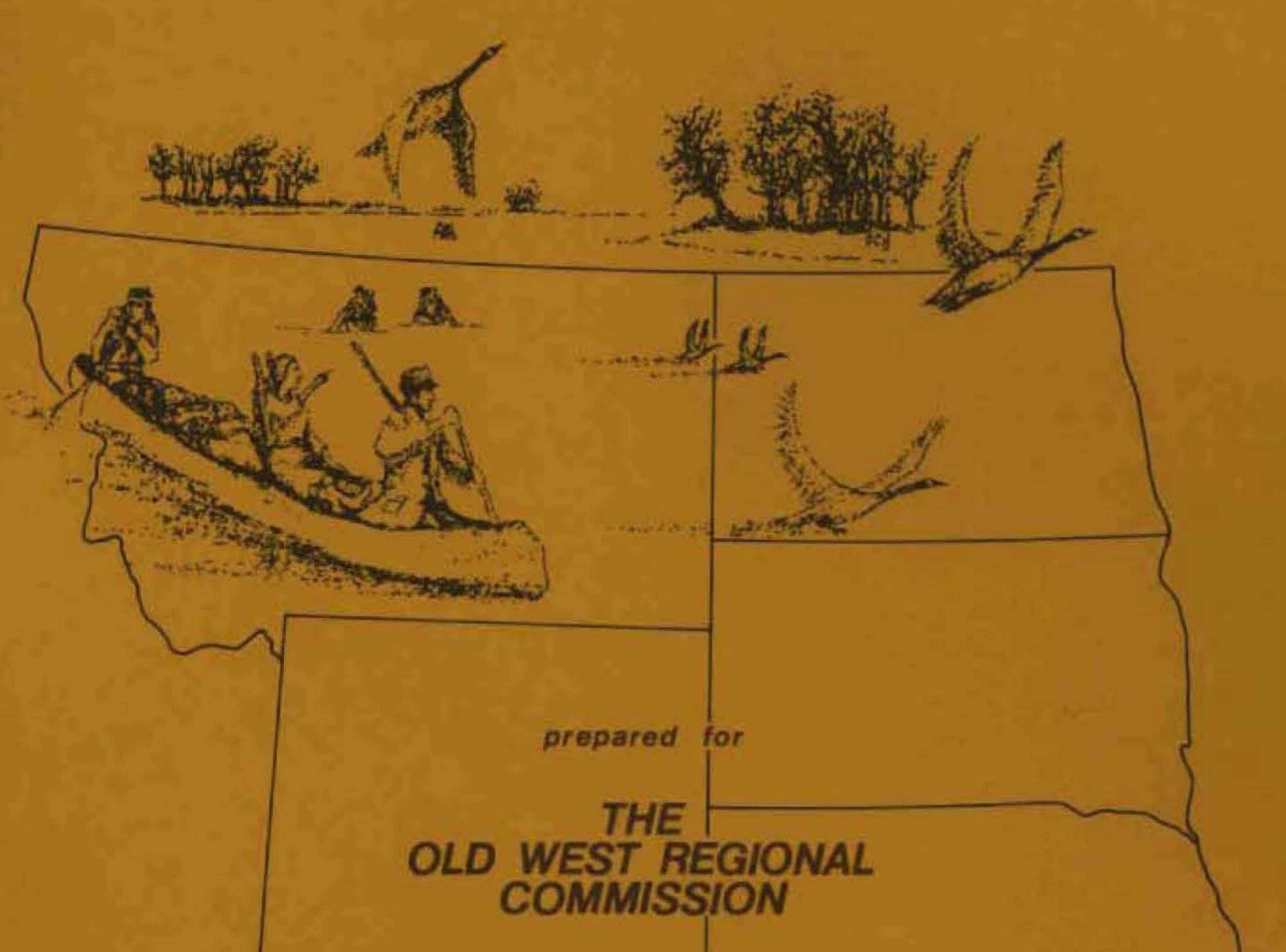
The effect of altered streamflow on furbearing mammals of the Yellowstone River Basin, Montana

YELLOWSTONE IMPACT STUDY

TECHNICAL REPORT NO. 6



prepared for

THE OLD WEST REGIONAL COMMISSION

by

DNRC WATER RESOURCES DIVISION — JULY 1977

MONTANA DEPARTMENT OF NATURAL RESOURCES & CONSERVATION

The effect of altered streamflow on furbearing mammals of the Yellowstone River Basin, Montana

by

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conducted by the

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July 1977

The Old West Regional Commission is a Federal-State partnership designed to solve regional economic problems and stimulate orderly economic growth in the states of Montana, Nebraska, North Dakota, South Dakota and Wyoming. Established in 1972 under the Public Works and Economic Development Act of 1965, it is one of seven identical commissions throughout the country engaged in formulating and carrying out coordinated action plans for regional economic development.

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FOREWORD

The Old West Regional Commission wishes to express its appreciation for this report to the Montana Department of Natural Resources and Conservation, and more specifically to those Department staff members who participated directly in the project and in preparation of various reports, to Dr. Kenneth A. Blackburn of the Commission staff who coordinated the project, and to the subcontractors who also participated. The Yellowstone Impact Study was one of the first major projects funded by the Commission that was directed at investigating the potential environmental impacts relating to energy development. The Commission is pleased to have been a part of this important research.

George D. McCarthy
Federal Cochairman

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Abbreviations used in this report

af	= acre-feet
af/y	= acre-feet per year
cfs	= cubic feet per second
cm	= centimeter
DFG	= Montana Department of Fish and Game
km	= kilometer
km^3	= cubic kilometers
m	= meter
mi	= mile
mmaf	= million acre-feet
mmt/y	= million tons per year
tr	= trace
USGS	= United States Geological Survey

Preface

THE RIVER

The Yellowstone River Basin of southeastern Montana, northern Wyoming, and western North Dakota encompasses approximately 180,000 km^2 (71,000 square miles), 92,200 (35,600) of them in Montana. Montana's portion of the basin comprises 24 percent of the state's land; where the river crosses the border into North Dakota, it carries about 8.8 million acre-feet of water per year, 21 percent of the state's average annual outflow. The mainstem of the Yellowstone rises in northwestern Wyoming and flows generally northeast to its confluence with the Missouri River just east of the Montana-North Dakota border; the river flows through Montana for about 550 of its 680 miles. The major tributaries, the Boulder, Stillwater, Clarks Fork, Bighorn, Tongue, and Powder rivers, all flow in a northerly direction as shown in figure 1. The western part of the basin is part of the middle Rocky Mountains physiographic province; the eastern section is located in the northern Great Plains (Rocky Mountain Association of Geologists 1972).

THE CONFLICT

Historically, agriculture has been Montana's most important industry. In 1975, over 40 percent of the primary employment in Montana was provided by agriculture (Montana Department of Community Affairs 1976). In 1973, a good year for agriculture, the earnings of labor and proprietors involved in agricultural production in the fourteen counties that approximate the Yellowstone Basin were over $141 million, as opposed to $13 million for mining and $55 million for manufacturing. Cash receipts for Montana's agricultural products more than doubled from 1968 to 1973. Since that year, receipts have declined because of unfavorable market conditions; some improvement may be in sight, however. In 1970, over 75 percent of the Yellowstone Basin's land was in agricultural use (State Conservation Needs Committee 1970). Irrigated agriculture is the basin's largest water use, consuming annually about 1.5 million acre-feet (af) of water (Montana DNRC 1977).

There is another industry in the Yellowstone Basin which, though it consumes little water now, may require more in the future, and that is the coal development industry. In 1971, the North Central Power Study (North Central Power Study Coordinating Committee 1971) identified 42 potential power plant sites in the five-state (Montana, North and South Dakota, Wyoming, and Colorado) northern Great Plains region, 21 of them in Montana. These plants, all to be fired by northern Great Plains coal, would generate 200,000 megawatts (mw) of electricity, consume 3.4 million acre-feet per year (mmaf/y) of water, and result in a large population increase. Administrative, economic, legal, and technological considerations have kept most of these conversion facilities, identified in the North Central Power Study as necessary for 1980, on the drawing board or in the courtroom. There is now no chance of their being completed by that date or even soon after, which will delay and diminish the economic benefits some basin residents had expected as a result of coal development. On the other hand, contracts have been signed for the mining of large amounts of Montana coal, and applications have been approved not only for new and expanded coal mines but also for Colstrip Units 3 and 4, twin 700-mw, coal-fired, electric generating plants.

In 1975, over 22 million tons of coal were mined in the state, up from 14 million in 1974, 11 million in 1973, and 1 million in 1969. By 1980, even if no new contracts are entered, Montana's annual coal production will exceed 40 million tons. Coal reserves, estimated at over 50 billion economically strippable tons (Montana Energy Advisory Council 1976), pose no serious constraint to the levels of development projected by this study, which range from 186.7 to 462.8 million tons stripped in the basin annually by the year 2000. Strip mining itself involves little use of water. How important the energy industry becomes as a water user in the basin will depend on: 1) how much of the coal mined in Montana is exported, and by what means, and 2) by what process and to what end product the remainder is converted within the state. If conversion follows the patterns projected in this study, the energy industry will use from 48,350 to 326,740 af of water annually by the year 2000.

A third consumptive use of water, municipal use, is also bound to increase as the basin population increases in response to increased employment opportunities in agriculture and the energy industry.

Can the Yellowstone River satisfy all of these demands for her water? Perhaps in the mainstem. But the tributary basins, especially the Bighorn, Tongue, and Powder, have much smaller flows, and it is in those basins that much of the increased agricultural and industrial water demand is expected.

Some impacts could occur even in the mainstem. What would happen to water quality after massive depletions? How would a change in water quality affect existing and future agricultural,industrial, and municipal users? What would happen to fish, furbearers, and migratory waterfowl that are dependent on a certain level of instream flow? Would the river be as attractive a place for recreation after dewatering?

