds of non-power flat water boats.

Most of the boaters identified one or more of the following as factors contributing to their boating experience: presence of natural features; convenience of a lake within an urban area; clean lake and well-maintained facilities; and friendliness of other boaters. The most frequent complaint cited (especially by sail boaters) pertained to the presence of motor boaters and motor boaters' lack for respect for non-power boats.

Park Administrator/Planner Responses

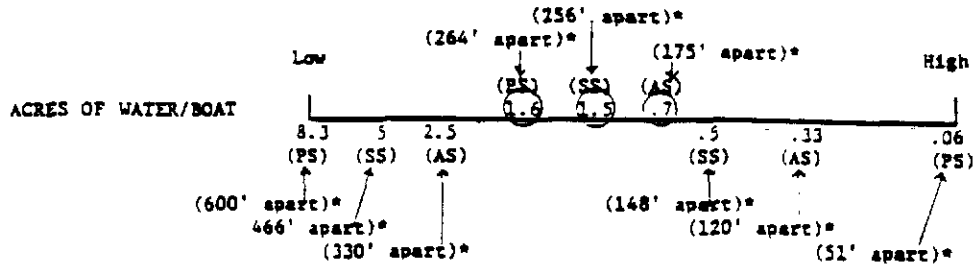
Suggested optimum capacities for non-powered flat water boating range from a low of 0.4 boats per acre to a high of 3 boats per acre, averaging 1.4 boats per acre of surface water.

The administrators agree that the maximum level of use should be determined by either: the physical space requirements for safe, unobstructed maneuvering of boats; or a consensus of user attitudes concerning the minimum distance required between boats for a pleasant boating experience to occur. One administrator noted that "the maximum use of non-powered boats is primarily determined by the number of power boats present".

Most of the administrators indicated that the type of boat (i.e., paddle boat, sail boat, canoe, etc.) and the size of the water body have some affect on optimum carrying capacity for non-power flat water boating.

Surveyor Observations

- The optimum distance between boats undoubtedly depends upon boat type (i.e., sail boats, canoes, row boats, etc.)
- Turnovers were generally more frequent at the city park lakes than at state park lakes. This is probably explained by the fact that many city parks rent out boats, thus resulting in more frequent turnovers.



FISHING

Reference	Facility	Standard
(31)*Corps of Engineers Report on Grand Chariton and Little Chariton Rivers	boat fishing	2.5 persons per boat and boat trailer. 1 acre of water surface for every 50 fisherman. 1 lb. of fish per fisherman day. Fish production should be 50 lbs. an acre each year.
(110) Placer County, Calif. Recreation Commission pp. 1-9	stream fishing	1 mile of stream for every 10 persons.
(127) Tennessee State Planning Commission, Part II, Vol. II, p. 24	fishing	Public fishing access area of 10 to 40 acres averaging at least 15 acres with 750 feet of water frontage. One per 300 acres of water surface.
(134) Wisconsin Department of Resource Development, p. 41	fishing	Nationwide average in 1958 of fish caught was 2.2 lbs. per day.
(108) ORRRC Report No. 7, pp. 78, 83, 84	fresh water fishing	Location should be within 60 to 69 miles or 2 hour's drive from urban coastal areas. Average catch in 1960 was 1 lb. of fish per angler per day from inlar waters.
(118) Soil Conservation Service, Book of Recreation Resources, pp. 1, 6	fishing	Minimum of 3 surface acres per lake Lake should be located within an hour's drive or approximately 50 miles of a city of 20,000 persons or the equivalent in smaller commu ties, and should be within 5 to 10 miles of a good highway with an all-weather road to property.
	fishing in anchored boats	4 to 7 boats per acre.

FISHING

Reference	Facility	Standard
(16) BOR, Water-Oriented Outdoor Recreation: Lake Erie Basin, p. D-9	fishing	1633 sq. ft. of parking area per car and trailer including ramp facilities. Turnover factor of 1.5. An average of 2 persons per car and boat.
(103) G. Nez, Urban Land, p. 4	fishing, rowing, and canoeing	1 lake or lagoon for every 25,000 people.
(135) Comprehensive Plan for Wisconsin. Outdoor Recreation. p. G-10, G-11	fishing area	One person per 3.6 acres of surface water. Estimating 2.2 persons per boat and 8 acres per boat.
	stream fishing	One fisherman per mile of stream.
	river fishing	One fisherman per 1/4 mile, approximately 3 acres per fisherman.
(63) Louisiana Parks and Recreation Commission, p. 3.0.16	boat fishing	A fishing boat requires 8 acres of water. 13 fishing boats require 104 acres of water to support one boat ramp. An average of 2.2 persons per boat would produce 88 optimum user days per 40 fishing boats during one day, or 88 persons per acre of land and 846 user days per acre of water. This would be .0114 acres of land and 1.182 acres of water per user day.
(28) Connecticut Department of Agriculture and Natural Resources, p. 41	fishing	Instant capacity of 5% of state population at state or other public fishing areas.

FISHING, BOAT

Participant Responses

Participant responses regarding preferred distances from other fishing boats range from a low of 50 feet to a high of 500 feet, averaging 214 feet between boats or approximately one boat for every acre of water. The density represented by this average is lower than the SCORP average of 1.8 boats per acre. Approximately 44 percent of the fishermen interviewed agreed that a distance of 200 feet between boats is optimum.

Several fishermen indicated they can tolerate a closer distance between other fishing boats if they are catching fish. One fisherman also mentioned that the optimum distance between boats also depends upon the typ. of fishing.

During the interviews, the following were cited as factors contributing to the boat fishing experience: presence of natural features; well-maintained facilities; friendliness of other fishermen; and designated areas in the lake which are soley for fishing. A few fishermen complained about not catching fish, the presence of waterskiers and motor boaters, and crowded launching ramps.

Park Administrator/Planner Responses

Suggested optimum capacities for boat fishing range from a low of 1 boat per acre to a high of 16 boats per acre, averaging 3½ boats per acre of water surface. It must be noted that 85 percent of the suggested optimum capacities ranged between 1 to 2 boats per acre. It is also noteworthy that one park administrator suggesting 16 boats per acre was interviewed at a very popular fishing lake.

On the basis of the survey results, there appears to be a consensus among administrators and planners, that the maximum level of use for boats will be determined by either: the minimum space required for safe operation and manuevering of boats and casting of lines; or a consensus of fisherman attitudes concerning the minimum distance required between boats for a pleasant fishing experience to occur.

Most of the administrators believe the following variable factors must be considered when determining optimum carrying capacity for a specific water body: size of boats; fish availability; location of lake; tolerance of fish species to people; water type and current speed. The type of fishing was another variable mentioned.

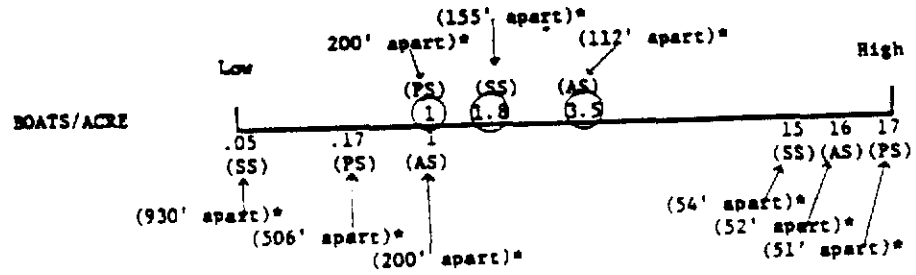
Most of the administrators/planners concur with the average SCORP turnover rate of 1.8 per day and an average of 2 fishermen per boat.

Surveyor Observations

- From the interviews conducted, it appears that boat fishermen will tolerate a more crowded situation (i.e., more boats per acre) if they are catching fish. This suggests that waterbodies that are either well-stocked or naturally abundant with fish might be able to (on the basis of user attitudes) accommodate more boats per acre.

- Optimum capacity levels resulting from this study should apply to anchored boats per fished acre.

Summary of Results



FISHING, SHORELINE

Participant Responses

Fishermen interviewed indicated preferred distances from other shore fishermen within a range of 5 feet to 100 feet, averaging 36 feet between fishermen. It is noteworthy that this average distance of 36 feet is considerably less than the SCORP average -- 109 feet. A preferred 5 foot spacing between fishermen was expressed only once, by a fisherman at a lake within a large city park. During the interview, this fisherman explained that he wants to "socialize with other fishermen" when he goes fishing. Another fisherman also fishing at a lake located in a large city preferred 100 feet between fishermen. Responses from dock and pier fishermen ranged from 8 to 25 feet between fishermen.

Several of the fishermen pointed out that the type of fishing has a bearing on the optimum distance between fishermen. For example, fishermen engaged in spin casting, fly fishing or other types of fishing which require frequent casting should be spaced farther apart than fishermen who are bait casting.

Park Administrator/Planner Responses

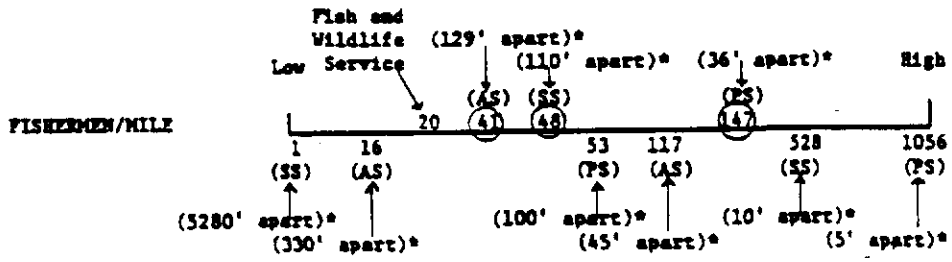
Suggested optimum capacities for shoreline fishing range from a low of 45 feet between fishermen to a high of 320 feet, averaging 130 feet between shoreline fishermen. This average space is slightly more than the SCORP average of 104 feet. One administrator noted that a space of 150 feet was optimum for surf fishing.

Over 80 percent of the administrator/planners agreed that the maximum level of use for shoreline fishing should be determined by either: the space required for safe handling of fishing equipment, especially casting; or a consensus of fishermen attitudes concerning the minimum distance required (socially) between fishermen for a pleasant fishing experience. Several administrators pointed out that "it is difficult to determine any justifiable maximum carrying capacity without taking into account a specific area" and "carrying capacity depends upon the number of fish being caught; if fishing is good, people will tolerate being shoulder to shoulder".

Most administrators agreed that the following variable factors should be used by park managers and recreation planners to help determine and select an optimum carrying capacity for shoreline fishing at a specific area: fish availability; tolerance of fish species to people; type of fishing (surf, fly, bail, spin cast, etc.), location of water body (urban or remote); extent of fished area; and stability of the shoreline. Tidal effects on the condition of fishing was also mentioned as a variable factor.

Most park administrators agreed with the average SCORP turnover rate of 1.7 per day (this represents a 7-hour stay during a 12-hour fishing day).

Summary of Results



SWIMMING

Reference	Facility	Standard
(21)*California Public Outdoor Recreation Plan, Part II, pp. 48, 84	neighborhood pool	One pool for each 3200 people. Pool with 1800 sq. ft. of water surface serves 150 persons at a time.
	community pool	One pool for each 25,000 people. Pool with 4500 sq. ft. of water surface serves 150 persons at a time.
	shoreline--ocean, lake, reservoir, or stream	25 effective feet of shoreline for each 1000 population, accommodates 150 persons per day, and 50 persons at one time. 25 effective feet include: a) 5000 sq. ft. for sunbathing. b) 2500 sq. ft. for buffer and picnic area. c) 1000 sq. ft. for water area for swimming. An effective foot consists of one lineal foot of shore with 100 foot-wide band of water suitable for swimming; 200 foot-wide strip of beach for sunbathing; 100 foot-wide buffer zone for utilities and picnicking.
(69) Meyer and Brightbill, Community Recreation, p. 404	pool	Minimum of 27 sq. ft. of water surface for each swimmer with a ratio of 2 square feet of deck area per square foot of water area. Total number of pools should serve between 3 to 5% of the total population at one time.
(126) Municipal and County Recreation in Tennessee, p. 41	pool	20 sq. ft. of pool and deck area for each 10,000 people in major metropolitan areas.

SWIMMING

Reference	Facility	Standard
		One pool for each 10,000 people in major metropolitan areas with over 10,000 population. One pool for each 7500 people in cities with between 10,000 and 35,000 population. One pool for each 5000 to 7500 people in cities with 5000 to 10,000 population.
(22) California Committee on Planning for Recreation Park Areas and Facilities, p. 57	regulation pool	A pool in a community recreation park adjoining a junior or senior high school requires: a) 1/2 acre site in a coastal and mountain region. b) 1 acre site in a valley or desert region. A pool located in a separate community recreation park requires: a) 1 acre site in a coastal and mountain region. b) 2 acre sites in a valley or desert region. Space surrounding a pool must be larger in a valley and desert region to accommodate users who remain there several hours for sunbathing and general relaxation.
(11) Athletic Institute, pp. 102-113	pool	A minimum of 27 sq. ft. of water per swimmer for recreational swimming; 45 sq. ft. per person for teaching purposes. Amount of water area per bather depends on size and shape of pool, ages of the bathers, width of deck and extent of sunning area, and nature of activity in which participants are engaged.

SWIMMING

Reference	Facility	Standard
(50) Gabrielsen and Miles, Sports and Recreation Facilities for School and Community, p. 177	pool	15 sq. ft. of water surface for each bather; 30 sq. ft. of water surface for each swimmer. A bather is a person who does not go into water over 5 feet in depth. Deck area should always equal or exceed square footage of water area since not more than 1/4 of the swimmers will be in the water at any one time. For cities under 30,000 in population, the maximum daily attendance expected at pools is 5% to 10% of total population.
(86) National Recreation and Park Association, Bulletin No. 50, p. 38	pool	8000 to 5250 sq. ft. of water surface per pool. There should be from 2 to 3-1/2 times more paved deck surface than water.
(128) Texas Comprehensive Outdoor Recreation Plan, Vol. 5, Section 14.4	pool	30 sq. ft. of water for each swimmer in the water. 2 to 1 proportion of deck area to water area.
	beaches	150 sq. ft. of water for each swimmer in the water. 300 sq. ft. of land for each swimmer not in the water.
(42) FHA Bulletin: Facts and Suggestions on Swimming Facilities, pp. 1-6	pool	Minimum of 20 sq. ft. of combined pool and deck area for each person using the pool. Standard recommended by The National Swimming Institute.
(30) Corps of Engineers, Delaware River Basin Report, p. W-33	beach	50 sq. ft. a person

SWIMMING

Reference	Facility	Standard
(119) Soil Conservation Service, Recreation Memorandum-3, p. 3	beach	100 to 200 sq. ft. of swimmable water per swimmer. 50 to 100 sq. ft. of beach per swimmer. Between 15% to 30% of swimmers are in the water at one time.
(87) National Recreation and Park Association, Bull. no. 51, pp. 6-8	beach	Most of the time there are more persons on the beach sunning than in the water. Since the amount of usable water space per person ranges from 50 to 100 sq. ft. the available site will determine the capacity of a particular bathing beach.
(16) BOR, Water-Oriented Outdoor Recreation: Lake Erie Basin, p. D-9	beach	75 sq. ft. of beach per person. Turnover factor is 1.5.
(132) Outdoor Recreation Plan for the State of Vermont, p. 93	public beaches or pools	Enough public beaches or pools to serve one tenth of the population at any one time. 2 linear feet of beach per user. Public swimming to be available within 10 miles of every family.
(99) The Comprehensive Outdoor Recreation Plan for New Jersey, p. 9	swimming and boating areas	1.25 acres for each 1000 population.
(45) Federal Power Commission p. 3	beach and swimming areas	Beach and swimming areas usually have a minimum shoreline length of 100 feet and a sand bottom. Larger areas have about one-foot of shoreline and a strip of beach extending 200 feet from the edge of the water for each five swimmers per day. Two single bath-change houses (or one house partitioned for men and women) are usually provided at each swimming area that attracts 50 or more peak-day swimmers.

SWIMMING

Reference	Facility	Standard
(135) Comprehensive Plan for Wisconsin, Outdoor Recreation, p. G-8	beach, rural area	3 supporting areas for each acre of beach. The acre of beach accommodates 185 swimmers, over 12 years old, at any given time. This provides 200 sq. ft. of beach per swimmer. With an average daily turnover of 3, the acre of beach and its 3 supporting acres accommodate 555 swimmers per day.
	beach, urban area	4 supporting acres for each acre of beach. The acre of beach accommodates 370 swimmers at a time. This provides 100 sq. ft. of beach per swimmer. With an average daily turnover rate of 3, the beach area accommodates 1110 swimmers per day.
(15) Bureau of Reclamation, p. 27	beach	One unit consists of 40 ft. of shoreline extending back approximately 550 ft. with space for related activities, parking and buffer strip.
(63) Louisiana Parks and Recreation Commission, p. 3.0.14	beach	A shoreline swimming unit should have a length of 600 ft. and a width of 665 ft. (565 ft. of width is land and 100 ft. is water). Maximum shoreline length should not exceed 3600 ft. A minimum unit of 9.2 acres (1.4 acres of water and 7.8 acres of land) has a 200 foot wide beach or play area and a 100 foot wide buffer zone for installation of utilities, tables, etc. The balance, 265 ft., accommodates 300 cars at a time. Minimum facilities are a change house, and sanitary facilities. At any one time an optimum capacity of 1200 persons may use the minimum shoreline facility. A turnover rate of 3 is expected. This allows 3600 persons to use the area on an average summer Sunday or 461.5 user days per

SWIMMING

Reference	Facility	Standard
		acre of land and 2571 user days per acre of water. This would be .0022 acres of land and .0004 acres of water per user day or 110 square feet per person per user day.
	pool	A minimum pool unit is one acre. It has space for a pool 75 ft. by 36 ft. or 2700 sq. ft. Facilities include bath house, filters, safety and sanitary equipment, and parking space for 90 autos. The pool provides space for 203 persons at one time with a turnover rate of 3; daily capacity would be 609 persons. This amounts to .0002 acres per person or 4.4 sq. ft. of water per person per user day.
(97) Nevada Department of Conservation and Natural Resources	shoreline	Average party is 4 persons, with 20 parties per acre. 40 persons are accommodated on .5 acre. One linear foot of shoreline per swimmer. Turnover rate is 2.
	neighbornood pool	60 persons are accommodated on .5 acre.
	community pool	150 persons are accommodated on 2.5 acres.
(28) Connecticut Department of Agriculture and Natural Resources, p. 41	swimming	Instant capacity of 3% of state population at state saltwater facilities and 3% at state fresh-water facilities.

SKIING, WATER

Participant Responses

Participant responses regarding preferred distances from other water skiers ranged from 50 feet to 600 feet, averaging 258 feet between different groups of water skiers or approximately 1½ acres of surface water per boat. This density is considerably higher than the SCORP average of 8.7 acres per boat. A space of 150 feet between groups of water skiers was the figure most often mentioned as the minimum acceptable distance. The most experienced skier interviewed (60 times/year) stated that he would prefer a standard of 2 acres per boat (a distance of about 300 feet between groups of skiers if evenly spaced). The one novice skier surveyed suggested 600 feet between ski groups. It is noteworthy that some of the skiers indicated that the lateral distance between skiers could be less than the frontal distance.

Several skiers interviewed felt that a designated water skiing area (devoted solely to water skiing) with a controlled circulation pattern is essential for a safe and pleasant water skiing experience. A few others did not like the idea of designated ski lanes. Complaints ranged from "the water being too choppy because of other boats" to "rule violators" and the "lack of respect for the safety of others". Most of the skiers indicated they were having a pleasant time, stating that one or more of the following items help to contribute to their pleasant experience: proximity of picnic facilities; available parking facilities; courteousness of other skiers; policing; available and clean comfort facilities; clean water; natural features; and limited amount of commercialism.

Park Administrator/Planner Responses

Suggested optimum capacities for water skiing ranged from 7 acres per boat to 40 acres per boat, averaging 12½ acres, per boat (or about 740 feet between boats if equally spaced). This average is somewhat less dense than the SCORP average of 8.7 acres per boat. It is noteworthy that 70 percent of the administrators interviewed suggested optimum capacities between 7 and 10 acres per boat.

Most of the administrators and planners agreed that the following factors have at least some bearing on the optimum carrying capacity for water skiing: the location of the water body (urban or rural); multiple use of the water area; shoreline configuration; controlled circulation pattern; and the degree of policing or supervision. Wind conditions, the expertise of the skiers, and the space required for dropping off and picking up skiers were other important factors.

Sixty-five percent of the administrators agreed with the following two SCORP averages: (1) a turnover rate of 2.4 per day (i. e., an average length of stay of 3.4 hours per day); and (2) 3 people per ski boat.

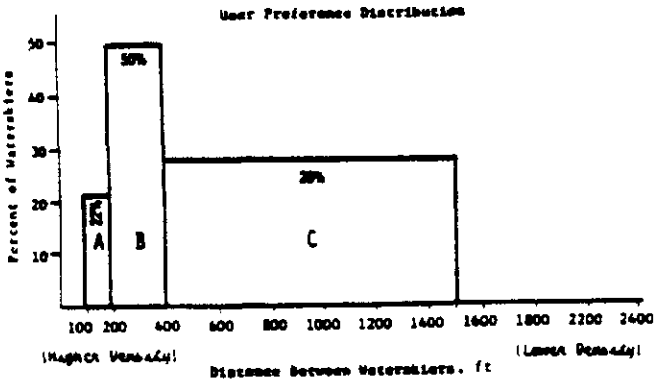
Surveyor Observations

- Water skiing is incompatible with other water-related activities such as swimming, boat fishing, and all other types of boating.
- Optimum carrying capacity guidelines for water skiing should apply to that portion of a water body designated solely for water skiing.

WATER SKIING

Reference	Facility	Standard
(135) Comprehensive Plan for Wisconsin, Outdoor Recreation, pp. G-10, G-11	water skiing	One person per 13.3 acres of water. Estimate 3 persons per boat, 20 acres per boat may be adequate, but 40 acres per boat is more desirable.
(63) Louisiana Parks and Recreation Commission, p. 3.0.15	water skiing area	One ski boat requires 40 acres of water, therefore, 13 ski boats would require 520 acres of water to support one ski boat ramp. With an average of three persons per ski boat, a ramp would produce 120 activity days during an optimum day use, or 120 user days per acre of land and .23 user days per acre of water. This amounts to .0083 acres of land and 4.33 acres of water per user day.

User Preference Distribution



Social Capacity Factors Table

Site Characteristics	Variance	User Characteristics	Variance
Amount/Location of Facilities		Travel Time	
Pleasant	-5	≤ 1 hr (57%)	-40
Unpleasant	+140	>1 hr (43%)	+120
Level of Development		Number of Other Activities	
High	-75	1 (16%)	+80
Moderate/Limited	+5	2-3 (34%)	+20
		>3 (52%)	-30
		Experience	
		None/Little/Some (44%)	
		Much (56%)	+50
			-20
		Age	
		≤ 25 (53%)	-20
		26-55 (47%)	+20
		Group Size	
		1-6 (88%)	0
		>6 (12%)	-15

C

CAPACITY TECHNIQUES

Source

URBAN RESEARCH DEVELOPMENT CORPORATION. 1980
Recreation Carrying Capacity Handbook
Methods and Techniques for Planning,
Design, and Management. (Prepared
for Office, Chief of Engineers, U.S.
Army) Vicksburg, Mississippi

Controlling The Carrying Capacity Of A Lake

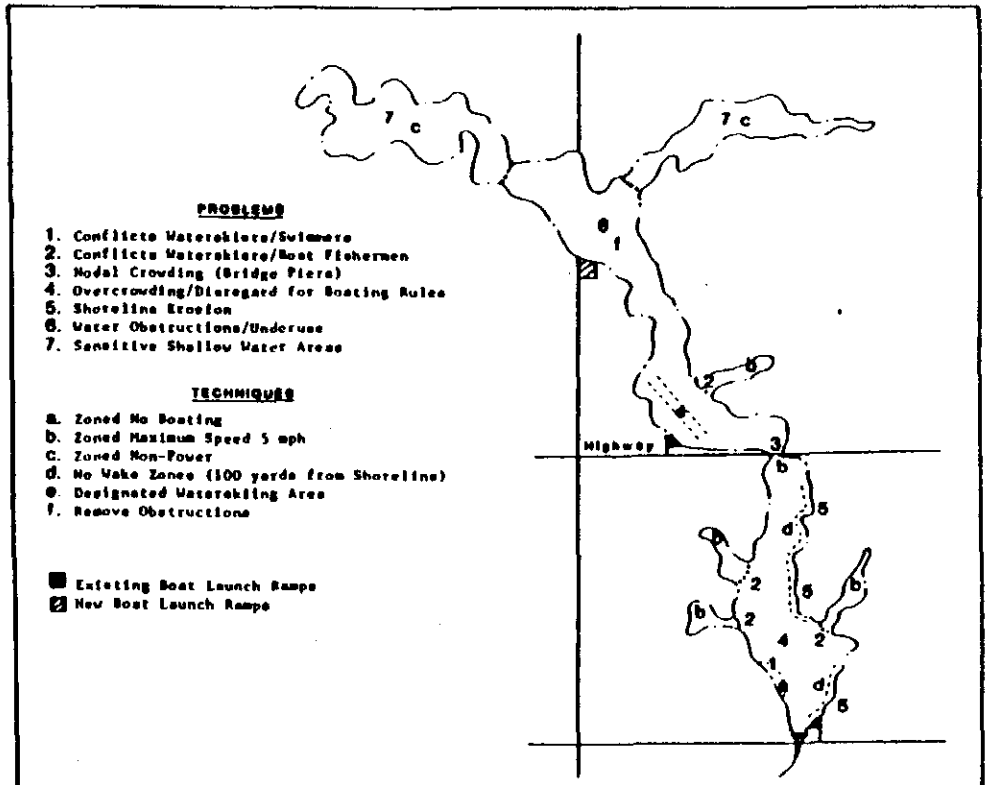
Purpose

This demonstration illustrates the application of various techniques to control the carrying capacity of a lake that has numerous capacity problems (Figure 35).

Selection and Application of Techniques

In selecting which techniques to apply, management first determines what the problems really are. In the case of conflicts between boaters and swimmers, the actual operation of boats presents the greatest danger. In other cases, it is only the speed, the wake, or the type of boat that really creates or aggravates the problem. In each case, management seeks to apply the technique that is most narrowly tailored to the real problem, is easiest to administer, and is most acceptable to users.

Many of the problems at the lake can be dealt with by different types of lake zoning (see Figure 35). Problems such as disregard for boating rules call for increased education of users and increased lake patrol/enforcement. Problems such as underuse of one portion of the lake (which may be related to the overcrowding in other portions of the lake) may call for certain improvements such as removal of obstructions and new boat launch ramps.



Controlling the Carrying Capacity on a Lake

Carrying Capacity Techniques

Technique	Activities Most Influenced by the Technique	Primary Problems/ Conditions That Could be Prevented or Solved as a Result of Using the Technique	Primary Application of the Technique: • Preventive • Corrective • Both - Could be used as both a preventive or corrective technique	Major Advantages	Major Disadvantages
GENERAL PLANNING AND ACTIVITY RELATIONSHIP TECHNIQUES					
Dispersing activity areas	Camping, picnicking, boat launching, marina activities, shore fishing	Overcrowding, overuse	Preventive	• Spreads use throughout the project • Likely to be accepted by users • Easily addressed during project area master planning	• Could increase maintenance and patrol costs
Varying levels of accessibility	Camping, picnicking, fishing, boat launching	Overcrowding, overuse, underuse	Both	• Very effective • Costs are saved if used during initial planning	• Limiting is unacceptable to users surveyed • Costs could be high if applied to correct problems
Providing selected impact area	Camping, picnicking, ORV riding	Overuse, underuse, overcrowding	Preventive	• Many Corps projects have areas which are scarred and could well serve as a selected impact area • Could reduce overcrowding and overuse in other activity areas and help to provide more of a variety of activity situations	• The sacrificed area gets abused, sometimes overused and overcrowded
Planning activity areas outside environmentally sensitive areas	Camping, picnicking, ORV riding	Overuse	Mostly preventive but could be used as both	• Easily addressed during project area master planning • Not costly • Environmentally sensitive areas could be used for nonintensive activities	• Some environmentally sensitive areas are very attractive (visually) locations

Technique	Activities Most Influenced by the Technique	Primary Problems/ Conditions That Could be Prevented or Solved as a Result of Using the Technique	Primary Application of the Technique: • Preventive • Corrective • Both- Could be used as both a preventive or corrective technique	Major Advantages	Major Disadvantages
Separating conflicting activities	Camping and day use; ORV and other activities	Overcrowding, user dissatisfaction	Both	• Easily addressed during project area master planning • Accepted by users surveyed • If done initially not costly	• Could be costly if applied remedially
Zoning areas on lake surface	Boat fishing, water-skiing, nonpower/ limited power boating, power boating, sailing, swimming	Boating conflicts, overcrowding	Both	• Very effective • Acceptable to users surveyed • Speed zoning can be accomplished by signs	• Difficult to enforce • Requires additional patrol boats and rangers
Planning for a variety of user experiences	Camping, picnicking, hiking, ORV riding, fishing	Overcrowding, user dissatisfaction	Preventive	• Easily addressed during initial project area planning • Not costly	
Locating functionally related activity areas close together	Camping, hiking, swimming, boat launching; picnicking, sunbathing, shore fishing	User dissatisfaction, underused	Preventive	• Easily addressed during project master planning • Not costly	• Could result in heavy use, overuse, or overcrowding
Using information and exposure	Camping, picnicking, fishing	Overuse, underuse, overcrowding	Both	• Easy to address the visual exposure of areas during initial site planning • Could be effective • Likely to be acceptable to users	— —
SITE PLANNING AND DESIGN TECHNIQUES Siting activities and facilities	Camping, picnicking, boat launching, swimming areas	Overuse, overcrowding	Preventive	• Easily addressed during initial site planning • Effective • Not costly	— —

Continued

Technique	Activities Most Influenced by the Technique	Primary Problems/ Conditions That Could be Prevented or Solved as a Result of *Using the Technique*	Primary Application of the Technique: • Preventive • Corrective • Both - Could be used as both a *preventive* or corrective technique	Major Advantages	Major Disadvantages
Redesigning areas	Camping, picnicking	Overuse, underuse, overcrowding	Corrective	• Effective	• Could be costly • Could disrupt recreation use • Unacceptable if used to reduce recreational use
Reducing the number of recreation sites or units	Camping, picnicking	Overcrowding, overuse	Corrective	• Very effective	• Unacceptable to users
Using various methods to control circulation	Camping, hiking, picnicking, ORV riding, horseback riding, waterskiing	Overuse, overcrowding	Both	• Very effective • Various materials can be used • Very cost-effective	• Could be unpopular
Hardening natural surfaces	Camping, picnicking, hiking, shore fishing	Overuse	Both	• Very effective in reducing overuse • Acceptable to users	• Costly • *Asphalt and* concrete less acceptable than fine gravel, wooden, and other more natural material
Using buffers	Camping, picnicking, hiking, ORV riding	Overcrowding	Both	• Very effective in affording privacy • *Acceptable to most* users • When developing new areas it is easy to leave natural vegetation	• Could block view of lake • *Some* users do not like buffers between campsites because it screens views and increases heat and insects • Plantings may be costly
Increasing facilities and site amenities	Camping, picnicking, hiking, shore fishing	Underuse	Corrective	• Could be effective • Likely to be well accepted by users	• Could result in overcrowding or overuse if not applied carefully