One of the first manifestations of Montana's growing concern for water in the Yellowstone Basin and elsewhere in the state was the passage of significant legislation. The Water Use Act of 1973, which, among other things, mandates the adjudication of all existing water rights and makes possible the reservation of water for future beneficial use, was followed by the Water Moratorium Act of 1974, which delayed action on major applications for Yellowstone Basin water for three years. The moratorium, by any standard a bold action, was prompted by a steadily increasing rush of applications and filings for water (mostly for industrial use) which, in two tributary basins to the Yellowstone, exceeded supply. The DNRC's intention during the moratorium was to study the basin's water and related land resources, as well as existing and future need for the basin's water, so that

Yellowstone River Basin

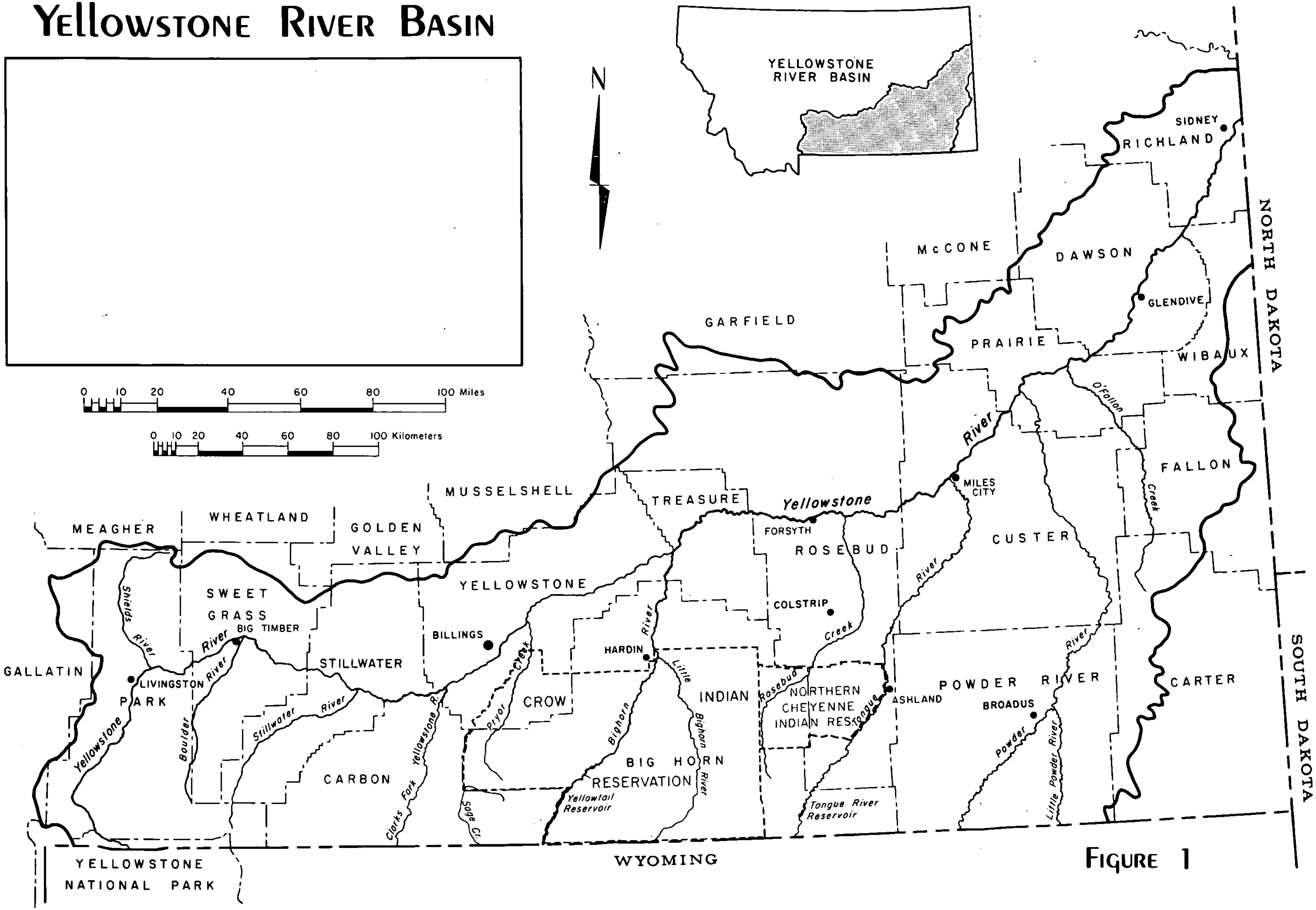

FIGURE 1

the state would be able to proceed wisely with the allocation of that water. The study which resulted in this series of reports was one of the fruits of that intention. Several other Yellowstone water studies were undertaken during the moratorium at the state and federal levels. Early in 1977, the 45th Montana Legislature extended the moratorium to allow more time to consider reservations of water for future use in the basin.

THE STUDY

The Yellowstone Impact Study, conducted by the Water Resources Division of the Montana Department of Natural Resources and Conservation and financed by the Old West Regional Commission, was designed to evaluate the potential physical, biological, and water use impacts of water withdrawals and water development on the middle and lower reaches of the Yellowstone River Basin in Montana. The study's plan of operation was to project three possible levels of future agricultural, industrial, and muncipal development in the Yellowstone Basin and the streamflow depletions associated with that development. Impacts on river morphology and water quality were then assessed, and, finally, the impacts of altered streamflow, morphology, and water quality on such factors as migratory birds, furbearers, recreation, and existing water users were analyzed.

The study began in the fall of 1974. By its conclusion in December of 1976, the information generated by the study had already been used for a number of moratorium-related projects--the EIS on reservations of water in the Yellowstone Basin, for example (Montana DNRC 1976). The study resulted in a final report summarizing all aspects of the study and in eleven specialized technical reports:

Report No. 1	Future Development Projections and Hydrologic Modeling in the Yellowstone River Basin, Montana.
Report No. 2	The Effect of Altered Streamflow on the Hydrology and Geomorphology of the Yellowstone River Basin, Montana.
Report No. 3	The Effect of Altered Streamflow on the Water Quality of the Yellowstone River Basin, Montana.
Report No. 4	The Adequacy of Montana's Regulatory Framework for Water Quality Control
Report No. 5	Aquatic Invertebrates of the Yellowstone River Basin, Montana.
Report No. 6	The Effect of Altered Streamflow on Furbearing Mammals of the Yellowstone River Basin, Montana.
Report No. 7	The Effect of Altered Streamflow on Migratory Birds of the Yellowstone River Basin, Montana.

Report No. 8 The Effect of Altered Streamflow on Fish of the Yellowstone and Tongue Rivers, Montana.

Report No. 9 The Effect of Altered Streamflow on Existing Municipal and Agricultural Users of the Yellowstone River Basin, Montana.

Report No. 10 The Effect of Altered Streamflow on Water-Based Recreation in the Yellowstone River Basin, Montana.

Report No. 11 The Economics of Altered Streamflow in the Yellowstone River Basin, Montana.

ACKNOWLEDGMENTS

This report was reviewed by and guidance received from John C. Orth, Director of the Montana Department of Natural Resources and Conservation; Orrin Ferris, Administrator of the DNRC's Water Resources Division; and Carole Massman, of the DNRC's Special Staff.

Other DNRC personnel providing assistance were Shari Meats, Jim Bond, and Pam Tennis, who performed editing and writing tasks. Graphics were coordinated and performed by Gary Wolf and Dan Nelson, with the assistance of June Virag and Gordon Taylor and of D. C. Howard, who also designed and executed the cover.

Introduction

The goal of this study was to assess the impact of reduced streamflows on furbearing mammals in the Yellowstone River Basin. Species present, their relative abundance, and important habitat types for each were to be determined. The flow-related impacts on each species and on the supplemental income of fur trappers were also to be assessed. The primary furbearing species studied was the beaver (*Castor canadensis*). Other species studied, but with less emphasis, were mink (*Mustela vison*) and muskrat (*Ondatra zibethicus*).

The two-year study began in the fall of 1974 and extended through the summer of 1976. Field work was confined to the Yellowstone River from Big Timber to the North Dakota border, the Bighorn River from Yellowtail Dam to its mouth, and the Tongue River from the Tongue River Reservoir to its mouth.

Methods

During the fall season of 1974 and 1975, beaver caches were located by aerial survey throughout the study area and plotted on maps (½" = 1 mile). During the 1975 survey, several parameters for each cache were recorded during the aerial survey:

1) location
2) river morphology
3) bank vegetation
4) primary cache vegetation

Cache location was defined as:

1) onstream--a) mainland or b) island
2) offstream--a) manmade or b) natural.

River morphology was categorized as: 1) braided--more than two water channels; 2) split--two water channels; or 3) straight--one water channel.

Bank vegetation was described as: 1) willow, 2) cottonwood, 3) mixed willow and cottonwood, or 4) other.

Vegetation in the cache was divided into two categories: 1) willow and 2) other.

Historical beaver population data were obtained from unpublished data in Montana Department of Fish and Game (DFG) regional files.

Several fur harvest parameters for beaver, mink, and muskrat, including estimated numbers trapped, total number of trappers, average catch per trapper, and average pelt price, were summarized from DFG state-wide fur survey and inventory reports (Egan 1975 and others).

As a part of this study, aerial photographs of the Bighorn River were analyzed to assess the effects of flow changes due to the closure of Yellowtail Dam in 1965. A detailed methodology of that part of the study and the results obtained are presented in Report No. 2 in this series (see Preface).

All statistical analyses were performed on a Monroe Programmable Calculator, Model 1785 W1, following methods presented in Snedecor and Cochran (1967).