Continued

Technique	Activities Most Influenced by the Technique	Primary Problems/ Conditions That Could be Prevented or Solved as a Result of Using the Technique	Primary Application of the Technique: • Preventive • Corrective • Both - Could be used as both a preventive or corrective technique	Major Advantages	Major Disadvantages
Employing certain site planning and design principles	Camping, picnicking, hiking	Overcrowding, overuse, underuse	Both	• Easy to consider these principles during initial site planning stage • Likely to be well accepted by users	— —
MANAGEMENT TECHNIQUES Rules and regulations Stricter enforcement	Boating, camping, picnicking, fishing	Overuse, overcrowding	Preventive	• Could be very effective in reducing overuse and overcrowding • Most users want rules to be enforced	• Could be costly and require additional patrolling rangers • Use of discretion may lead to unpopular results
Imposing new rules and regulations	Boating, camping, picnicking, swimming	Overcrowding, overuse	Preventive	• Provides guidance for users in specific situations	• Rules often violated • More rules to be enforced • Users must know rules • Some limitations because of Title 36
Limiting the number of people per group	Camping, picnicking, ORV riding	Overuse, overcrowding	Both	• Effective in reducing overcrowding and overuse • Works best if group areas are also provided	• Unpopular with users • Difficult to enforce an exact number
Policies: Closing the gate	Camping, picnicking, boat launching, swimming, sunbathing	Overcrowding, overuse	Preventive	• Very effective control • Easy to administer • Acceptable to users	• Use must be monitored • Requires knowledge of overcrowding indicators • Might be difficult to administer if there are several access points

Continued

Technique	Activities Most Influenced by the Technique	Primary Problems/ Conditions That Could be Prevented or Solved as a Result of Using the Technique	Primary Application of the Technique: • Preventive • Corrective • Both - Could be used as both a preventive or corrective technique	Major Advantages	Major Disadvantages
Closing areas	Camping, picnicking, hiking, swimming, sunbathing, power boating, boat fishing	Overuse	Preventive	• *Cost-effective* (vs. rehabilitation) • Acceptable to users	• Requires knowledge of critical point
Requiring permits to use recreation areas	Camping, picnicking, boating, ORV riding	Overcrowding, overuse, user frustrations	Both	• Guarantees out-of-towners will have a spot • Reservations could be applied only to some sites or activity areas • Very effective	• Does not control carrying capacity per se • Is unpopular with users surveyed • Costly to administer • Limited by Title 36 • May deny opportunity when no need to
Charging or increasing fees	Picnicking, swimming, camping	Overcrowding	Both	• Could be very effective • Equity • Provides money • Many ways to apply this technique	• Effective only when fee is set by market demand • Equity • Limited by Title 36 • Unpopular to users
Creating user turnovers	Camping, boating, boat launching	Overcrowding	Both	• Could be very effective • Not costly	• Could be unpopular • Could be difficult to administer
Services: Increasing maintenance and restoration	Camping, picnicking, shore fishing	Overuse	Both	• Very acceptable with users • Effective	• Could be costly • Could require closing recreation resource
Providing more and better information	Boat launching, boating, fishing, camping, ORV riding, picnicking, water-skiing	Overuse, overcrowding, underuse	Both	• Very acceptable with users • Could be very effective	• Could be costly

Continued

D

MATRIX CRITIQUE

MATRIX CRITIQUE

The ecological species consortium approach to recreation carrying capacity on the water surface of Lake Berryessa is unique. An application of the interactions analysis between recreational activities provides an insight to activity organization and population levels reached by water surface users.

The matrix provides a framework to systematically organize a seemingly disorganized recreational population. The matrix facilitated being descriptive about activities, an understanding of what is involved, and what the resource requirements are so that the activity can occur.

The activities need accurate definition so we know exactly what is being addressed. Swimming, for example, is in three categories. This is important because if people are truly swimming by the definition of the word, why should we be concerned with water depth and the degree of bottom slope? In reality, a designated "swim area" is a place where people go to stand, squat, and sit in water. A few people may actually swim a few strokes or yards. We need to be more definitive in the activity description and resource requirements.

Unless we know what people expect in return for their recreation experience, i.e., why they participate in certain activities or where they choose to participate in that activity, the current recreation standards will not be adequate even for planning. We need a better understanding of both questions

above. Where people choose to participate in certain recreation activities has a local and regional significance. It affects systems planning and recreation marketing. It also is a reflection on the "quality" of experience. If people receive a quality experience, they will tend to return to the same place.

The matrix recognizes all water recreation activities. Too often just the standardized more familiar activities are considered in planning and the other activities are overlooked. Technological advances continually result in new sophisticated toys that challenge resource managers. If we stayed current with these advances and really got into the anatomy of the "toys," the management problems could be reduced and we could accommodate the activity better. Off-road vehicles are a good example of an activity we did not come to grips with and now the off-road vehicles are looked upon as major problems for resource managers. We made no concerted effort to accommodate them from the beginning or to shape the nature of the activity. Fortunately, on a lake, there is the opportunity to work on a clearly defined recreation area and prohibit certain activities that jeopardize public health and safety.

Unless we begin to acknowledge and understand the nonstandard recreation activities, the technological advances will thwart the validity of all our recreation management, planning, and development efforts. People will be using mini-submarines while we are still talking about the water-skier/fishing boat conflicts. The matrix facilitates relating new activities to existing activities. A framework of systematic, organized thought is provoked by the matrix. The unthinkable becomes thinkable.

The matrix requires the following:

A. Investigators who are knowledgable in ecology and human behavior.

B. Investigators who are knowledgable about the water body in question and how it is utilized for recreation.

C. Water bodies in excess of 1,000 surface acres.

D. Definitive information about the activities, the resources required and the expectations of the recreational participants. All the recreational activities and other uses of the water surface must be acknowledged.

Research would be helpful to verify, or reject, the assumptions made during the matrix interaction evaluations. Specifically, the reasons why people participate in various activities; are their expectations satisfied? It would be helpful to know the proportionate amount of participants in each activity. It would also be helpful to know specific resource requirements for each activity. Our best judgments based on knowledge and experience, were almost all that were available during the analysis.

The final analysis of the matrix is that it provides management a means to identify the quality and capability of the resources being managed, and an understanding of the nature of water surface user conflicts. Management has a better understanding of what "tools" to use to separate conflicting activities by space, time, restriction, and enforcement. The "capacity" of the water surface can hopefully provide visitors with a safe, quality type of recreation experience.

CHAPTER IX

CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS AND RECOMMENDATIONS

General

This analysis provides an understanding of the carrying capacity concept, its complexity, and how capacity relates to the recreation use of Lake Berryessa. Only the water user activities, the water surface, and the recreation facilities providing access to the water are analyzed. Land recreation activities are intentionally excluded. There are no absolute numbers recommended to limit the recreation use of Lake Berryessa. The reasons for this position are: (1) a lack of recreation standards that cover the numerous capacities for the recreationists, the resource, and management; (2) saturation of water surface recreation use to capacity is an instantaneous momentary localized phenomenon; (3) the capacity concept is primarily a planning tool, not a water surface management tool per se; and (4) Lake Berryessa management needs guidance to ensure public health, safety, a favorable experience, and optimum recreational use.

The conclusions, recommendations, and management techniques give management and the public some latitude on how Lake Berryessa can accommodate present recreation use. Recreation standards for 11 water activities are in Appendix B.

Conclusions

1. Lake Berryessa is a Federal water development that ensures public access to project lands and water for recreation purposes. The lake is a valuable recreation resource which provides fresh water recreation opportunities to a service area which contains 6.8 million people.

2. Lake Berryessa continues to experience increased recreation use. In 1986, 1.9 million visitor days were reported which is a doubling of use within 6 years. Recreation use will continue to increase as the regional population and water activity popularity increase.

3. Lake Berryessa has a shortage of day use facilities for short-term visitors. Additional day use facilities are badly needed to provide access to the water surface.

4. Lake Berryessa's water surface receives pockets of concentrated use in proximity of the concession and public use access areas along the western and southern portions of the lake. The northern portions of the lake do not receive as much use as the rest of the lake.

5. Lake Berryessa accommodates 44 different water activities year-round. The lake also has the unique capability of providing solitude experiences even during peak use periods. Only 11 of the 44 activities have recreation standards. Those standards provide limited resource requirement information.

6. Carrying capacity of the Lake Berryessa recreation system is dependent on: (a) land for water access, (b) water access facilities, and (c) on the water. Water access facilities for short-term day use and long-term moorage is the limiting factor. The short-term visitor facilities are used at or

near capacity during the recreation season. The land and water surface have not reached a physical carrying capacity.

7. Carrying capacity on Lake Berryessa's water surface is dependent upon administration, biological, physical, social, and temporal factors. Management ultimately determines the "recreation carrying capacity" of a water body that is suitable for recreation use.

8. Carrying capacity on the water surface should be used for planning rather than as a management concept. Recreation users of the water surface will determine their own personal capacity and respond by migrating, mutating, or leaving the lake area. Management can influence optimum capacity which may be different from personal capacities participants reach. Capacities are usually instantaneous on a water surface and associated with perceived crowding. Long-term lessees are repeat users of the lake and have the best opportunity to avoid experiencing crowding on the water surface. They usually wait at their cabin site until the other users leave before returning to use the lake.

9. Conflicts between water surface users usually cause a perception of capacity occurring. The most potential conflicts occur between motorized and nonmotorized uses. Those seeking a solitude experience are most sensitive to potential activity conflict.

10. Conflicting uses are usually separated by space, time, regulations, and enforcement. Zoning, by time and space, reduces conflict and enables more participants to use the water surface. Management can ultimately prohibit certain activities on the lake to protect the public health, safety, and ensure enjoyment.

11. Management, with public input, must determine if solitude is a worthy quality to protect. The tradeoff is additional day-use development to provide access to remote unused lake areas.

12. As the Lake Berryessa area becomes more urbanized and recreation use increases on the lake, it is inevitable some recreation activities will be restricted or eliminated.

13. Speed and boat size influence perceptions of capacity and are particularly impressionable on small, no-power, or low-powered watercraft.

14. Providing additional recreation opportunities on land to help visitors avoid "killing time" will enhance the total satisfaction and overall quality of experience at Lake Berryessa. These additional activities should be designed to provide fun while visitors within their group are waiting for their turn to use their boat on the lake.

15. The ecological consortium matrix for population distribution and organization provides insight into the interactions of recreation activity participants on a water surface. The matrix facilitates an understanding how the activities relate to each other in interfacing situations. A better understanding of the interactions should help management determine how activity conflicts can be avoided and the visitor recreation experience can be enhanced.

Recommendations

1. Management should continue to accommodate the diversified recreation activities on Lake Berryessa provided public health and safety are not jeopardized by any one activity.

2. Develop additional day-use facilities for greater public access to the water.

3. Consider establishing boat-use traffic patterns where needed. For example, studies should be conducted in the arm between Markley Cove, Neither Cove, and the Narrows to determine if buoys should be placed in the middle of the channel. Boats using that area would be required to stay to the right of the buoys to avoid collisions. In areas of heavy traffic and constricted shorelines, other activities, e.g., still-boat fishing and trolling, could be encouraged in bays and coves where there is no traffic.

4. Consider zoning areas to separate motorized and nonmotorized craft. Examples include the northern part of the lake above Putah Creek, including Putah Creek across the lake to the east shore midway between Tully and Anderson Canyon drainages into the lake. The zoning could separate the paddle craft, and low-speed boats from the higher speed activities. The speed activities would be restricted to the south areas of the lake during the prime recreation season of April 1 through October 15. The zoning can be nonmotorized; nonmotorized -- no-wake motorized, or a 5-mph low speed if there is a way to enforce the speed limit. The zoning should be lifted during October 15 through March 31.

5. Increase fishing opportunities in the northern part of the lake by improving the fish habitat. Fishermen in boats would be more inclined to use an area which has a higher catch rate.

6. The Bureau and concession operators should establish a program to designate and develop specific sites for camp-boating and implement a permit program for using the sites. Establishing the two programs is essential to

control litter on the shoreline, reduce the fire hazard, and eliminate uncontrolled defecation around the lake. Fees could be charged for services related to camp-boating, for using the sites, and reduce competition and conflict with houseboats for use of the sites.

7. The Bureau should consider establishing additional means to convey use information to the public. Information can be provided through a boat permit program and increasing visitor information services in the resorts and public access areas.

8. Additional corrective measures to discourage diving from the highway bridges and rock formations are badly needed and should be considered. Patrolling these areas and having the limited number of law enforcement personnel write accident reports is not an efficient use of their time. The bridges and rocks are isolated from the rest of the activity on the lake. Law enforcement officers' presence on the busy parts of the lake would be more effective for achieving optimum capacity.

9. The Bureau, for evaluating the recreational carrying capacity of Lake Berryessa, must compare alternative uses of the land that provides access to the lake and the quality of solitude on the water. Land use decisions should attempt to meet human needs and desires. These are the primary criteria for judgment. Any decisions made should allow future resource managers sufficient flexibility to make decisions to meet the needs of changing times, and for accommodating greater off-season use. Long-term planning objectives should be identified and followed.

10. Consider limiting the size of power and sailboats on the lake. Sailboats should be limited to 30 feet in length. Studies for determining

the powerboat length limit should be done.

11. Based on the total experience a visitor receives at Lake Berryessa, and applying Gold's (1980) activity quality scale, management needs to focus on "killing time." The quality of experience at Lake Berryessa can be raised from "killing time" to a higher level by providing a diversity of other recreation activity opportunities within the resorts and public areas to complement water activities. The diversity of activities could include, but not be limited to horseshoe pits, volleyball, badminton, playground equipment, basketball goals, wading ponds, etc. When the water surface use reaches a perceived "capacity," visitors who choose not to go on the lake will have other activities available. Additional opportunities are better than killing time and will enhance the quality of the total experience at Lake Berryessa.

12. Further research is needed for the subjects listed below:

a. Peak period use observations to determine the proportionate number of participants per activity. This would require high resolution aerial photographs that allow determining the activity people are pursuing and where the activity is occurring.

b. Water surface use patterns should be studied to provide insight to separating conflicting activities by area, time, and regulation. Use of visitor activity diaries would be ideal to ascertain areas used for water activity staging, where the water activity was participated in, the time of day, water surface conditions, total number of participants, age, and impressions of crowding. In addition to the diary, transmitters could be placed on volunteer boats and their reservoir movements monitored by

satellite in a similar manner as wildlife studies done on the grizzly bears.

c. A year-round study of the Lake Berryessa visitor demographic profile, where they originated, where they parked, and what they expect from their experience(s) based on the leisure profile.

d. Visitors need to be polled to determine their desire for additional facilities such as horseshoe pits, volleyball courts, playground equipment, basketball goals, etc., to expand their Lake Berryessa experience.

e. Lake Berryessa management should consider adopting the Corps of Engineers' computerized boat permit system utilized at the Corps' Lake Sidney Lanier, Georgia.

CHAPTER X

MANAGEMENT TECHNIQUES

MANAGEMENT TECHNIQUES

Water recreation is popular throughout the United States. Many lakes are experiencing heavy use. The managing Federal, State, county, and city agencies responsible for recreation have developed various techniques to deal with heavy recreation use. These techniques are listed as a part of the Lake Berryessa management "tool chest." An awareness of the techniques and their possible applicability to Lake Berryessa may help management solve conflicts that are not identified in this analysis. Other techniques by Urban Research and Development Corp., are included in Appendix C.

Management Options

1. Designate beaching sites for houseboats and camp-boaters and set up a reservation system.

2. Develop habitat conservation efforts for establishing fishing areas all over the reservoir to distribute the fishing pressure. Are habitats available for certain species? Is it desirable to introduce additional species?

Establish fishing classes by concessions to enhance fishing success.

3. Develop and encourage more off-season use of the lake such as special events such as rallies for water skiing in wet suits.

4. Education

a. Encourage user clinics for activities such as jet skiing sponsored by manufacturers and/or delears. Power Squadrons, Coast Guard, and USBR people could conduct classes on the safe, acceptable use of the "water toys" and how added skills may enhance their experience.

b. Provide the latest weather information.

c. Establish an interpretation program about the lake.

5. Management should adopt the NPS (National Park Service) guidelines regarding the number of houseboats using a water body. The limiting factor is the available beaching areas with privacy and weather element protection. The NPS also gauges the houseboat use by the number of complaint letters pertaining to houseboat conflicts.

6. Management should consider establishing a boat permit system to ensure contact with lake users and to provide information about safe boating and conduct, lake conditions, and a general education program. Incompatible activities could be sorted out to minimize activity conflict. Policing of the lake should be increased during peak periods of use.

7. Management should establish traffic patterns in heavy boat use areas in confined, narrow waterways of the reservoir such as the stretch of the main channel from the "Narrows" to "Markley Cove." Buoys should be placed in the center of narrow waterways and boats should stay to the right of the buoys when entering or departing the area. Other passive uses of narrow areas should be prohibited during peak periods to reduce activity conflicts.

8. Management should diversify the land-based recreation activities to complement the water-based activities. Day-use sites could be developed with nontraditional facilities such as horseshoe pits, volleyball courts, basketball goals, badminton courts, or any activity that occupies peoples' time while they wait for a turn to use the water.

Management Techniques

1. Prohibit certain activities on the lake.

2. Prohibit activity generally - special permit issued.

3. Restrict activity to certain areas such as staying within one-fourth mile of shore.

4. Schedule special event for activity-permit issued.

5. Separate activity by area-zoning.

6. Separate activity by exclusive use.

7. Separate activity by time.

8. Encourage activity by special facilities

   a. e.g., water ski slalom, jump, and use of night lights

   b. e.g., special cranes to lift keel sailboats

9. Designate areas for group activities.

10. Establish recreation use patterns, e.g., clockwise travel patterns.

11. Encourage people to participate in more compatible activities.

12. Impose a length-of-stay limitation, e.g., people may keep their boat on the lake for a 2-week period during the recreation season.

13. Add more patrol boats. ("Water areas that are policed can accommodate more boats per acre than those which are not policed." Optimum Recreation Carrying Capacity p. III - 18).

14. Increase public contact and education of lake users. Water safety and regulations are the subjects people must be cognizant of for a safe and quality experience.

15. Require boat operators to obtain a boat permit for Lake Berryessa. Show a 10-minute presentation on boat safety on Lake Berryessa as an education effort; provide latest literature.

16. Determine which qualities of the leisure profile will be emphasized or deemphasized.

17. Reclamation should develop an educational program about safe boating on Lake Berryessa and provide any information users should have which would enhance their boating experience.

18. Conduct periodic meetings with Berryessa recreators to iron out problems.

19. Researchers found many of the motorized and nonmotorized activity conflicts on other lakes occur within 200 to 300 feet of the shoreline. To reduce the conflicts, managers of heavily used Wisconsin lakes have placed buoys 200 to 300 feet from shorelines. Motorboats are required to stay beyond the 200- to 300 foot buoys and use middle portions of the lakes.

20. Waterskiing is one of the most popular activities on Lake Berryessa. It also requires more space than most activities because of relatively high speeds and has a greater potential to interact with other activities. Water skiing is a prime safety concern for Reclamation managers. Management can manipulate waterskiing to enhance both the experience and safety of participants.

A traffic pattern should be established for the area generally used by water skiers. Install 10- by 10-foot rafts in the waterski area for takeoff and dropoff. These rafts need to be anchored and used as substitutes for beaches. They reduce conflict with shore and beach activities and make more efficient use of the open water by reducing the commute to the shore areas. A specific area, or specific areas, can be designated for waterskiing. Waterskiing usually occurs during peak air temperature periods of the day. That means water used by water skiers can be used for other activities before or after peak air temperatures.

During windy periods which generate waves in excess of 1 foot, waterskiers will tend to use calm waters found on leeward shores. Waterskiers effectively compete with other activities and tend to eliminate other uses of calm water. If there is a prevailing wind, a designated area for water skiing could be established on a leeward shore or in a bay. There must be sufficient depth, an absence of underwater hazards, and a means to clearly identify the exclusive use area.

Water skiing can be organized into learners, skilled, and competition. Each can be accommodated safely by assigning time slots. Learners need the greatest space because of frequent spills. Competition may require organization and periodic exclusive area designation for slalom runs, jumps, and stunt skiing.

Organization requires full cooperation of participants, concessions, and the Bureau. The Bureau must notify other users in advance about the closed off area(s).

When waterskiing occurs in a mixed use area, require water skiers to wear a high-visibility vest or object in addition to a personal flotation device. Tow boats should use a high-visibility flag to signal a downed skier.

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APPENDICES

APPENDIX A- A Lake Berryessa Map

APPENDIX B- Recreation Standards

APPENDIX C- Capacity Techniques

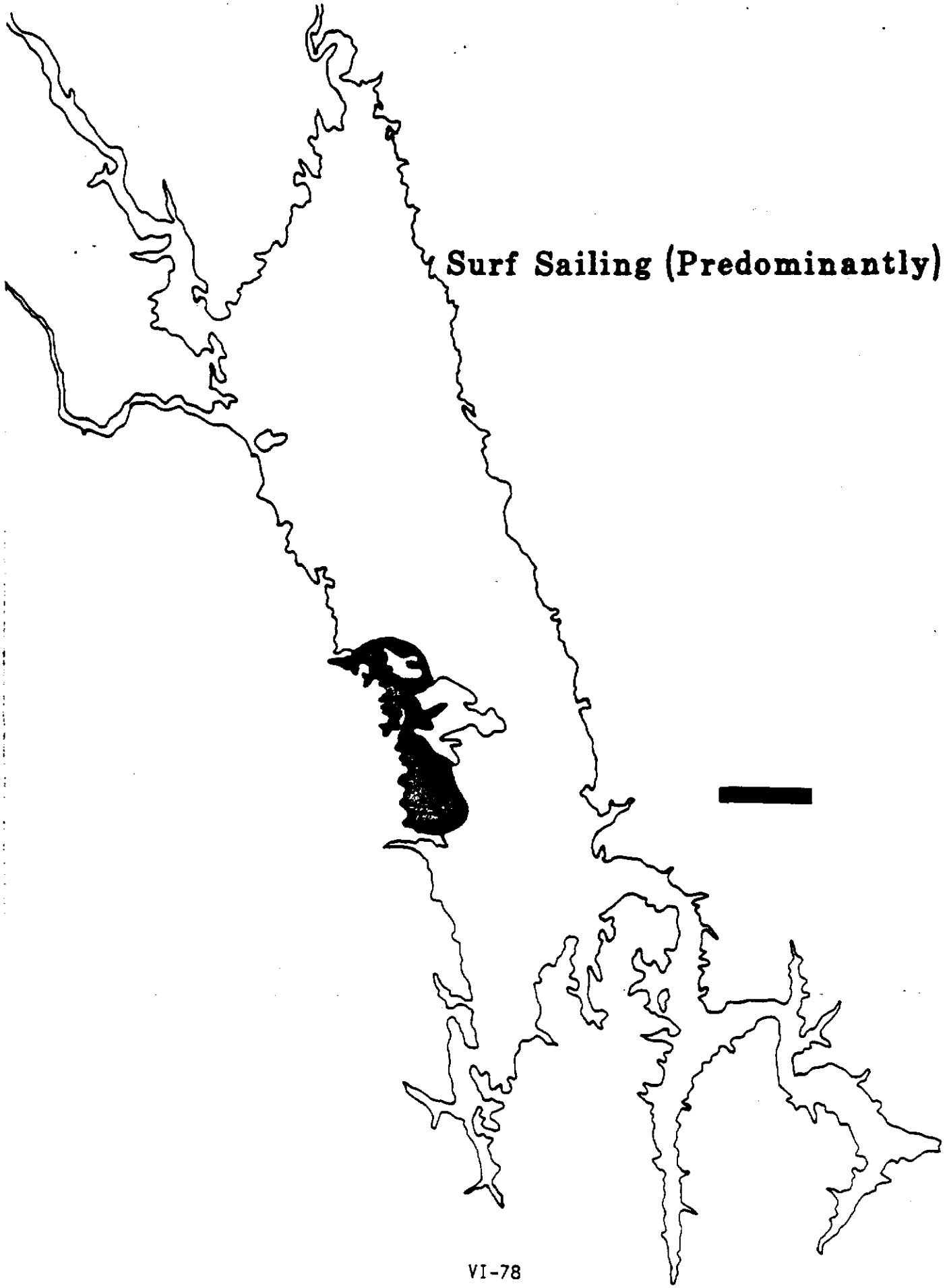
APPENDIX D- Matrix Analysis Critique

SURF SAILING - EXPERIENCE: Risk

Activity description. - Surf sailing, an individual sport, requires the use of a surfboard up to 12 feet long by 2.5 feet wide equipped with a mast up to 12 feet high and a sail containing up to 78 ft^2. The sail size varies with the amount of wind. Some surfboards have 1.5-foot centerboards. The participant hangs onto and manipulates a wishbone-shaped boom to capture and dump the wind. Steering is accomplished by shifting the participant's weight and manipulating the sail to cause the board to turn in the desired direction. Skilled surf sailors can move up to 25 mph, run in waves over 5 feet high, and execute 180° turns within the length of the surfboard. The activity usually occurs during windy and warmer times of the day.

Resource requirements. - There are no recreation capacity standards for surf sailing. The activity requires sufficient water for flotation - at least 3 feet deep. Winds 5 to 15 mph are best, but the more skilled participants can handle greater velocities. The water area should be sufficient to allow at least 1/4- to 1/2-mile runs. Water and air temperature should be greater than 70 °F. Wet suits for maintaining body warmth and flotation are desirable for marginal temperatures. Sandy bottoms with water depth 2 to 4 feet are desirable for takeoff and landing. This activity usually occurs during the warm recreation season.

Figure VI-34. - Surf sailing

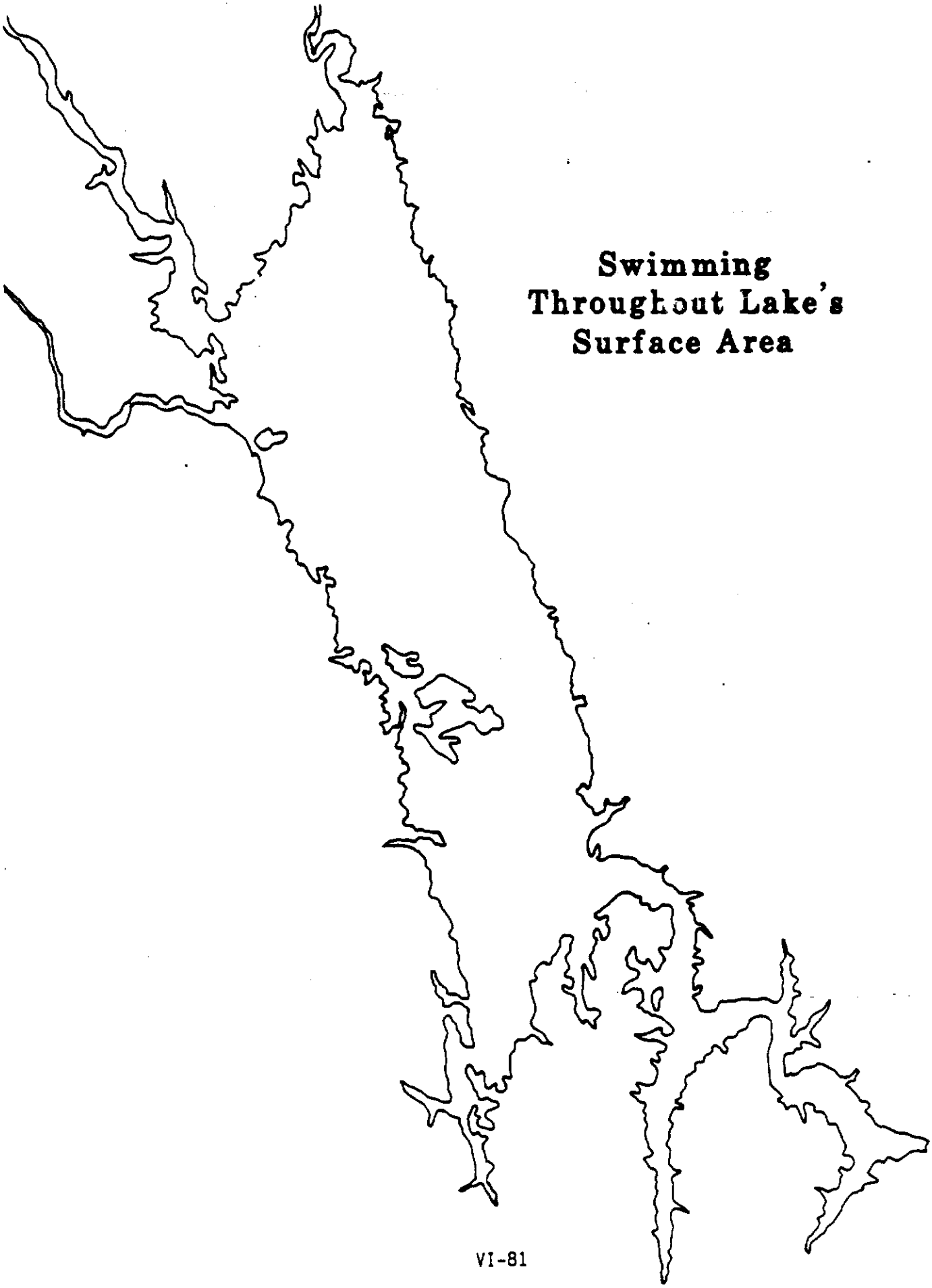

Surf Sailing (Predominantly)

SWIMMING - EXPERIENCE: Social

Activity description. - The dictionary describes swimming as "propelling oneself through water by means of movements of the body or parts of the body; gliding through water; to float on water, and float, or swim on a body of water." There are three categories of swimming at Lake Berryessa: (1) the primary purpose is being active to the letter of the definition, (2) swimming is incidental to other waterborne activities, e.g., water skiing, scuba diving, surfsailing, etc., and (3) social swimming which usually occurs in designated swim areas without formal organization of the activity. The activity ranges in attire from "skinny dipping" to full wet suits to maintain body warmth. The activity usually occurs during the warm seasons of the year and warm times of the day.

Resource requirements. - There are numerous recreation capacity standards for swimming. The former Bureau of Outdoor Recreation compiled swimming standards from numerous recreation agencies. These standards are in Appendix B. Air and water temperatures above 70 °F are desirable. Wave action of any kind can be tiring and wind is a chill factor that will discourage swimming. Nude swimming requires privacy and solitude. Sandy beaches and swim area with sandy bottoms and a 3° to 6° slope are desirable in designated swim areas. Designated swim areas should be clearly identified with buoys, floating lines, and signs to separate swimming from other water activities. Water depths in designated swim areas should not exceed 7 feet except in designated diving board areas. This activity usually occurs during the warm recreation season.