For ease in collection and interpretation of data, each of the rivers was divided into study sections (shown in figure 7 on page 17). Eleven sections, identified in table 2 on page 20, were delineated on the Yellowstone. Tables 3 (page 21) and 4 (page 21) show the seven and four river sections chosen for the Tongue and Bighorn rivers, respectively.

Existing situation

HABITAT REQUIREMENTS

BEAVER

The mention of beaver habitat generally brings to mind the image of a picturesque mountain valley with a series of beaver dams impounding water, a centrally located lodge, and aspen and willows in abundance. While a great number of beaver do inhabit such settings (Rutherford 1964, Hall 1960), another niche capable of supporting healthy beaver populations is the large prairie river system. Meriwether Clark observed beaver on the Yellowstone River near the mouths of the Clarks Fork, Bighorn, and Tongue rivers on his return trip in 1806 (Walcheck 1976).

The activities of men caused drastic reduction in these early beaver populations on the plains cottonwood river bottoms (Rutherford 1964). After protective measures were introduced in 1876 and strengthened to a complete ban on trapping in 1916 (Mussehl and Howell 1971), beaver populations in Montana and elsewhere rebounded until open seasons were declared by the Fish and Game Commission in 1953.

Beaver living along the Yellowstone River appear to utilize willow as their primary food source. Beaver cuttings were also principally willow in a western Montana river (Townsend 1953). Young cottonwood trees are undoubtedly also important (Rutherford 1964, Grasse and Putnam 1950).

A few beaver lodges and dams have been observed on side channels and backwater areas (figures 2, 3, and 4). However, the large volume of flow (especially during flood stages) in the main channel makes construction of dams and lodges impossible (Gill 1972), and most beaver on the Yellowstone, Tongue, and Bighorn rivers reside in bank dens (figure 5).

Beaver store their winter food supply in a cache (figure 6) located near the den in the deepest available water (Grasse and Putnam 1950). By the time ice forms, most of the cache has sunk to the river bed and is accessible all winter.

MINK

Mink are found along streams and lakes where they feed on small mammals, birds, eggs, frogs, crayfish, and fish (Burt and Grossenheider 1964). Although mink are generally associated with water, they often wander long distances from water in search of food (Adams 1961). Movements of mink over

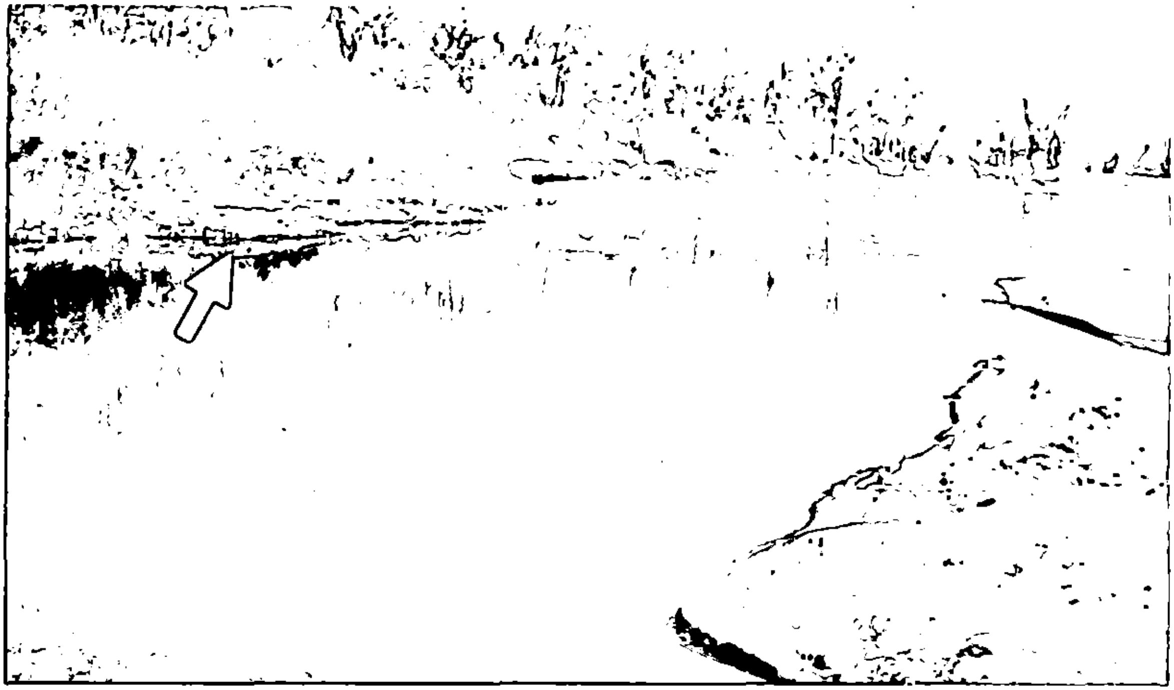

Figure 2. Beaver lodge and cache next to willow stand on Yellowstone River backwater.

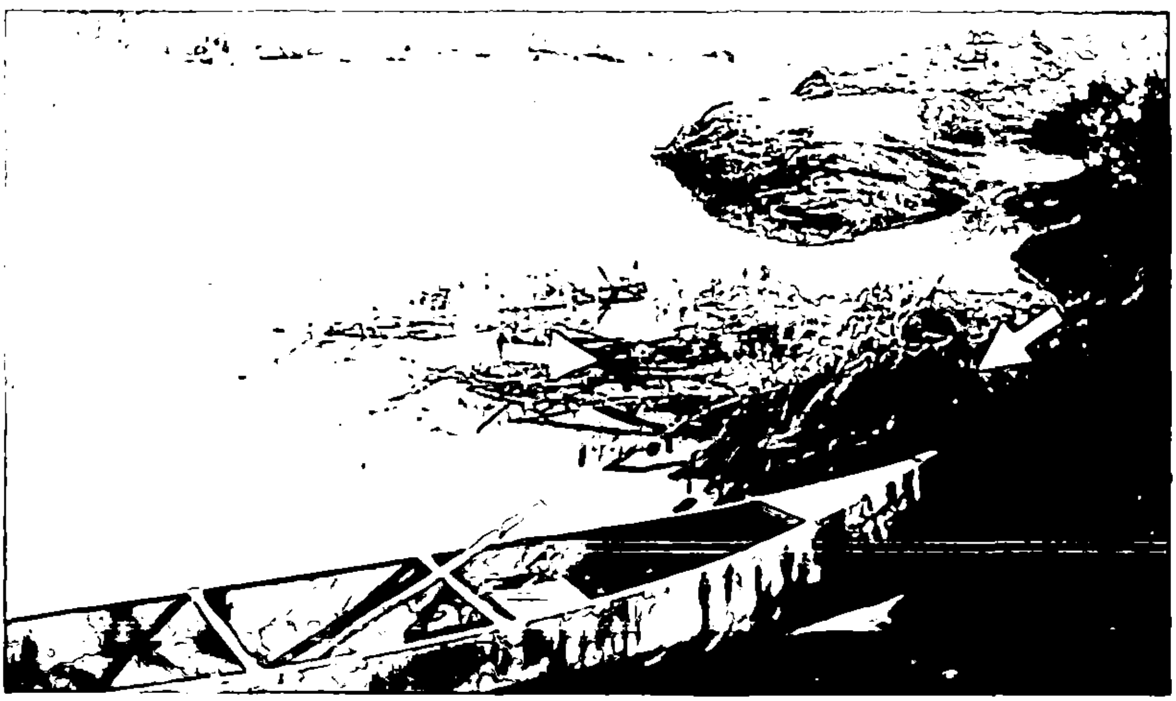

Figure 3. Beaver lodge and cache in backwater of the Yellowstone River.

Figure 4. Beaver lodge in a high water channel of the Yellowstone River (at Isaac Homestead) which beaver have dammed.

Figure 5. Beaver bank den high water entrance.

Fiqure 6. Beaver cache, beaver draq tail, bank den entrance, and biologist, Pete Martin.

30 km (20 miles) have been documented (Mitchell 1961, Hibbard and Adams 1957). For this reason mink are much less dependent than beaver on the flows of a river system for survival.

MUSKRAT

Marshes, lakes, and backwater areas are primary muskrat habitat (Errington 1937, Sather 1958). Any area with emergent vegetation and stable water levels is potential muskrat habitat.

Muskrat are versatile feeders (Errington 1941), feeding on almost any plant growing near their dwelling. Some of the more common food plants are cattail, river and hardstem bullrush, arrowhead, smartweed, and various sedges and duckweeds (Sather 1958).

Sather (1958) found Nebraska muskrats inhabiting both bank dens and "typical" houses on lakes and marshes. All houses were located in water ranging from 43.2 to 101.6 cm (17 to 40 inches) in depth. His study revealed that muskrat populations decreased when water-level fluctuations decreased the amount of available emergent vegetation. Friend et al. (1964) found that muskrat experience disease, parasitic infection, and heavy weight losses in areas with lowered water levels during winter. Ice formed on the bottoms, freezing the muskrats' feed beds. Stable water levels result in increased population densities through a reduction in natural mortality (Donahoe 1966).

RIVER OTTER

River otter (*Lutra canadensis*) are apparently scarce throughout the study area. In the 1973-74 season, only three otter were taken by trappers.

Fish comprised the major portion of the diet of river otter in western Oregon (Toweill 1974). Salmonidae were the most important single food item. Sheldon and Toll (1964) found river otter feeding primarily on warm-water fish in a central Massachusetts reservoir. It seems likely that river otter prey upon more abundant fish species and those with lesser swimming ability (Ryder 1955).

Since current fish populations in the Yellowstone would not seem to indicate a limited food supply, some other factor, perhaps man himself, must be responsible for the low otter populations in the study area.