Figure VI-35 Swimming

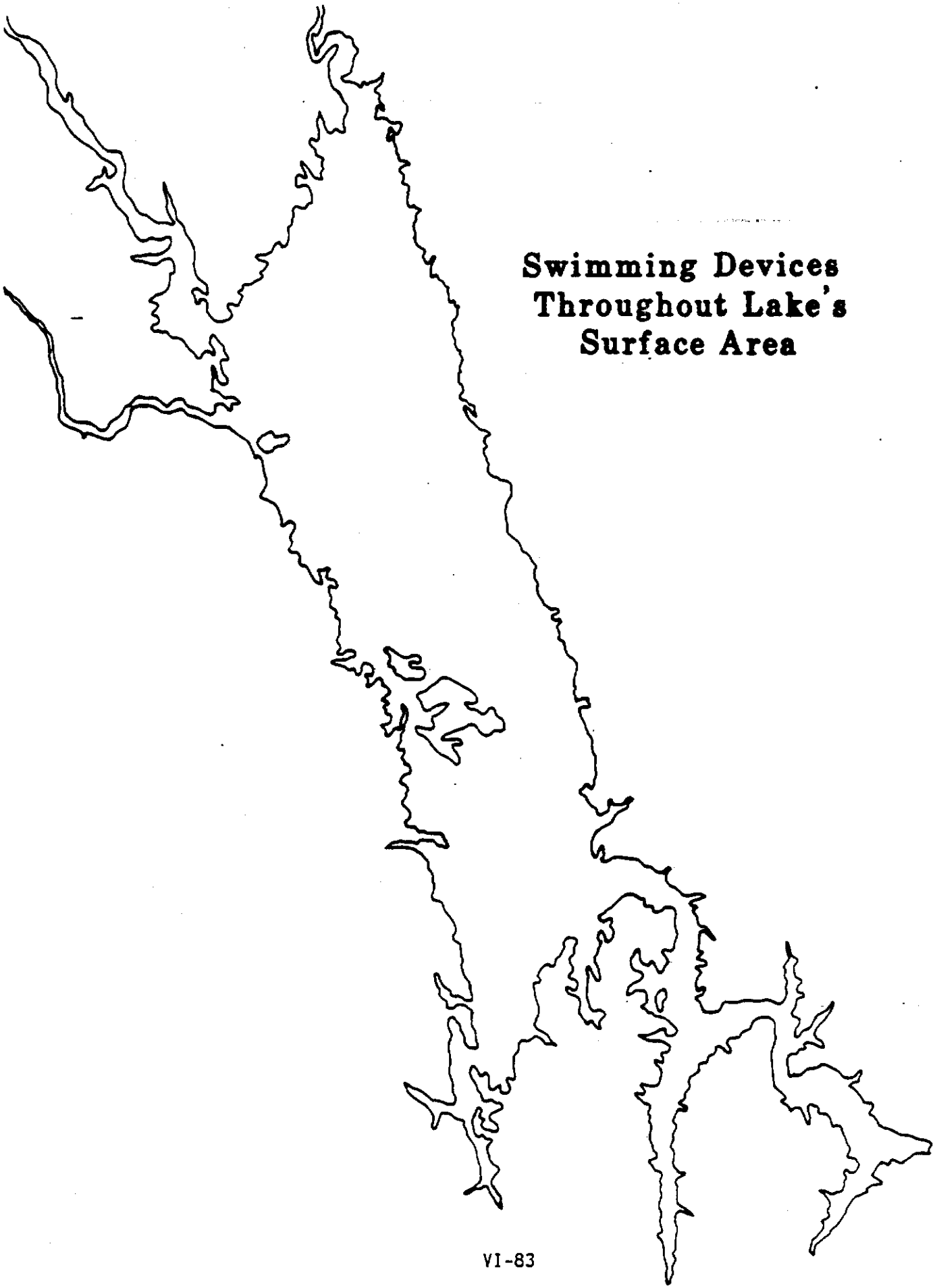

Swimming
Throughout Lake's
Surface Area

SWIMMING DEVICES - EXPERIENCE: Social

Activity description. - This activity is basically the same as swimming but with the assistance of flotation and propelling devices. The devices range from fins for the feet, to hand paddles, to styrofoam kick boards, and inflatable devices for kids' arms. There are numerous configurations of inflatable flotation toys ranging from simple rings to replicas of animals like alligators and dinosaurs. People try to get on top of and float on these devices. They are often used for "horseplay." The activity usually occurs during the recreation season.

Resource requirements. - Requirements are similar to a regular swimming area. There should be less than a 10-percent slope, sandy bottom, and fairly shallow water up to 4 feet deep. Use occurs most often in the summer months when the water and air temperatures are above 70 °F.

Figure VI-36. - Swimming devices



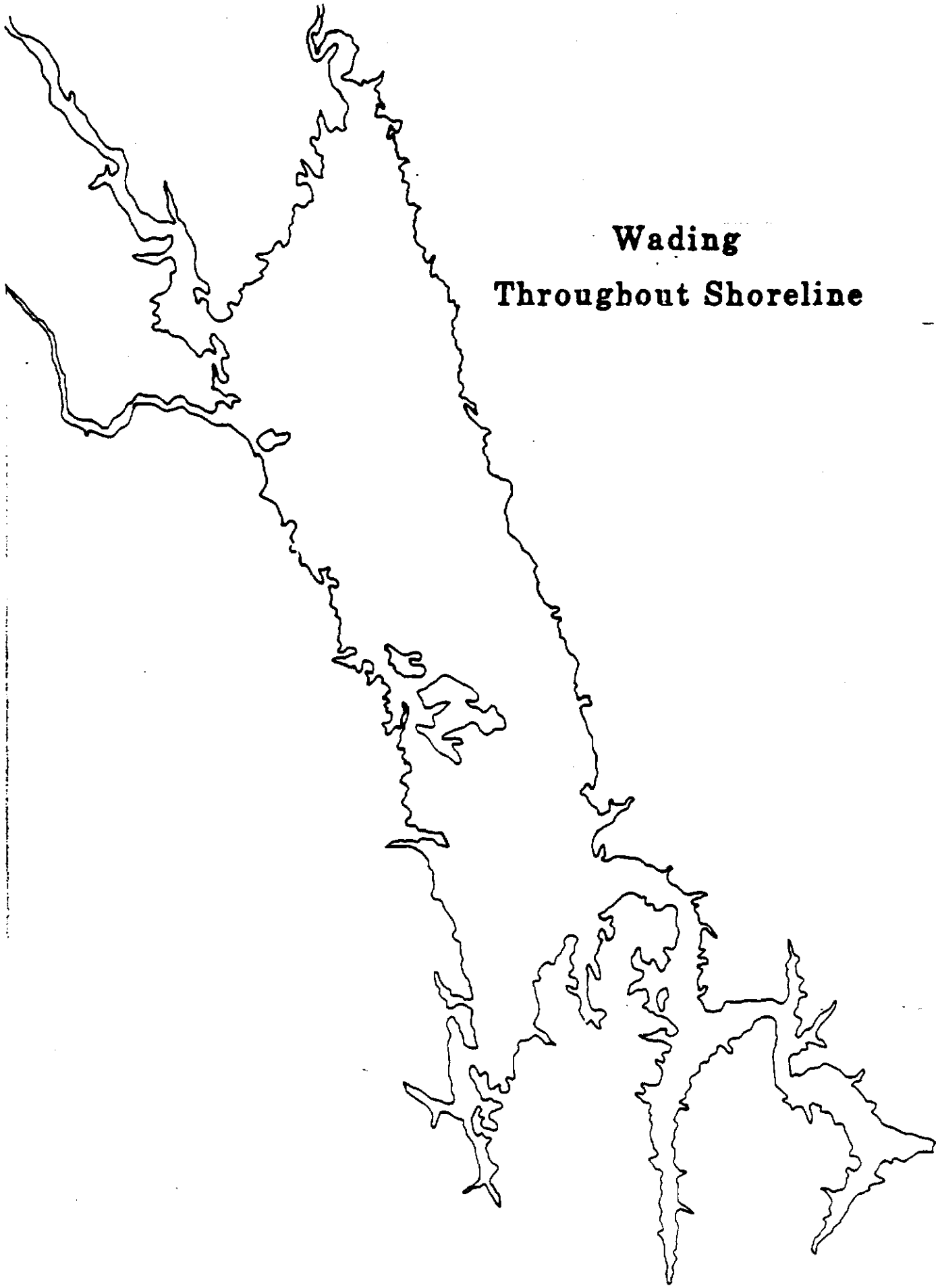
Swimming Devices Throughout Lake's Surface Area

WADING - EXPERIENCE: Solitary

Activity description. - Wading is walking in or through the water. People usually wade into the water no deeper than above the knee. Sometimes tennis or canvas shoes are worn so people do not hurt their feet on the lake bottom. Wading is an informal passive activity and can be participated in by an individual or several people together. People wade to cool themselves during hot days, splash, or explore for things such as flat rocks to skip on the water surface. The activity can occur day or night.

Resource requirements. - There are no recreation standards for wading. The activity requires access to the shoreline and physical characteristics that permit walking in the water. The characteristics include a firm sandy or rock bottom to support a person's weight, no mud or aquatic vegetation, an underwater gradient less than 12°, and a water temperature greater than 70 °F. Wading usually occurs during the warm recreation season.

Figure VI-37. - Wading


Wading
Throughout Shoreline

WATERSKIING - EXPERIENCE: Competent

Activity description. - Waterskiing occurs while being towed on two skis, one ski, or barefooted behind a motorboat. Speeds range from 12 mph for hydraulic lift, to 16 mph for beginning skiers, to learning to ski on one ski at 25 to 30 mph for top speed of a skiing novice, to competition and barefoot skiing at 36 mph, to a world record of 122 mph for speed skiing. Water ski towlines range from 40 to 50 feet for trick skiing, 75 feet standard length, and 150 to 200 feet for kite skiing. One to six skiers can be towed behind one boat depending on the horsepower and size of the boat.

Waterskiing is an exhilarating activity that can be participated in by a wide range of age groups of individuals that have the physical ability and stamina. There is excitement getting up on the skis and a thrill of staying up, executing turns, and jumping boat wakes. There is a wide range of equipment available for skiers, including flotation devices for safety in case of spills, and suits for warmth and bouyancy. Equipment can be purchased or may be rented from concessionaires. Waterskiing usually occurs in the warmer summer months at Lake Berryessa. With the use of wet suits, this activity occurs on a yearround basis at the lake.

Resource requirements. - Recreation standards for waterskiing range from 5 to 40 surface acres per unit. Petersen (1968) found some agencies use 60 surface acres per unit. See Appendix B. Most waterskiing requires large open areas with fairly calm waters. Anderson (1968) recommends water body dimensions of approximately 2,000 feet long and 1,000 feet wide (equivalent to 45.4 acres) and at least 300 feet in which to turn. Waves less than 1 foot high can be acceptable. Waves tend to accelerate the rate of becoming physically tired and shorten the experience. A minimum depth of 3 feet is needed for takeoff and

landing at the staging site. A minimum of 5 feet is needed during this experience. The authors prefer 6 feet.

The towboat must have sufficient power for hydraulic lift and to sustain that lift during the skiing experience. There must be at least two people in the boat - an observer for the skier and a driver. Water temperatures should be about 70°F or higher. Personal flotation devices ranging from ski belts to full vests to wet suits, are required to keep downed water skiers afloat until the towboat retrieves them. Some States advise use of fluorescent color flotation devices so the downed water skier is more conspicuous to other boat traffic. Areas used for waterskiing should be free of aquatic vegetation. The air temperature should be at least 70°F.

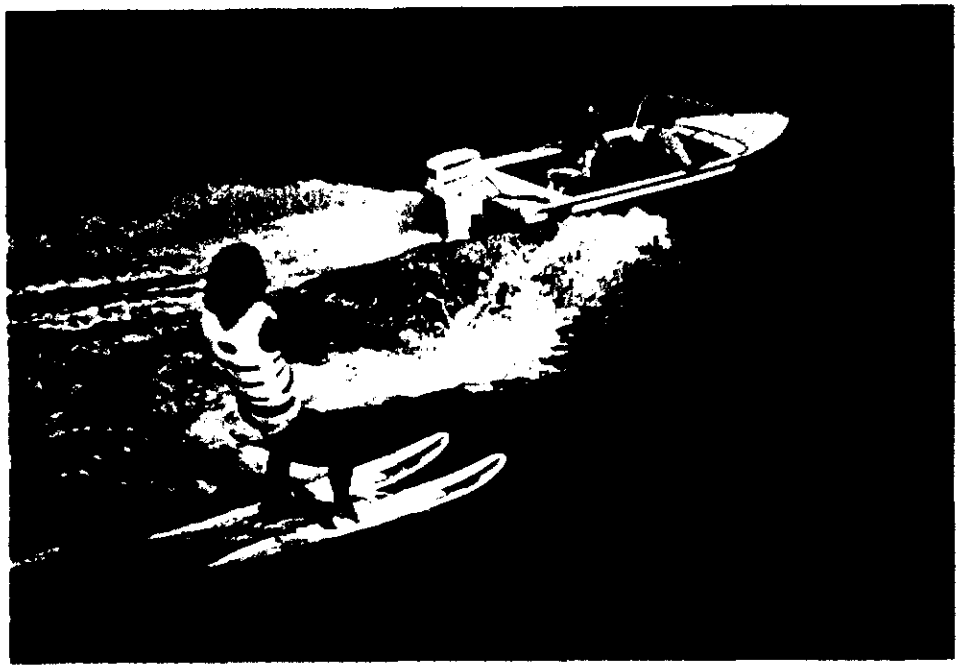
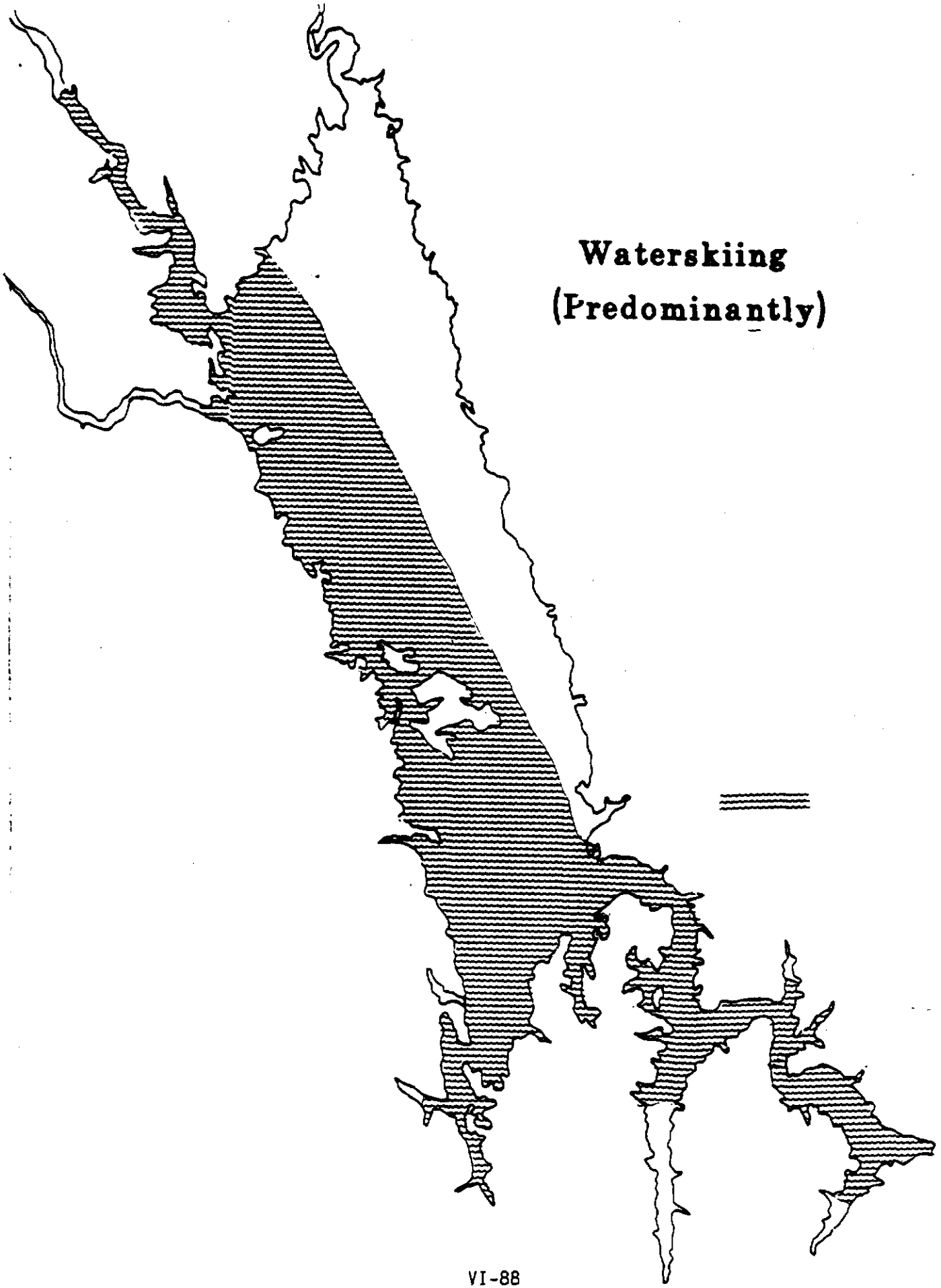


Figure VI-38. - Waterskiing


Waterskiing
(Predominantly)

WET BICYCLING - EXPERIENCE: Social

Activity description. - Wet bicycling is really the use of a tricycle designed for one or two people. The wheels are like tractor tires with a "tread" designed for propulsion in the back and a front tire designed for steering. The tires provide the flotation. A bicycle crank with pedals, sprocket, and a chain drive to the rear wheels is turned by the participants' feet and legs. It moves 1 to 3 mph. Concessions usually rent wet bicycles during the recreation season. The activity usually occurs during the warmer times of the day.