INVENTORY OF ANIMALS

Montana's beaver trapping season begins on November 10 and ends on March 31 of the following year. The mink and muskrat trapping seasons, both of which also begin on November 10, end on December 31 and April 30, respectively. There are occasionally some minor adjustments in these opening and closing dates (see table C-1 of appendix C).

During the 1973-74 trapping season, 13 species of mammals were trapped for their fur by 315 trappers in Fish and Game Regions 5 and 7 (table 1, figure 7). Muskrat topped the list with an estimated 4,160 pelts taken. Beaver were second with 2,942 pelts. Other species with over 2,000 pelts taken included skunk (*Mephitis mephitis*), raccoon (*Procyon lotor*), and fox (*Vulpes vulpes*). Between 300 and 1,000 mink, bobcat (*Lynx rufus*), coyote (*Canis latrans*), and badger (*Tacides taxus*) were trapped. Animals with fewer than 100 pelts taken included weasel (*Mustela* spp.), lynx (*Lynx canadensis*), marten (*Martes americana*), and river otter.

The only animals listed in table 1 and classified as "furbearers" by state legislature are muskrat, beaver, mink, otter, and marten; all others are either classified as "predators" or are unclassified (Mitchell and Greer 1971). Because marten are closely associated with climax spruce-fir forests (Hawley and Newby 1957), a vegetation type which does not occur along the lower Yellowstone River, and because otter are exceptionally rare in Regions 5 and 7, only the remaining three furbearers, beaver, mink, and muskrat, were dealt with in this study.

TABLE 1. Furbearer species and numbers trapped in Fish and Game Regions 5 and 7 during the 1973-74 fur trapping season.

Species	Region 5[a]	Region 7[a]	Total
Muskrat	3,269	891	4,160
Beaver	1,946	996	2,942
Raccoon	1,595	1,009	2,604
Skunk	942	1,267	2,209
Fox	754	1,591	2,345
Coyote	386	437	823
Mink	346	209	555
Bobcat	273	469	742
Badger	82	251	333
Weasel	34	42	76
Canada Lynx	29	4	33
Marten	10	0	10
Otter	2	1	3

[a]183 trappers in region 5, 132 in region 7

The relative density of beaver in the study area is shown in figures 7 and 8. The Yellowstone River had the most caches over the study period, with 0.87 caches/km (1.40/mile) in 1975 (table 2). The Tongue River supported 0.63 caches/km (1.01/mile), and the Bighorn River had 0.55 caches/km (0.88/mile) in 1975 (tables 3 and 4).

The Morgan Creek-to-Shadwell Creek section of the Yellowstone, mainly downstream from Intake Diversion Dam, and the Pompey's Pillar Creek-to-Bighorn River section had the highest densities of beaver caches, over 1.3 per river kilometer (2/mile) for both years (table 2, figure 7). These two sections are highly braided with many islands and abundant willow and young cottonwood stands. The two lowest-density sections of the Yellowstone, 8 and 11 (just downstream from Miles City and just upstream from the North Dakota border), are characterized by little vegetation and only one river channel.

Both the Tongue and Bighorn rivers have major water impoundments. In 1975, the river sections immediately downstream from both dams had the fewest beaver caches for those rivers. These sections are characterized by one channel and few deciduous trees or shrubs. In 1975, no section of the Bighorn or Tongue rivers had 0.75 or more caches/km (tables 3 and 4), while nine of the eleven sections of the Yellowstone attained at least that level (table 2). The free-flowing Yellowstone River is apparently supporting a higher-density beaver population than either the Tongue or Bighorn rivers.

Historical beaver populations as indicated by the number of caches on the Yellowstone, Bighorn, and Tongue rivers are presented in table 5. Beaver populations on the Columbus-to-Bighorn River reach of the Yellowstone were high in 1956 with .977 caches/km. A population low for this reach was

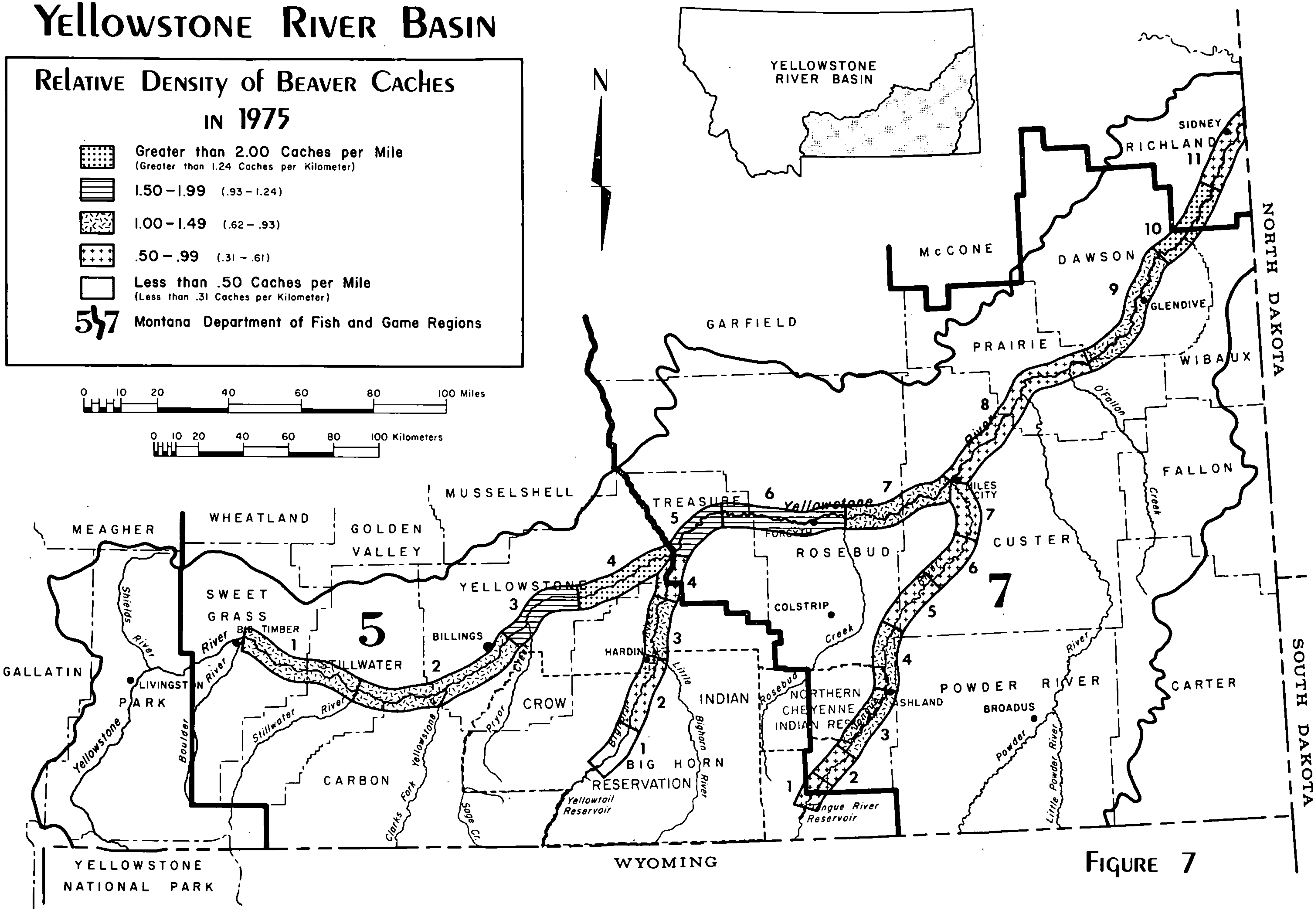
Yellowstone River Basin
Relative Density of Beaver Caches in 1975
Greater than 2.00 Caches per Mile
(Greater than 1.24 Caches per Kilometer)
1.50 – 1.99 (.93 – 1.24)
1.00 – 1.49 (.62 – .93)
.50 – .99 (.31 – .61)
Less than .50 Caches per Mile
(Less than .31 Caches per Kilometer)
5⁄7 Montana Department of Fish and Game Regions
0 10 20 40 60 80 100 Miles
0 10 20 40 60 80 100 Kilometers
N
YELLOWSTONE RIVER BASIN
McCONE
RICHLAND
SIDNEY
DAWSON
GLENDIVE
PRAIRIE
WIBAUX
GARFIELD
NORTH DAKOTA
SOUTH DAKOTA
MUSSELSHELL
TREASURE
FORSYTH
ROSEBUD
COLSTRIP
CUSTER
MILES CITY
FALLON
MEAGHER
WHEATLAND
GOLDEN VALLEY
SWEET GRASS
BIG TIMBER
YELLOWSTONE
BILLINGS
STILLWATER
GALLATIN
LIVINGSTON
PARK
CARBON
CROW
HARDIN
BIG HORN
RESERVATION
INDIAN
NORTHERN CHEYENNE INDIAN RES.
ASHLAND
POWDER RIVER
BROADUS
CARTER
Yellowstone River
Shields River
Boulder
Stillwater River
Clarks Fork Yellowstone
Pryor Creek
Sage Cr.
Bighorn River
Little Bighorn River
Yellowtail Reservoir
Rosebud Creek
Tongue River
Tongue River Reservoir
Powder River
Little Powder River
O'Fallon Creek
Creek
YELLOWSTONE NATIONAL PARK
WYOMING
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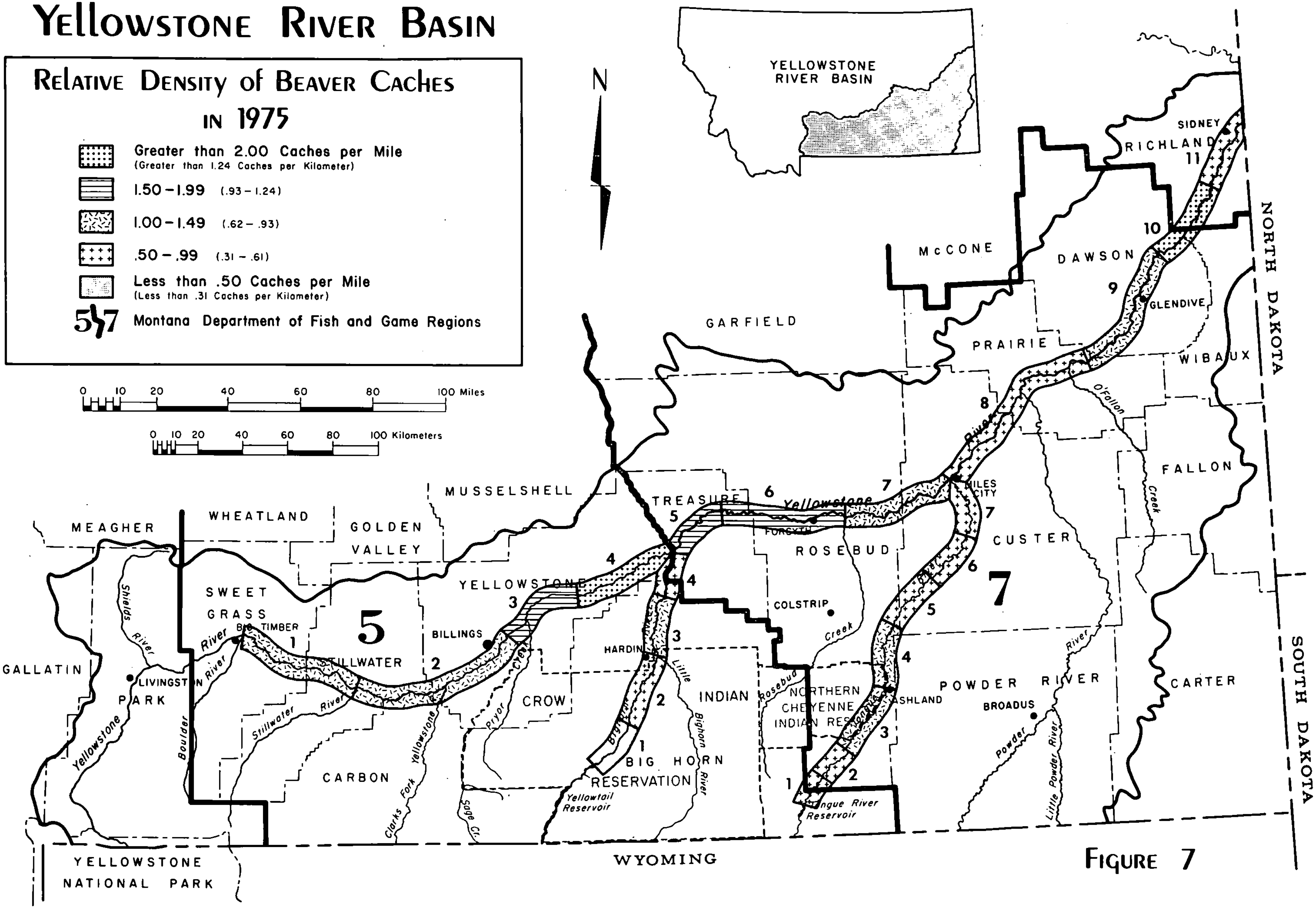
Figure 7



YELLOWSTONE RIVER BASIN
RELATIVE DENSITY OF BEAVER CACHES IN 1975
Greater than 2.00 Caches per Mile
(Greater than 1.24 Caches per Kilometer)
1.50 – 1.99 (.93 – 1.24)
1.00 – 1.49 (.62 – .93)
.50 – .99 (.31 – .61)
Less than .50 Caches per Mile
(Less than .31 Caches per Kilometer)
5|7 Montana Department of Fish and Game Regions
0 10 20 40 60 80 100 Miles
0 10 20 40 60 80 100 Kilometers
N
YELLOWSTONE RIVER BASIN
McCONE
GARFIELD
RICHLAND
SIDNEY
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GLENDIVE
PRAIRIE
WIBAUX
FALLON
NORTH DAKOTA
SOUTH DAKOTA
CARTER
CUSTER
MILES CITY
POWDER RIVER
BROADUS
ROSEBUD
COLSTRIP
FORSYTH
TREASURE
MUSSELSHELL
WHEATLAND
GOLDEN VALLEY
MEAGHER
SWEET GRASS
BIG TIMBER
STILLWATER
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LIVINGSTON
PARK
CARBON
BIG HORN
HARDIN
CROW
INDIAN
RESERVATION
NORTHERN CHEYENNE INDIAN RES
ASHLAND
Yellowstone River
Shields River
Boulder
Stillwater River
Clarks Fork Yellowstone
Sage Cr.
Pryor Cr.
Big Horn River
Little Bighorn River
Yellowtail Reservoir
Rosebud Creek
Tongue River Reservoir
Powder River
Little Powder River
O'Fallon Creek
WYOMING
YELLOWSTONE NATIONAL PARK
5
7

FIGURE 7

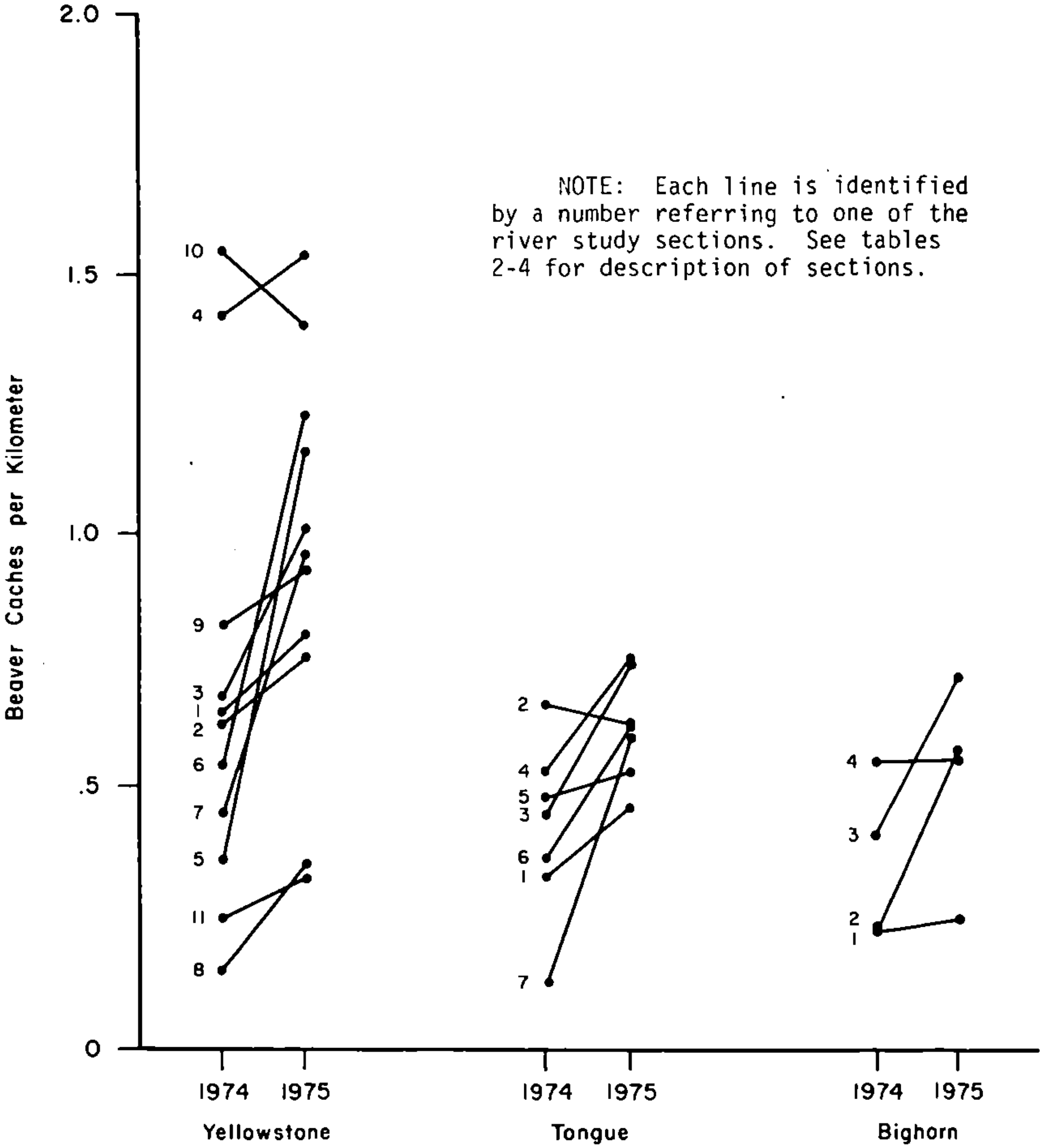

Figure 8. Beaver densities of the Yellowstone, Tongue, and Bighorn rivers in 1974 and 1975 by study section .

TABLE 2. Beaver cache counts on the Yellowstone River; 1974 and 1975.