Resource requirements. - Wet bicycling requires little or no wind, waves less than 1 foot high, and water at least 2 feet deep for flotation. Water and air temperatures should be above 70 °F. Wet bikes cannot effectively compete with motorized activities for the use of common space. The use of wet bikes should be within a quarter mile of the shore.

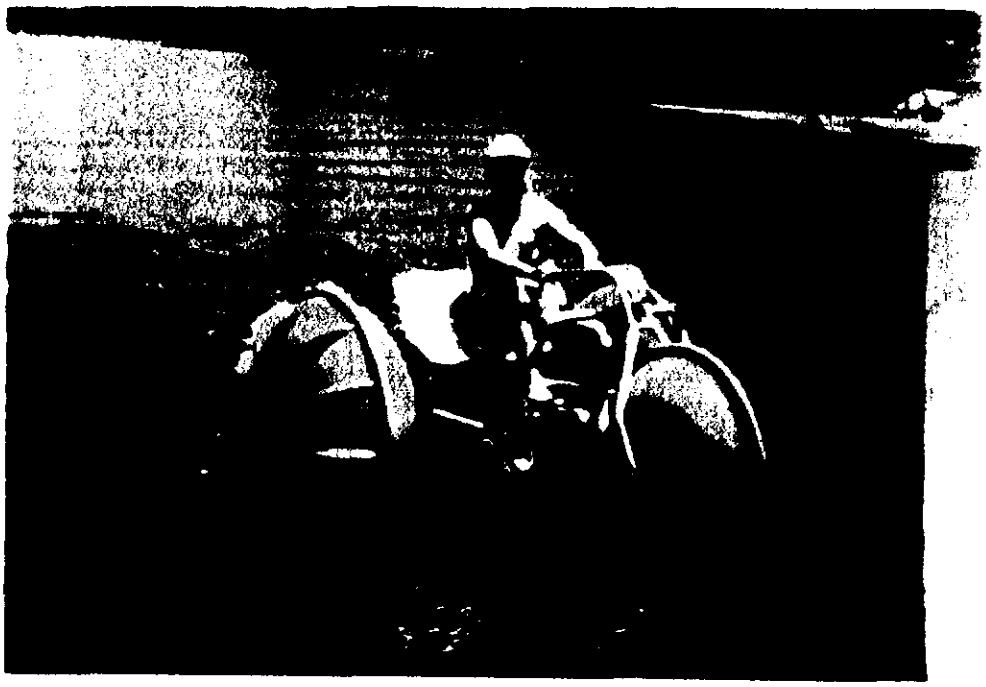
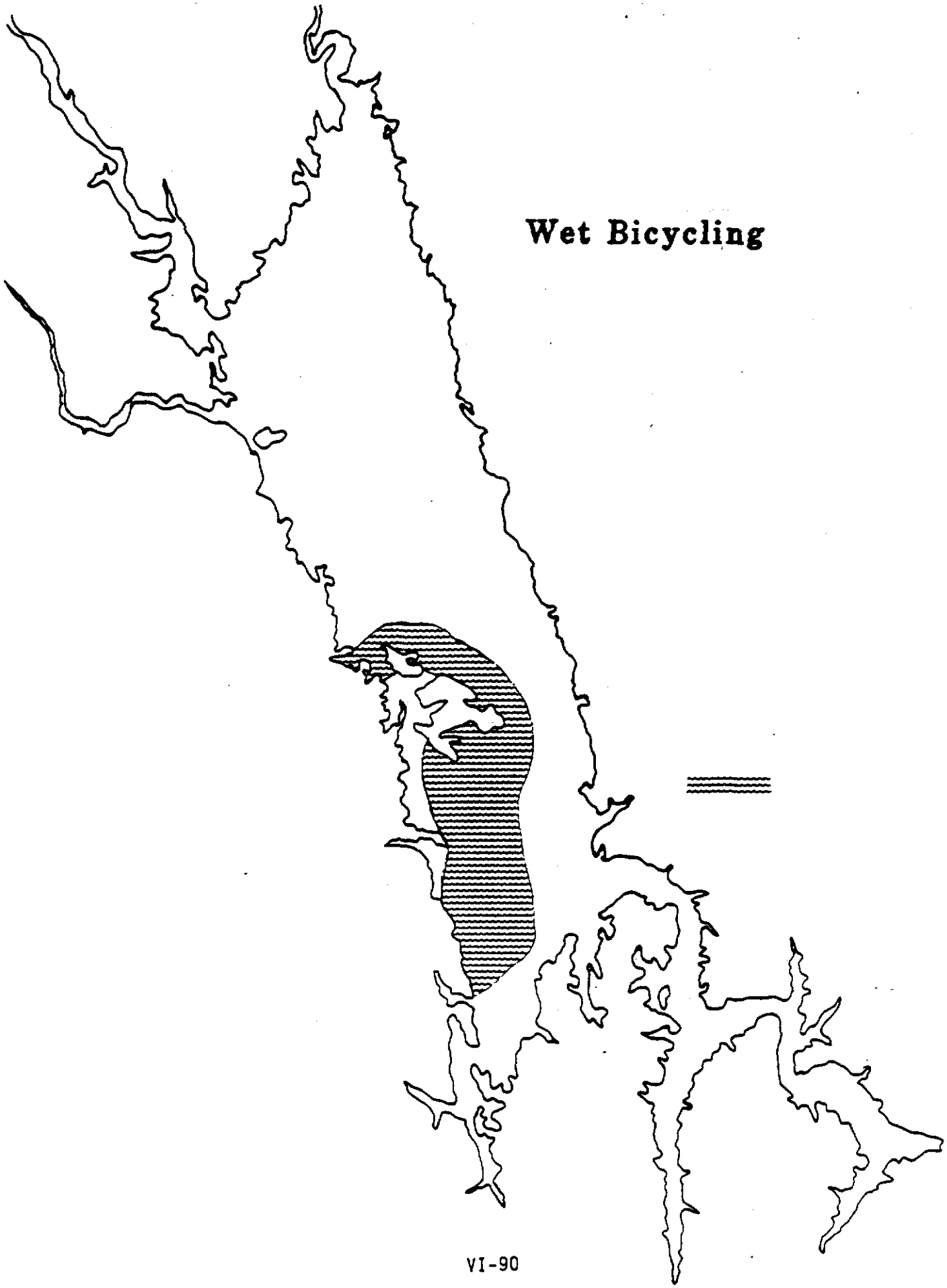


Figure VI-39. - Wet bicycling


Wet Bicycling

WIENER RIDING - EXPERIENCE: Risk

Activity description. - Wiener riding is a new activity involving four to five people riding an inflated "salami shaped" 12- by 2-foot pontoon behind a power towboat. Speeds range up to 20 mph. The skill involved is staying on the wiener. The activity usually occurs during the warmer times of the day.

Resource requirements. - There are no recreation standards for wiener riding. Water depth requirements are at least 2 feet for staging and flotation, to 5 feet minimum while being towed. Wave height would range from calm to 2 feet. Water and air temperature would be a minimum of 70°F with warmer temperatures preferred. Wet suits would help people tolerate cooler temperatures and would provide flotation when they fall off of the wiener. This activity usually occurs during the warm recreation season.

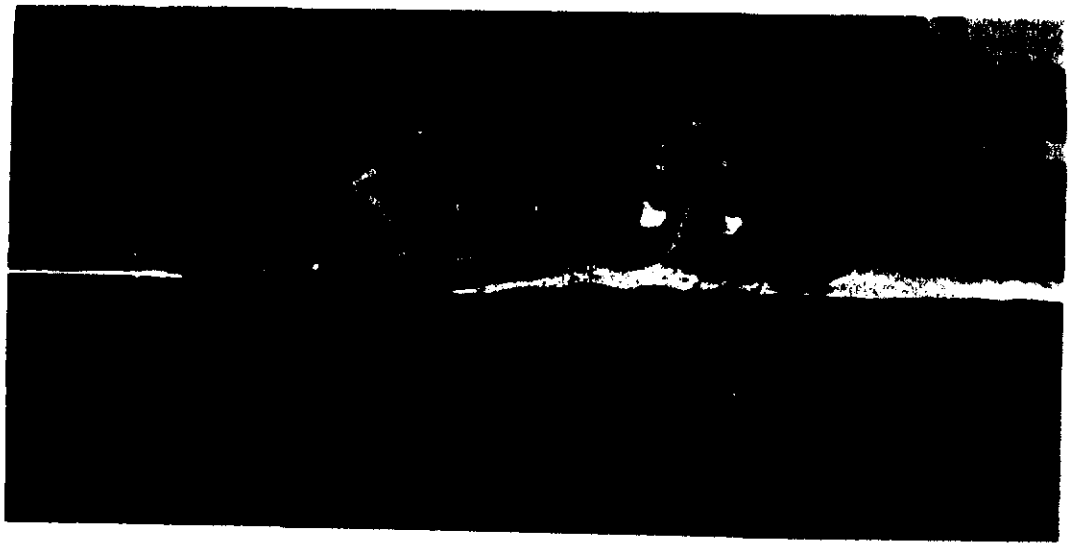
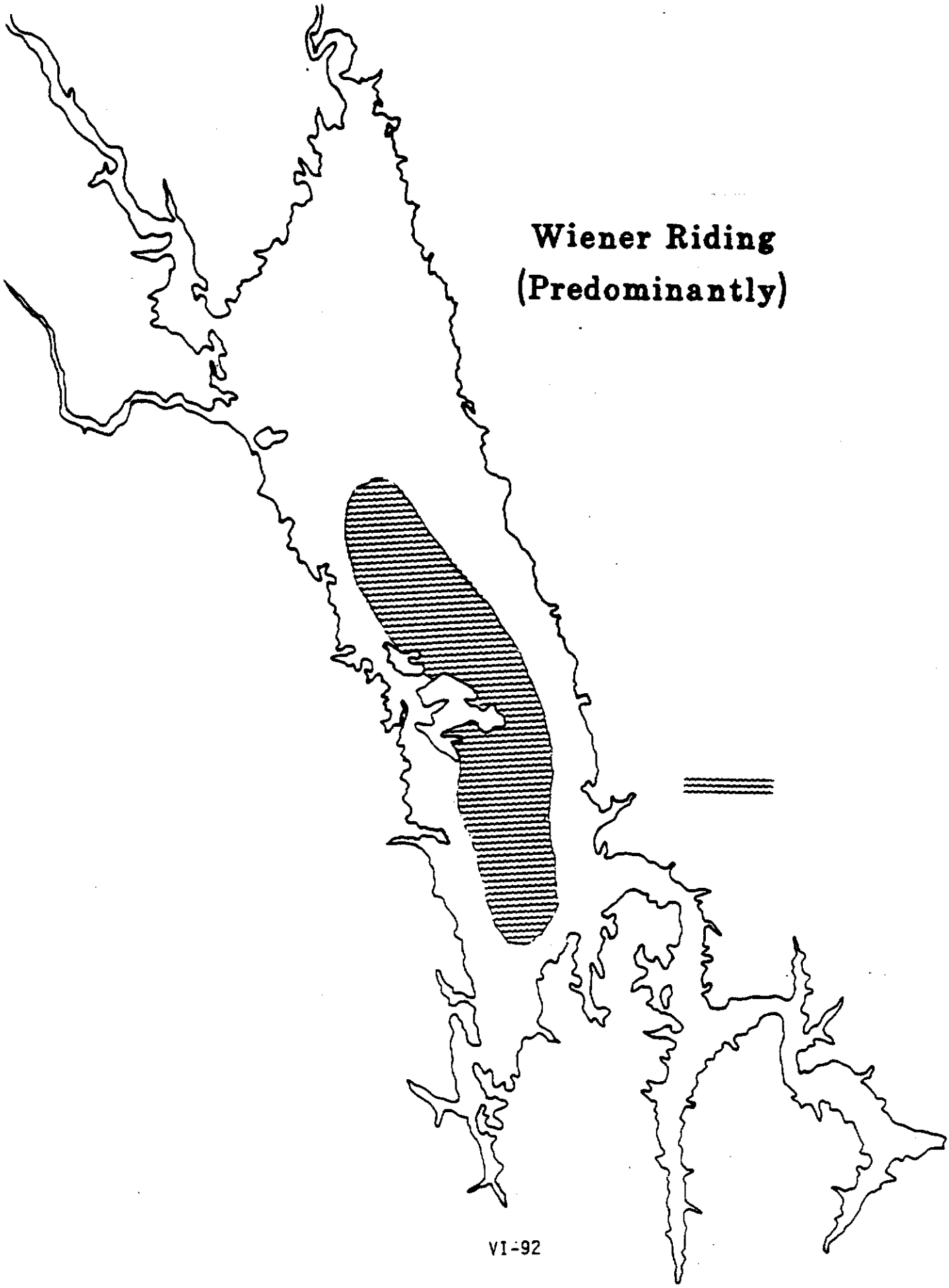


Figure VI-40. - Wiener riding


Wiener Riding
(Predominantly)

SWIMMING COMPETITION - EXPERIENCE: Competition

Activity description. - Usually 800 to 1,000 participants are actively involved in the swim competition. The minimum age requirement is 19 years. The event was established by the Davis Aquatic Masters. The triangular swimming course extends 2 miles out from Acorn Swim Beach into the lake. Participants compete among one another and the clock for first place honors. This activity usually occurs on the first weekend in June.

Resource requirement. - There are no recreation capacity standards for this activity. This swimming event is coordinated between the Bureau of Reclamation and the Davis Aquatic Masters. This swim competition requires a minimum depth of 3-1/2 feet of water or more. Preferably the starting and ending points are sandy beaches free of sharp rocks and other obstacles. The optimum water temperature ranges from 60°F to the mid- 70°F. For best swimming conditions during this activity, boat traffic is held to a minimum through the cooperative efforts of the Bureau of Reclamation and the Napa County Sheriff's boat patrol.

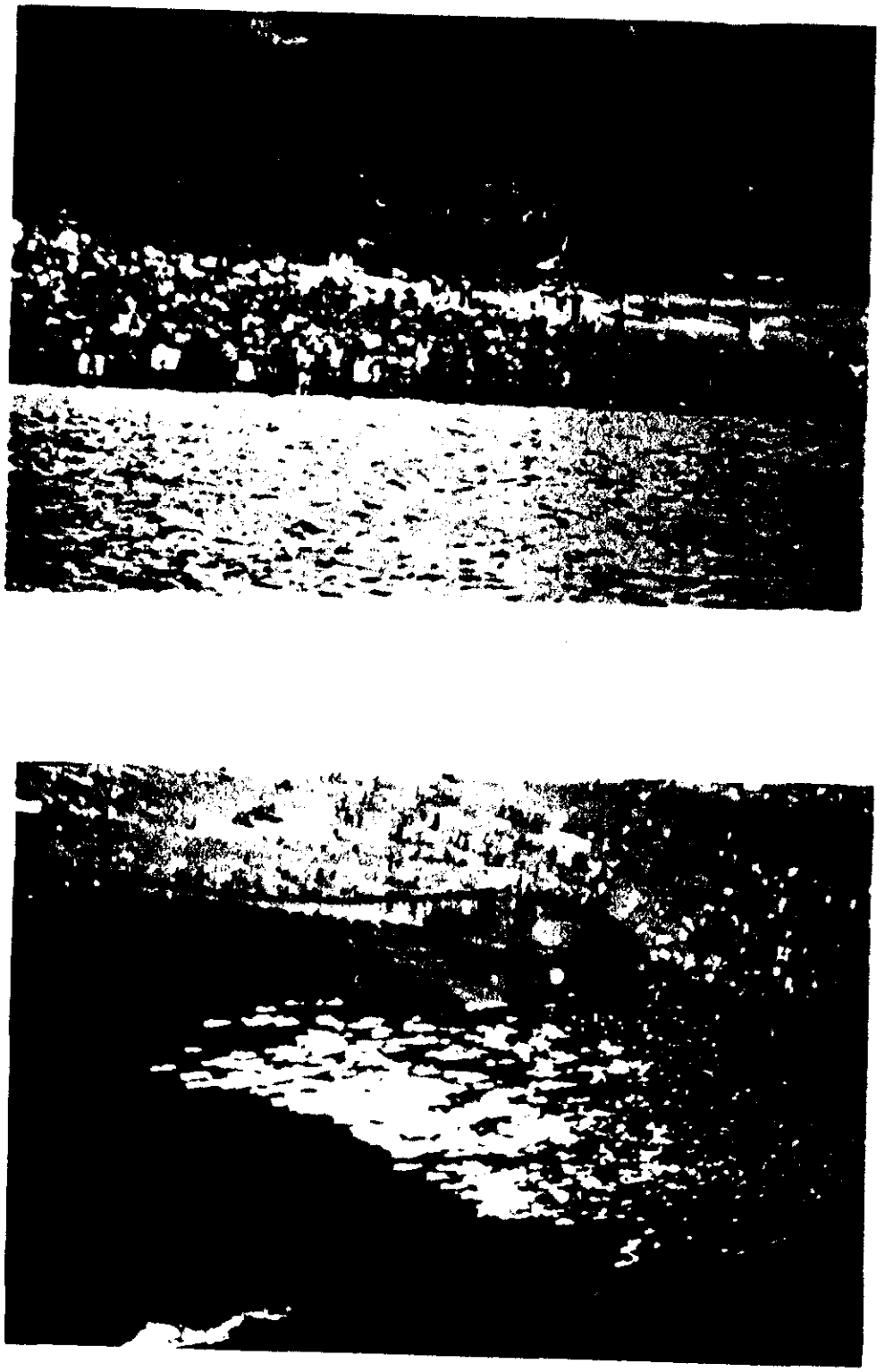
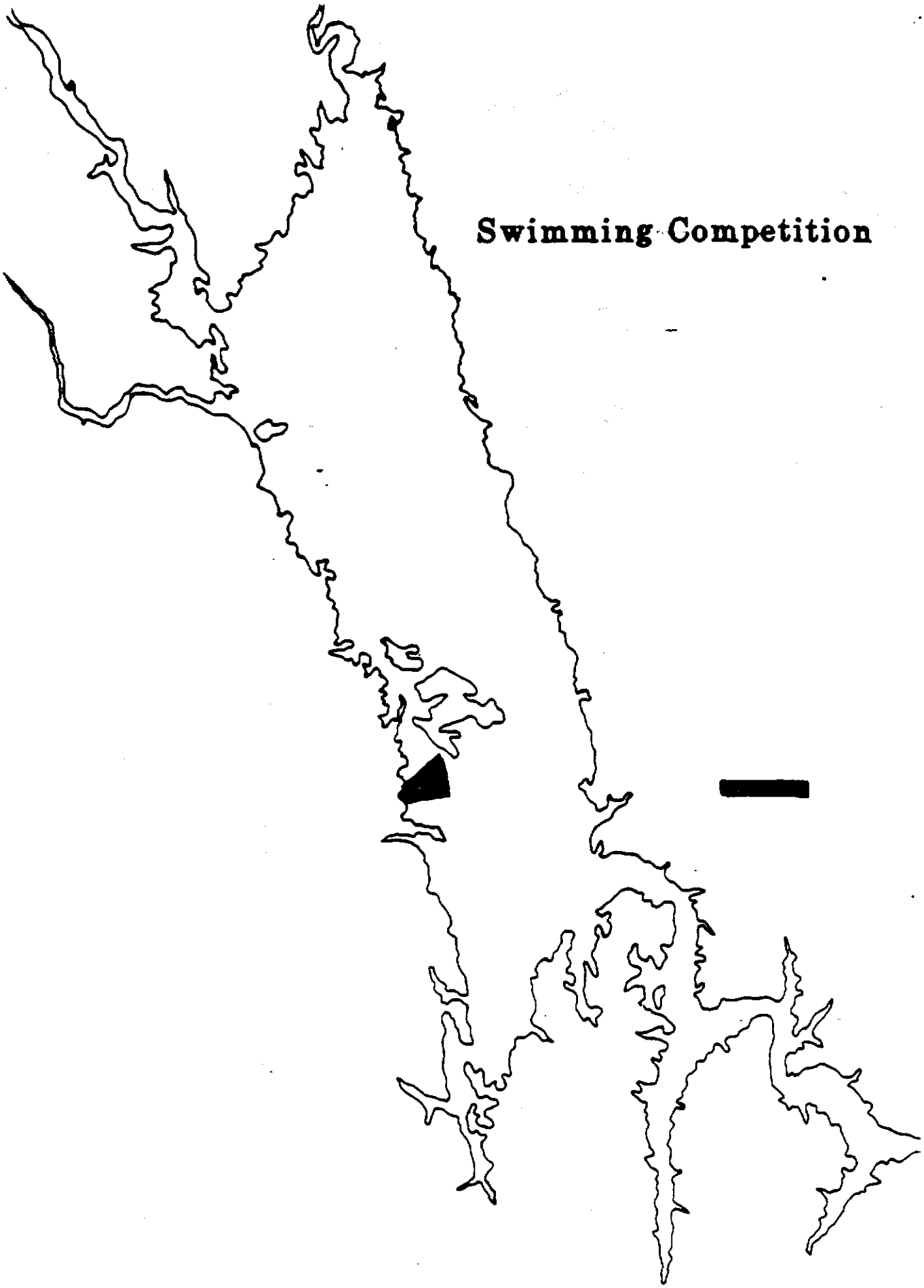


Figure VI-41. - Swim competition


Swimming Competition

TOURNAMENT FISHING - EXPERIENCE: Competent

Activity description. - Tournament fishing is sponsored by organizations such as the Western Bass Association. The common species of fish desired is usually the largemouth and/or smallmouth bass. The tournaments usually begin in January and end in April. There are approximately 100 to 300 participants who fish from boats. The tournaments start at approximately sunrise and end at approximately 3:00 p.m. Check-in and weigh-in are usually held at Spanish Flat Resort at 3:30 p.m.

Resource requirements. - There are no recreation standards for this activity. Competition fishing requires a boat with a large engine to enable coverage of the large surface area of the lake, thus improving one's potential for catching more fish. Water depths for fishing range from 8 feet to 50 feet on the average. The coves and inlets provide the angler the best fishing opportunity for success. Minimum size limits are 12 inches with a possession limit of five fish.

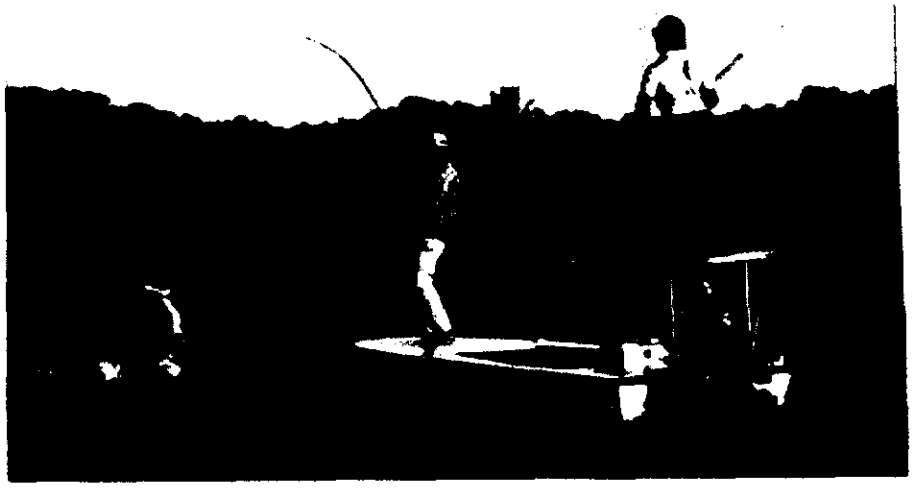
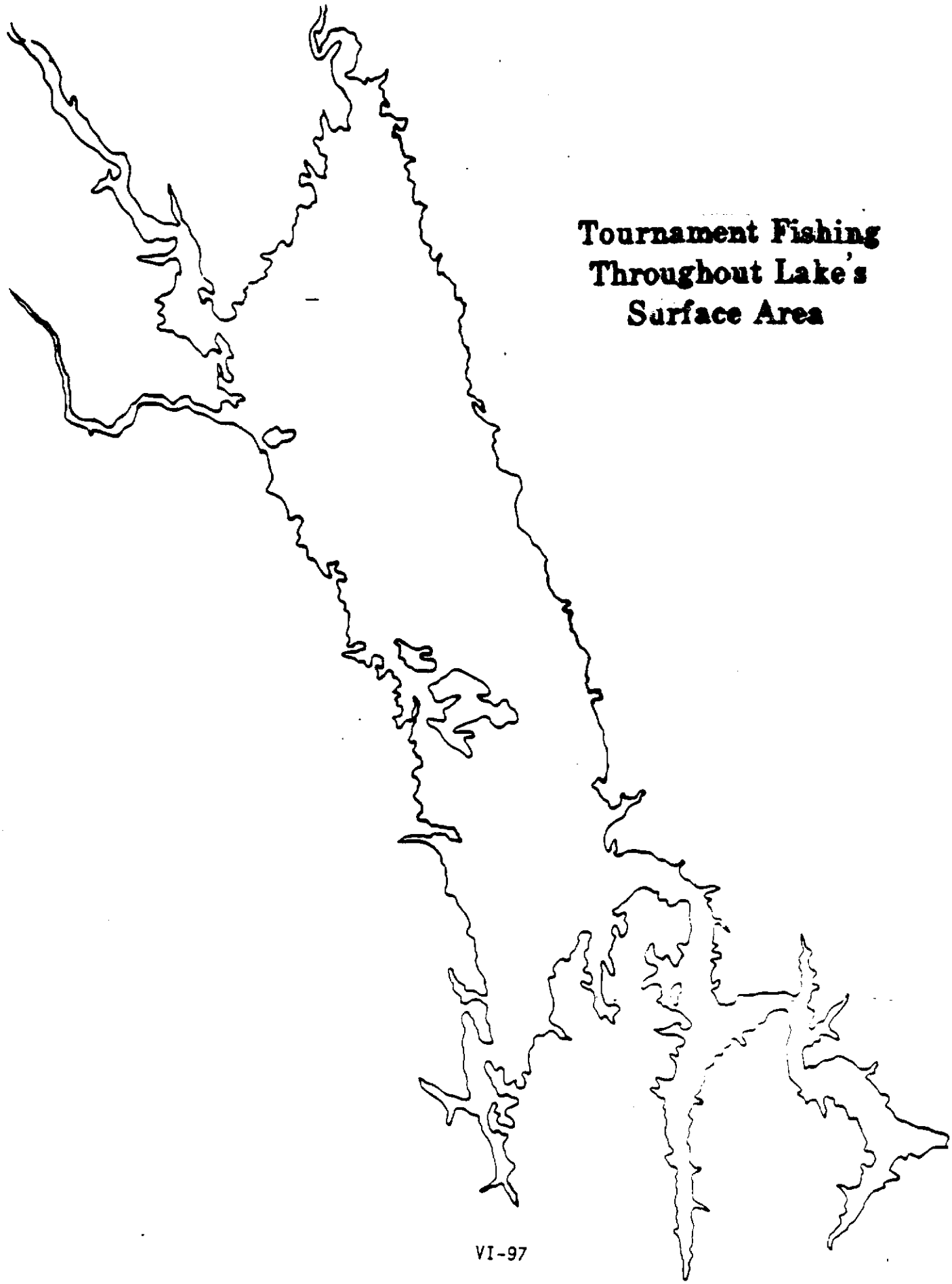


Figure VI-42. - Tournament fishing


Tournament Fishing
Throughout Lake's
Surface Area

BIATHLON - EXPERIENCE: Competent

Activity description. - This activity is held twice a year, usually during the months of September and October when the recreation activities are at a minimum. There are approximately 150 participants in each of the two events. This event requires strong swimming and bicycling skills.

Resource requirements. - There are no recreation resource standards for this activity. Resource requirements are reduced boating activity, no aquatic vegetation, minimum water depth of 5 feet, and water temperatures in the middle 60's are ideal for this activity. After the swimming part of this event, the participants bicycle from Oak Shores Park north to Eticura Creek (approximately 13 miles north of Oak Shores Park) and return. The Napa County Sheriff's Department and the Bureau of Reclamation's Ranger Division safe-guard the activity in the water and on the highway.