Section	Length[a]	1974		1975		Percentage of Change
		Caches	Caches/km	Caches	Caches/km	
1. Boulder River to Stillwater River	69.0 (42.9)	46	0.67	55	0.80	+20
2. Stillwater River to Alkali Cr.	85.4 (53.1)	53	0.62	64	0.75	+21
3. Alkali Cr. to Pompey's Pillar Cr.	50.7 (31.5)	34	0.67	50	0.99	+47
4. Pompey's Pillar Cr. to Bighorn River	52.9 (32.9)	74	1.40	80	1.51	+ 8
5. Bighorn River to Froze-to-Death Cr.	41.4 (25.7)	15	0.36	47	1.14	+213
6. Froze-to-Death Cr. to Rosebud Cr.	73.0 (45.4)	40	0.55	88	1.21	+110
7. Rosebud Cr. to Tongue River	63.6 (39.5)	29	0.46	59	0.93	+103
8. Tongue River to Hatchet Cr.	101.0 (62.8)	16	0.16	35	0.35	+119
9 Hatchet Cr. to Morgan Cr.	73.9 (45.9)	59	0.80	67	0.91	+14
10. Morgan Cr. to Shadwell Cr.	50.0 (31.1)	76	1.52	69	1.38	- 9
11. Shadwell Cr. to North Dakota Border	72.7 (45.2)	18	0.25	24	0.33	+33
TOTALS AND AVERAGES	733.7 (456.0)	460	0.63	638	0.87	+39

[a]Length in km (mi)

TABLE 3. Beaver cache counts on the Tongue River, 1974 and 1975.

Section	Length[a]	1974		1975		Percentage of Change
		Caches	Caches/km	Caches	Caches/km	
1. Tongue R. Dam to Deadman's Gulch	30.6 (19.0)	10	0.34	14	0.46	+40
2. Deadman's Gulch to Brown's Gulch	26.1 (16.2)	17	0.65	16	0.61	- 6
3. Brown's Gulch to Spring Cr.	55.8 (34.7)	25	0.45	41	0.73	+64
4. Spring Cr. to Hart Cr.	59.7 (37.1)	32	0.54	44	0.74	+38
5. Hart Cr. to Horse Cr.	45.7 (28.4)	22	0.48	24	0.53	+ 9
6. Horse Cr. to Circle L Cr.	41.0 (25.5)	15	0.37	25	0.61	+67
7. Circle L Cr. to Mouth	45.4 (28.2)	11	0.24	27	0.59	+145
TOTALS AND AVERAGES	304.3 (189.1)	132	0.43	191	0.63	+45

[a]Length in km (mi)

TABLE 4. Beaver cache counts on the Bighorn River, 1974 and 1975.

Section	Length[a]	1974		1975		Percentage of Change
		Caches	Caches/km	Caches	Caches/km	
1. Yellowtail Afterbay Dam to St. Xavier Bridge	26.5 (16.5)	6	0.23	7	0.26	+17
2. St. Xavier Bridge to Little Bighorn R.	40.5 (25.2)	9	0.22	23	0.57	+156
3. Little Bighorn R. to Pocket Cr.	39.4 (24.5)	16	0.41	28	0.71	+75
4. Pocket Cr. to Mouth	29.1 (18.1)	16	0.55	16	0.55	0
TOTALS AND AVERAGES	135.6 (84.3)	47	0.35	74	0.55	+57

[a]Length in km (mi)

TABLE 5. Historical beaver cache counts on three sections of the Yellowstone River, the Bighorn River, and the Tongue River.

	Yellowstone River Reach									Bighorn River			Tongue River		
	Columbus to Big Horn River			Forsyth to Miles City			Miles City to Glendive								
	No. of caches	Caches/km	km/cache	No. of caches	Caches/km	km/cache	No. of Caches	Caches/km	km/cache	No. of caches	Caches/km	km/cache	No. of caches	Caches/km	km/cache
1953	-	-	-	80	.777	1.29	77	.479	2.09	-	-	-	66	.418	2.39
1954	-	-	-	64	.622	1.61	83	.516	1.94	-	-	-	110	.677	1.48
1955	-	-	-	58	.564	1.77	38	.236	4.23	55	.45	2.2	-	-	-
1956	198	.977	1.02	58	.564	1.77	31	.193	5.19	-	-	-	44	.271	3.69
1957	-	-	-	46	.447	2.24	29	.180	5.55	-	-	-	78	.48	2.08
1962	-	-	-	49	.476	2.1	24	.149	6.70	-	-	-	47	.289	3.46
1965	-	-	-	7	.068	14.7	21	.131	7.66	-	-	-	13	.08	12.5
1968	88	.434	2.30	34	.330	3.03	28	.174	5.74	18	.15	6.8	30	.185	5.42
1969	124	.612	1.63	32	.311	3.22	30	.186	5.36	30	.25	4.1	66	.406	2.46
1974	179	.869	1.15	43	.505	1.98	60	.405	2.47	47	.347	2.89	77	.441	2.27
1975	219	1.06	.941	84	.986	1.01	78	.526	1.9	74	.546	1.83	137	.784	1.28

NOTE: Hyphens indicate a lack of data. All data prior to 1974 obtained from files of Montana Department of Fish and Game Regional Headquarters in Billings and Miles City.

Distances used in calculations differed. The ones used by the Department of Fish and Game for all calculations from 1953 to 1969 were, for the three sections of the Yellowstone in order of their appearance in the table, 202.7, 102.9, and 160.9 km, and for the Tongue River, 162.5 km. The Bighorn River length used in those calculations is not known. The distances used for the present study (1974 and 1975 data), obtained from USGS Yellowstone River mileage tables, were, for the five areas, 206.0, 85.2, 148.2, 135.6, and 174.7 km respectively.

recorded in 1968 when only .434 caches/km were observed. In 1975, the number of caches observed during this study (219) was the highest ever recorded. Density in 1975 was 1.06 caches/km.

Observations on the Forsyth-to-Miles City reach of the Yellowstone peaked in 1953 and 1975 with 80 and 84 caches observed, respectively. The observance of only 7 caches in 1965 seems unreasonably low; however, the cache survey was performed at the proper time. Either the population was that low, the beaver delayed building caches for some reason that year, or the observer introduced bias. The 1968 and 1969 seasons were also low with 0.33 and 0.31 caches/km observed, respectively.

Peak numbers of caches observed in the Miles City-to-Glendive reach occurred in 1954 (83 caches) and 1975 (78 caches). Lows were observed in 1962 and 1965 when only 0.149 and 0.131 caches/km were observed, respectively. This section of the river supported the lowest-density beaver population on the Yellowstone River every year except 1965.

The numbers of caches/km on the Bighorn River were comparable to the poorest section of the Yellowstone. The recorded low was in 1968, 18 caches, while the high was 74 caches observed in 1975.

Peaks in the Tongue River beaver population were observed in 1954 and 1975 with 110 and 137 caches, respectively. The low figure was recorded in 1965 when only 13 caches were observed. The population level fluctuated more widely on the Tongue River than the other rivers, excluding the 1965 Forsyth-to-Miles City reach of the Yellowstone.

Looking at all five river reaches, it appears that beaver population highs occurred in 1953, 1954, and again in 1975, with 1975 being the highest on record. The low apparently occurred in 1965. The Yellowstone River sections have supported more beaver (i.e., caches/km) than either the Tongue or Bighorn rivers. The Tongue River supported a denser population than did the Bighorn.

Fur harvest data for beaver, mink, and muskrat for Fish and Game Regions 5 and 7 (see figure 7) and the entire state for the fourteen-year period from 1960-61 through 1973-74 are given in tables 6, 7, 8, and 9. The same data (numbers trapped, total number of trappers, average catch per trapper, and average pelt price) are graphically shown in appendix A. Statistical relationships among numbers trapped and the other parameters were determined by linear regression analysis at the $p = .05$ and $p = .01$ levels (Snedecor and Cochran 1967). The resulting correlation coefficients are presented in table 10. These relationships which were statistically significant are shown graphically in appendix B.

BEAVER

Numbers of beaver trapped in the study area were highest in 1960-61, 1962-63, and 1972-73. The fewest trapped occurred in the mid-60's with 1965-66 registering the low for Region 5. Over the 14 years, Region 5 averaged 1,388 beaver trapped compared to 1,022 per year in Region 7.

TABLE 6. Beaver, mink, and muskrat trapped state-wide and in Fish and Game Regions 5 and 7, 1960-74.

Season	Beaver			Mink			Muskrat		
	R-5	R-7	State	R-5	R-7	State	R-5	R-7	State
1960-61	2,300	1,800	23,000	1,048	206	8,700	2,925	428	31,100
1961-62	2,100	1,300	16,000	839	170	6,400	4,860	672	31,112
1962-63	2,100	2,100	22,000	1,150	512	9,100	6,642	1,279	45,900
1963-64	915	599	16,000	1,220	368	9,600	3,366	1,370	49,000
1964-65	714	294	7,800	797	154	5,800	2,722	219	22,000
1965-66	533	1,306	11,000	974	177	7,000	2,495	516	39,800
1966-67	839	533	12,200	777	115	6,200	2,047	130	33,100
1967-68	989	713	11,890	493	149	4,580	1,245	422	19,610
1968-69	1,059	818	12,405	390	192	5,750	1,689	1,330	31,245
1969-70	1,619	922	14,135	641	168	8,070	2,117	1,256	44,270
1970-71	943	391	8,435	255	95	3,621	1,296	501	22,453
1971-72	1,005	641	10,030	213	60	3,158	1,439	329	24,498
1972-73	1,866	1,888	15,612	249	233	4,041	2,704	1,657	34,075
1973-74	1,946	996	13,162	346	209	4,029	3,269	891	22,908
AVERAGE	1,388	1,022	13,834	671	201	6,146	2,773	786	32,219

NOTE: Variations in the lengths of trapping seasons for these years and restrictions placed on trappers that could have affected the numbers of furbearers trapped are explained in appendix C.

TABLE 7. Beaver, mink,and muskrat trappers state-wide and in Fish and Game Regions 5 and 7, 1960-74.