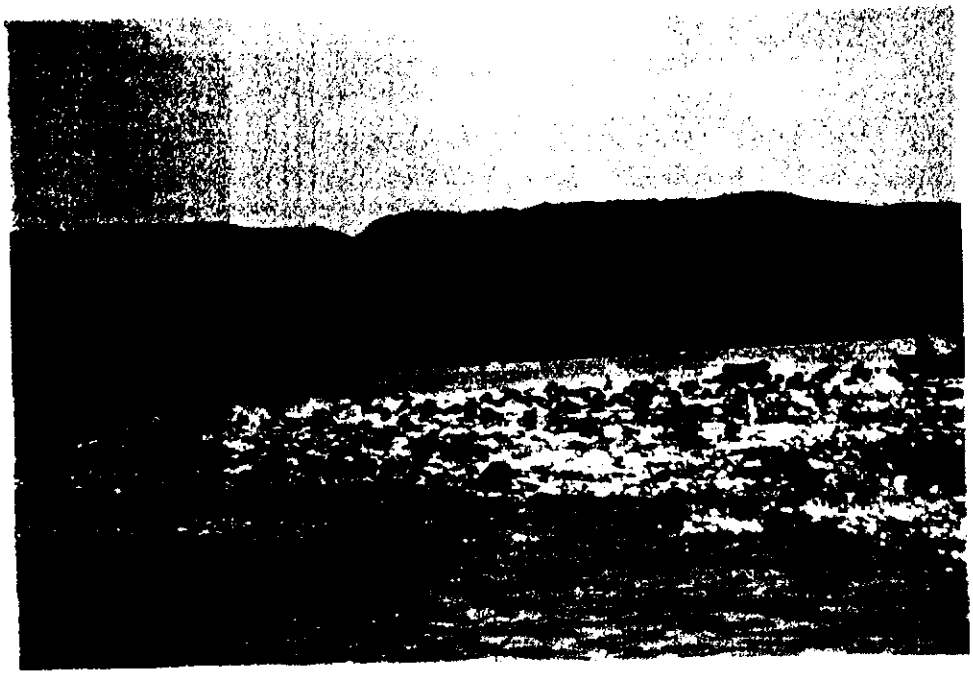
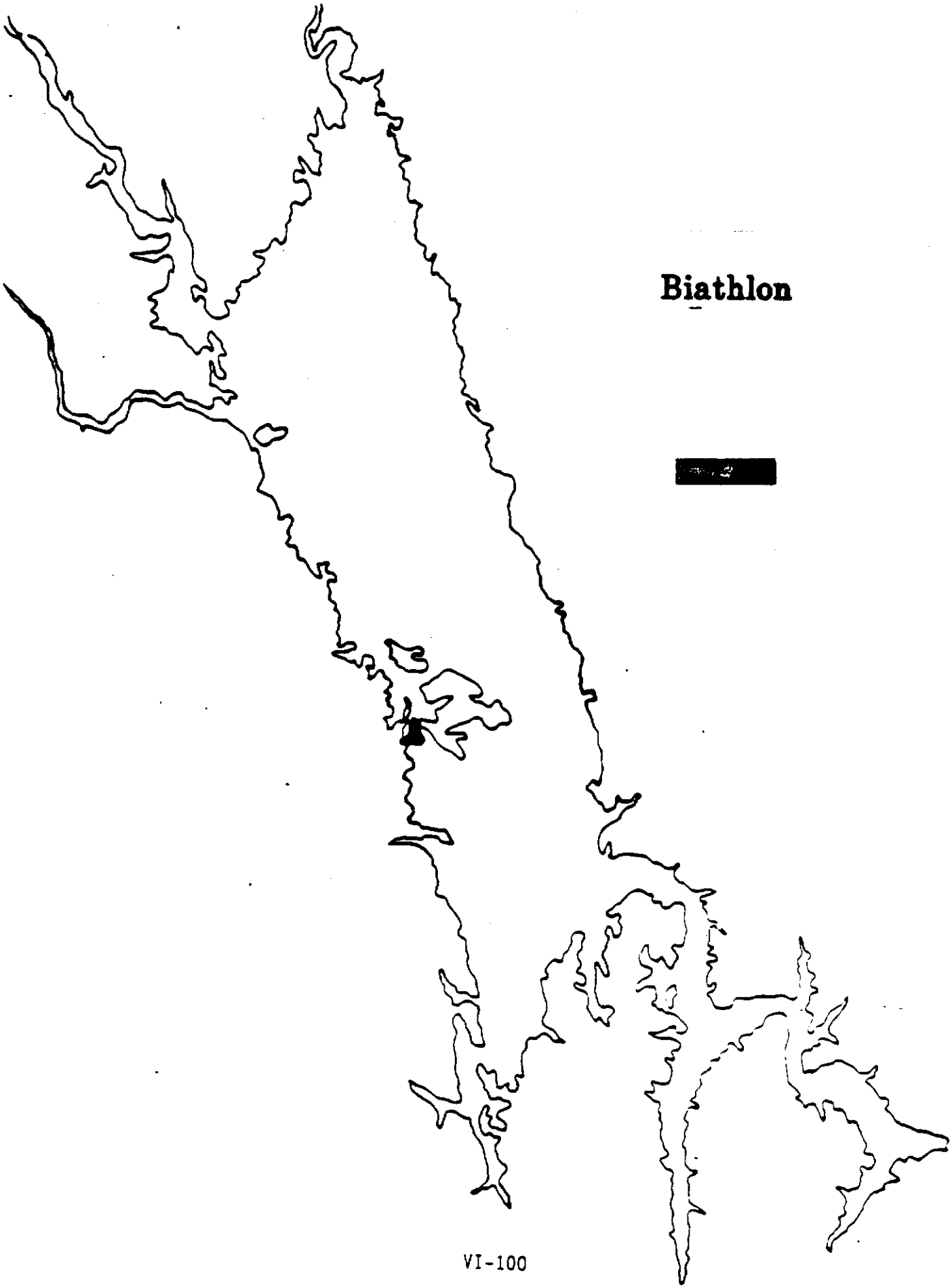


Figure VI-43. - Biathlon biking and swimming


Biathlon

TRIATHLON - EXPERIENCE: Competent

Activity description. - The triathlon is usually held during a weekend in mid-September, with approximately 125 participants. The event consists of a 2-mile swim, a 2-mile run, and 26 miles of bicycling. The swimming and running part of the event takes place in Oak Shores Park area, and the bicycling event to Eticura Creek ends upon return to the entrance station at Oak Shores Park.

Resource requirements. - There are no recreation resource standards for this activity. However, in order for this activity to run smoothly, boating and vehicle traffic must be controlled in Oak Shores Park and on the highway. Water temperature is in the 60's; water depths should be 5 feet or greater. The Napa County Sheriff's Department and the Bureau of Reclamation's Ranger Division provide the safe-guarding in the water and on the highway.

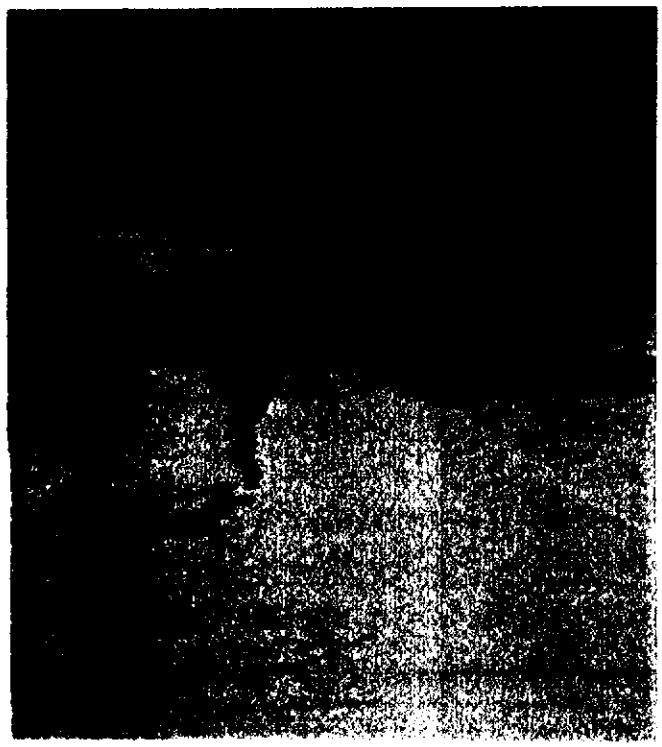
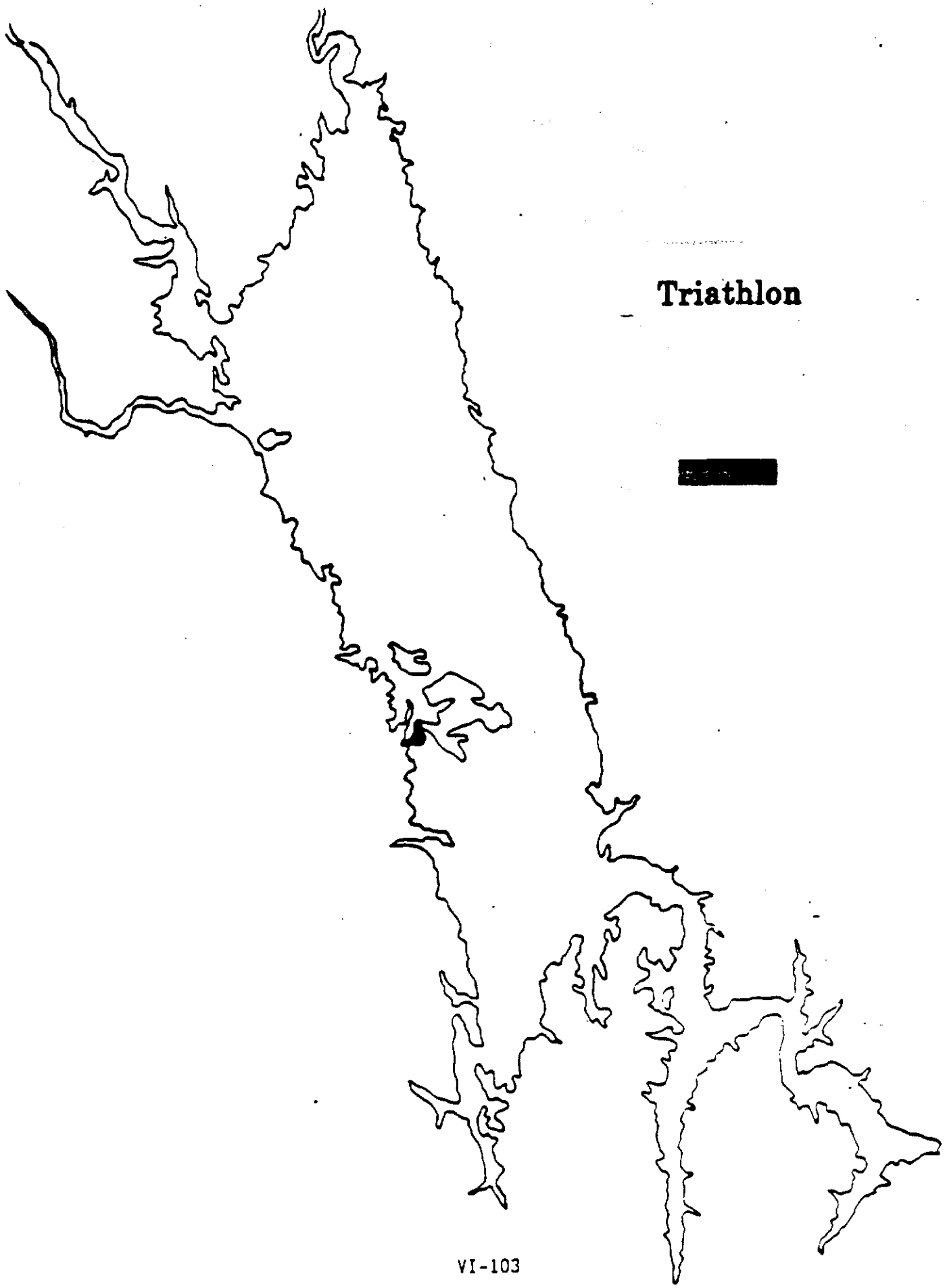


Figure VI-44. - Triathlon run

Triathlon swimming and biking


Triathlon
[redacted]

SAILING REGATTA - EXPERIENCE: Competent

Activity description. - The regattas usually take place during summer holiday weekends with approximately 50 to 150 participants. Points of entry are Lake Berryessa Marina and Rancho Monticello Resorts. The vessels sail north toward Big Island and onto the main body of the lake. Vessel speeds range from 5 to 20 mph.

Resource requirements. - There are no recreation standards for this activity. Minimum water depths are at least 6 feet. Light winds and wave action less than 1 foot high are preferred as well as air temperatures in the middle 80's. Vessels range from 12 to 18 feet in length and usually carry one to three passengers. Other boats need to be kept outside of the race course area.

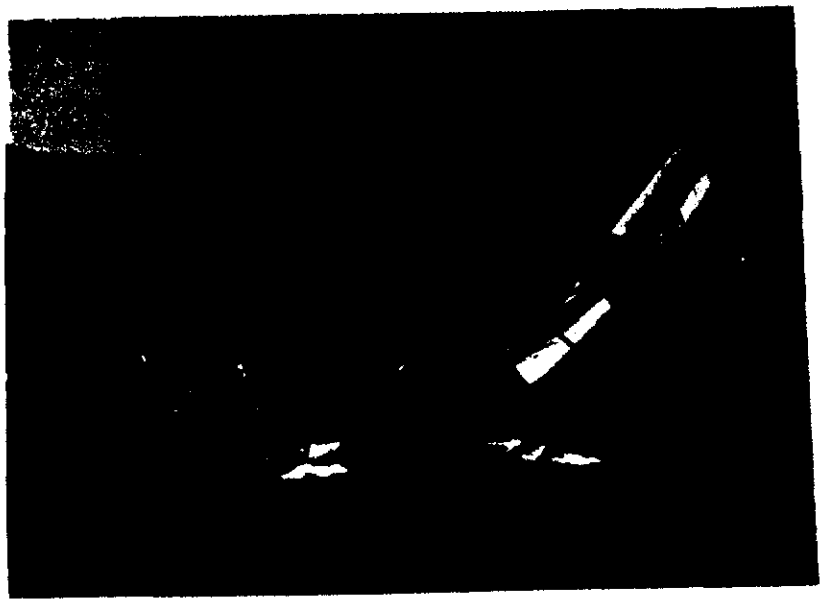
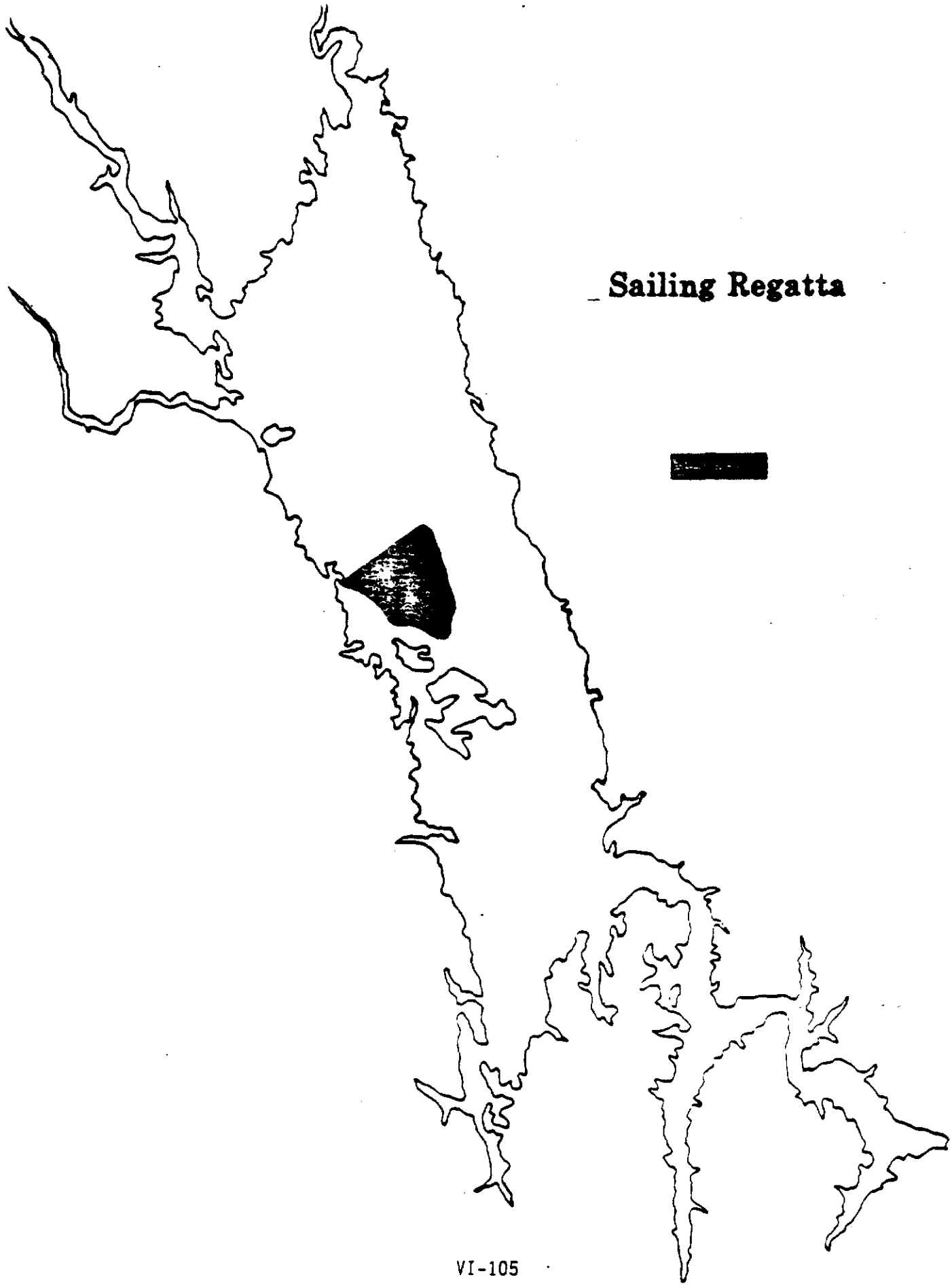


Figure VI-45. - Sailing regatta


Sailing Regatta