Season	Beaver			Mink			Muskrat		
	R-5	R-7	State	R-5	R-7	State	R-5	R-7	State
1960-61	95	51	794	92	35	831	93	29	746
1961-62	91	66	707	94	34	765	108	28	689
1962-63	74	50	635	93	35	681	95	46	650
1963-64	65	47	695	100	38	857	92	44	848
1964-65	47	24	501	92	24	611	81	18	575
1965-66	38	40	536	99	26	625	73	20	625
1966-67	57	38	586	81	21	636	76	16	651
1967-68	66	36	670	73	24	594	68	29	623
1968-69	62	46	652	53	21	558	67	29	622
1969-70	87	56	850	81	27	770	98	41	897
1970-71	50	32	556	43	17	485	57	21	578
1971-72	68	35	622	50	18	451	65	24	597
1972-73	115	83	861	69	35	606	109	56	785
1973-74	131	87	997	75	51	738	131	54	890
AVERAGE	75	49	690	78	29	658	87	33	698

TABLE 8. Average catch per trapper for beaver, mink, and muskrat state-wide and in Fish and Game Regions 5 and 7, 1960-74.

Season	Beaver			Mink			Muskrat		
	R-5	R-7	State	R-5	R-7	State	R-5	R-7	State
1960-61	34.3	33.1	30.0	11.4	5.9	10.5	31.4	14.8	41.7
1961-62	12.9	19.2	22.5	3.9	5.0	8.4	45.0	24.0	45.1
1962-63	28.5	43.0	34.6	12.4	14.9	13.4	69.9	27.8	70.6
1963-64	14.2	12.8	23.2	12.3	9.8	11.2	36.8	31.1	57.7
1964-65	14.9	12.1	15.6	8.5	6.4	9.5	33.2	12.3	39.1
1965-66	14.0	32.7	20.4	9.8	6.8	11.2	34.2	25.8	63.6
1966-67	14.7	14.0	20.9	9.6	5.5	9.7	26.9	8.1	50.8
1967-68	14.9	19.6	17.8	6.8	6.3	7.7	18.3	14.8	31.5
1968-69	17.2	18.4	19.0	7.4	9.2	10.3	25.1	45.6	50.3
1969-70	18.7	16.6	16.6	7.9	6.2	10.5	21.7	31.0	49.3
1970-71	18.9	12.2	15.0	6.0	5.5	7.5	22.7	23.5	38.9
1971-72	14.9	18.5	16.1	4.2	3.3	7.0	22.2	14.0	41.0
1972-73	16.2	22.6	18.1	3.6	6.7	6.7	24.7	29.5	43.4
1973-74	14.9	11.4	13.2	4.6	4.1	5.5	25.1	16.5	25.8
AVERAGE	18.5	20.4	20.2	8.1	6.8	9.2	31.2	22.8	46.3

NOTE: Variations in the lengths of trapping seasons for these years and restrictions placed on trappers that could have affected the average catch per trapper are explained in appendix C.

TABLE 9. Average pelt price for beaver, mink, and muskrat state-wide and in Fish and Game Regions 5 and 7, 1960-74 (dollars).

Season	Beaver			Mink			Muskrat		
	R-5	R-7	State	R-5	R-7	State	R-5	R-7	State
1960-61	8.33	7.91	8.86	10.89	8.06	11.13	0.46	0.45	0.48
1961-62	7.89	7.31	8.21	8.78	13.18	9.34	0.76	0.83	0.77
1962-63	10.22	8.23	10.26	10.01	16.95	10.71	1.01	0.76	0.81
1963-64	8.52	9.23	10.18	13.57	15.82	12.38	0.89	0.80	0.98
1964-65	8.55	7.36	9.63	8.79	14.41	10.18	0.86	0.67	0.88
1965-66	9.48	10.29	11.54	9.92	15.18	10.23	1.07	1.24	1.16
1966-67	10.61	9.82	10.23	7.60	11.75	10.01	0.69	0.66	0.72
1967-68	11.63	10.55	10.67	6.66	9.36	9.12	0.40	0.54	0.68
1968-69	12.59	10.81	13.52	10.78	10.01	10.88	0.67	0.74	0.79
1969-70	10.60	9.55	11.00	5.68	9.88	8.33	0.90	0.88	0.95
1970-71	9.52	7.95	9.29	4.13	6.45	4.69	0.74	0.67	0.88
1971-72	12.47	12.78	12.69	5.02	9.79	6.03	1.07	1.06	1.31
1972-73	15.06	12.92	15.95	9.41	15.30	11.74	1.52	1.46	1.43
1973-74	14.47	14.62	15.95	10.29	16.74	14.46	2.00	1.56	1.98
AVERAGE	10.71	9.95	11.28	8.68	12.35	9.95	0.93	0.88	0.99

TABLE 10. Correlation coefficients of linear regression analysis of numbers of furbearers trapped vs. numbers of trappers, average catch per trapper, and average pelt price.

	Region	Number of Trappers (13)[a]	Average Catch Per Trapper (13)[a]	Average Pelt Price (13)[a]
Beaver	5	0.773[b]	0.805[b]	0.045[d]
	7	0.562[c]	0.829[b]	0.029[d]
Mink	5	0.886[b]	0.963[b]	0.594[c]
	7	0.551[c]	0.893[b]	0.623[c]
Muskrat	5	0.572[c]	0.937[b]	0.212[d]
	7	0.818[b]	0.812[b]	0.379[d]

[a]Degrees of freedom = number of years of compatible data minus one.

[b]Statistical significance (p = .01) of correlation (Snedecor and Cochran 1967).

[c]Statistical significance (p = .05) of correlation (Snedecor and Cochran 1967).

[d]These correlations were not significant.

The largest number of beaver trappers was recorded in 1973-74 for both regions, after lower peaks in 1960-61, 1961-62, 1969-70, and 1972-73. Region 5 has consistently had more beaver trappers, averaging 75, while Region 7 has averaged 49 beaver trappers.

The average annual catch per trapper in Region 5 has decreased from highs in the early sixties to an average of about 14.5 beaver per trapper. A slight rise was recorded in the 1969-70 and 1970-71 seasons. Region 7 success has fluctuated widely from 43.0 per trapper in 1962-63 to 12.1 in 1964-65 and 12.2 in 1970-71. Overall, Region 7 has averaged 20.4 beaver per trapper compared with 18.5 beaver per trapper in Region 5.

Beaver pelt prices have averaged higher in Region 5 ($10.71) than in Region 7 ($9.95). Both regions are below the state-wide average of $11.28 per pelt. Prices have trended generally upward with state-wide peaks in 1968-69, 1972-73, and 1973-74. Region 5 registered its highest prices during the 1972-73 season, and the highest prices in Region 7 came in 1973-74.

Statistical analysis reveals a positive significant (p = .01) relationship between numbers of beaver trapped and average catch per trapper in both Regions 5 and 7 (table 10, figure B-2 of appendix B). The relationship between numbers trapped and number of trappers, although significant (p = .01 in Region 5 and p = .05 in Region 7) had smaller correlation coefficients than calculated for average-catch-per-trapper comparisons. There was an insignificant relationship between numbers trapped and average pelt price, suggesting that the pelt price has no effect on the number of beaver trapped. Trappers taking beaver are probably doing it for recreation as well as profit.

Assuming that trappers, both recreationists and professionals, have a higher catch rate when populations are higher, it seems likely that average-catch-per-trapper curves would correlate well with population curves. Only further study aimed at obtaining a substantial number of consecutive years of population estimations could bear this theory out.

MINK

The 1962-63 and 1963-64 seasons were the peak mink harvest years in both Regions 5 and 7 (table 6). The trend has been generally downward since then; the fewest mink were caught in the 1971-72 season. There has been a slight recovery in the last two years. Considerably more mink have been harvested in Region 5 than in Region 7, with averages of 671 and 201, respectively.

Region 5 also had more mink trappers over the years (average 78) than did Region 7 (average 29). Numbers of trappers remained relatively steady from the 1960-61 through 1965-66 trapping seasons in Region 5, declining to lows during the 1970-71 and 1971-72 seasons. Region 7 was stable from 1960-61 through 1963-64 at a median level. It declined in 1964-65 and was then stable at a low level through 1971-72. Both regions showed substantial increases in the next two years.

Average-catch-per-trapper figures indicate that Region 7 had the highest and lowest yearly average catches, ranging from 14.9 in 1962-63 to 3.3 in 1971-72. Region 5 had a higher overall average catch (8.1 mink per trapper) than did Region 7 (6.8). Both regions have trended downward since the highs recorded in the early sixties.

Mink pelt prices have been consistently high in Region 7, averaging $12.35 per pelt. Pelt prices were highest in 1962-63 and lowest in 1970-71. Region 5 prices followed the same pattern as in Region 7 but averaged only $8.68.

Statistical analysis revealed high correlations between numbers taken and average catch per trapper. In Region 5, the correlation coefficient (r) was 0.963. Both Region 5 and 7 regressions were significant at the $p = .01$ level. The linear regression between number of mink trapped and mink trappers was significant in both Region 5 ($p = .01$) and Region 7 ($p = .05$). Mink pelt prices were significantly related to the number of mink trapped in both regions ($p = .05$). These data suggest that Region 5 has more mink than Region 7. Region 5 had more mink trapped, more trappers, and a higher average catch per trapper, even though Region 7 had a higher average pelt price. Perhaps professional trappers enter the mink market only when prices are right.

MUSKRAT

Region 5 far exceeded Region 7 in numbers of muskrat trapped, with an average of 2773 per year compared with only 786 per year in Region 7. However, the number trapped in Region 5 has decreased drastically from over 6600 in 1962-63 to lows of 1245 in 1967-68 and 1296 in 1970-71. Region 7 peaks occurred in 1963-64 and 1972-73 at 1370 and 1657 muskrat taken, respectively.

Region 5 muskrat trappers numbered over 100 in 1961-62, 1972-73, and 1973-74. The highest number, 131, trapped in 1973-74. The fourteen-year average was 87. Region 7 averaged 33 muskrat trappers per year. Peak years were 1962-63, 1972-73, and 1973-74. The last two years have shown the highest number of trappers on record in Region 7.

Average muskrat catch per trapper in Region 5 was 31.2 muskrats. Before the 1966-67 season, the average catch was more than 30 muskrats per trapper, with a peak of nearly 70 in 1962-63 (nearly 80 in 1955-56). Since the 1966-67 season, the average has been in the 20's except for 1967-68, which had the low catch of 18.3 muskrats per trapper. Peak muskrat seasons in Region 7 occurred in 1963-64, 1968-69, and 1969-70 with 31.1, 45.6, and 31.0 muskrats per trapper, respectively. The low occurred in 1966-67, when trappers caught an average of only 8.1 muskrats each.

Muskrat pelt prices have increased considerably since the 1967-68 season. That year, in Region 5, muskrat pelts brought $0.40 each; they were worth $0.54 in Region 7. Prices in 1973-74, the highest on record, were $2.00 in Region 5 and $1.56 in Region 7. Region 5 had the highest overall average, $0.93, while Region 7 averaged $0.88 per muskrat pelt.

Average muskrat catch per trapper, like beaver and mink catches per trapper, had higher correlation than either number of trappers or pelt price with numbers trapped in both regions 5 and 7. Correlation coefficients, both significant at the $p = .01$ level, for the two areas were 0.937 and 0.812, respectively. In Region 7, the muskrat/trapper correlation was significant at $p = .01$, while that of Region 5 was significant at $p = .05$. Average pelt price was not significantly related to the number of muskrats trapped. From these data it seems that Region 5 has the most muskrat, the most trapped, the most trappers, and the highest catch per trapper. That numbers trapped were not significantly related to pelt prices in either region suggests that the trappers trapped for recreation as well as profit.

BEAVER CACHE CHARACTERISTICS

The beaver cache parameters observed in 1975 along the Yellowstone River are shown in table 11. Ninety-five percent of the caches were included in this analysis; five percent were omitted due to technical failure in data collection. Of the analyzed caches, 53 percent were constructed adjacent to islands. Thirty-five percent were built next to mainland banks. The other 12 percent were not actually on the river but were associated with it; three percent were in man-made structures (irrigation ditches) and nine percent in springs or small tributaries within the Yellowstone River floodplain.

Ninety-six percent of the observed caches were included in the Tongue River analysis (table 12); four percent were omitted because of technical difficulties. On the Tongue River, only 7 percent of the caches were located next to island banks. Eighty-seven percent were built next to the mainland, and another 6 percent were found in offstream locations.

TABLE 11. Characteristics of observed caches on the Yellowstone River, as percentages.

Section[a]	Caches Observed	Location				River Morphology				Cache Vegetation		Bank Vegetation			
		Onstream		Offstream											
		Island	Mainland	Man-made	Natural	Braided	Split	Straight	Offstream	Willow	Other	Willow	Cottonwood	Willow and Cottonwood	Other
1	100	45	24	7	24	22	36	11	31	100	0	51	0	49	0
2	100	48	41	0	11	34	38	17	11	100	0	41	6	52	2
3	100	58	32	0	10	36	50	4	10	100	0	32	2	56	10
4	99	61	34	1	4	65	24	6	5	100	0	39	0	59	1
5	100	60	38	0	2	62	28	9	2	100	0	36	0	53	11
6	99	52	39	7	2	60	24	7	9	100	0	36	1	52	11
7	97	53	37	7	4	26	36	28	11	98	2	37	4	53	7
8	91	22	50	0	28	9	22	41	28	100	0	88	0	6	6
9	72	54	40	0	6	48	27	19	6	98	2	71	2	25	2
10	91	57	30	5	8	62	21	5	13	100	0	25	2	70	3
11	96	61	22	9	9	74	4	4	18	100	0	30	4	65	0
AVERAGE	95	53	35	3	9	46	29	13	12	100	tr[b]	42	2	51	5

[a]Descriptions of sections in table 2.

[b]tr = trace; a value less than .05 percent

TABLE 12. Characteristics of observed caches on the Tongue River, as percentages.

Section[a]	Caches Observed	Location: Onstream: Island	Location: Onstream: Mainland	Location: Offstream: Man-made	Location: Offstream: Natural	River Morphology: Braided	River Morphology: Split	River Morphology: Straight	River Morphology: Offstream	Cache Vegetation: Willow	Cache Vegetation: Other	Bank Vegetation: Willow	Bank Vegetation: Cottonwood	Bank Vegetation: Willow and Cottonwood	Bank Vegetation: Other
1	93	15	77	0	8	0	15	77	8	100	0	62	15	15	8
2	100	6	94	0	0	0	13	88	0	100	0	44	0	44	13
3	95	8	85	3	5	0	15	77	8	100	0	28	3	51	18
4	95	2	95	0	2	2	12	83	2	98	2	17	7	67	10
5	92	9	86	0	5	0	14	82	5	100	0	36	0	55	9
6	96	13	79	0	8	0	25	67	8	100	0	33	4	50	13
7	100	4	89	0	7	0	11	81	7	96	4	37	4	30	30
AVERAGE	96	7	87	1	5	1	15	79	6	99	1	32	4	49	15

[a]Descriptions of sections in table 3.

TABLE 13. Characteristics of observed caches on the Bighorn River, as percentages.

Section[a]	Caches Observed	Location: Onstream: Island	Location: Onstream: Mainland	Location: Offstream: Man-made	Location: Offstream: Natural	River Morphology: Braided	River Morphology: Split	River Morphology: Straight	River Morphology: Offstream	Caches Vegetation: Willow	Caches Vegetation: Other	Bank Vegetation: Willow	Bank Vegetation: Cottonwood	Bank Vegetation: Willow and Cottonwood	Bank Vegetation: Other
1	100	43	29	0	29	29	14	29	29	100	0	71	0	14	14
2	96	68	18	0	14	32	9	36	14	95	5	55	9	36	0
3	100	43	50	0	7	46	29	18	7	100	0	36	0	46	18
4	100	50	44	0	6	50	25	19	6	94	6	50	6	44	0
AVERAGE	99	52	37	0	11	41	33	15	11	97	3	48	4	40	8

[a]Descriptions of sections in table 4.

On the Bighorn River (table 13), with 99 percent included in the analysis, 11 percent of the caches were offstream and 89 percent onstream, 52 percent of them next to islands and 37 percent next to mainland banks.

Braided and split reaches of the river provided more beaver habitat than did straight reaches, demonstrated by the fact that 46 percent of caches on the Yellowstone were in braided sections and 29 percent were in split sections. The Bighorn caches were located primarily in braided (41 percent) and split (33 percent) river sections also. Only on the Tongue River, which has few split and braided sections, were there more caches located in straight river sections. Sixteen percent of the caches on the Tongue were located in braided or split channel sections.

Willow (*Salix* spp.) is the primary food source of beaver throughout the study area. On the Yellowstone River, willow was the primary vegetation in 100 percent of the caches. It was the primary vegetation in 99 percent and 97 percent of the caches on the Tongue and Bighorn rivers, respectively. The bank vegetation next to 42 percent of the caches on the Yellowstone was pure willow. Fifty-one percent of the caches were constructed next to mixed willow and cottonwood trees (*Popalus* spp). Thus, 93 percent were built adjacent to willow or willow-cottonwood stands. On the Bighorn River, 88 percent of the caches were found next to willow or willow-cottonwood vegetation. Eighty-one percent of the caches on the Tongue River were located next to willow or willow-cottonwood vegetation.

Beaver population data (caches/km) were compared to cache location data (table 14). Few significant relationships were discovered. There were negative relationships between natural offstream sites and beaver caches/km on all three rivers. They were significant ($p = .05$) on the Yellowstone and Bighorn rivers (figure 9). The data appear to indicate that use of offstream sites is not dependent on population levels.

On each of the three rivers, the braided sections provided the highest positive relationships between caches/km and river morphology, though not at significant ($p = .05$) levels. Field observation in the study area supports the conclusion that beaver prefer braided sections of the river. One would expect that, as the population of beaver increased, they would move out from the preferred braided areas to split and even straight channel locations, thus decreasing the percentage of caches located in the braided sections. As indicated earlier, beaver populations are at high levels throughout the study area. Low population levels probably would show significant numbers of caches in the braided sections.

All three rivers demonstrated negative relationships between caches/km and pure willow stands and positive relationships between caches/km and mixed willow-cottonwood stands. The relationships were at significant levels ($p = .05$ or higher) on the Tongue and Bighorn rivers (figures 10 and 11). Even though willows are the primary food of beaver, some factor seems to prevent them from locating next to pure willow stands. Since cottonwood-willow stands occur later in the succession of island formation, after the soil depth has increased, it may be that beaver are selecting the cottonwood-willow sites because the bank is higher, affording a better place in which to build their bank lodges.

Table 14. Correlation coefficients of linear regression analysis of beaver cache/km data with cache location, river morphology, and bank vegetation data on the Yellowstone, Bighorn, and Tongue rivers.

River	Degrees of Freedom[a]	Location			River Morphology			Bank Vegetation		
		Island	Mainland	Natural Offstream	Braided	Split	Straight	Willow	Cottonwood	Willow and Cottonwood
Yellowstone	(10)	0.502	0.091	-0.632[b]	0.421	0.196	-0.509	-0.485	-0.363	0.454
Bighorn	(3)	0.198	0.472	-0.908[b]	0.670	0.550	-0.417	-0.967[c]	0.223	0.947[b]
Tongue	(6)	-0.661	0.574	-0.483	0.557	-0.097	0.089	-0.864[c]	-0.348	0.717[b]

[a]Sections of river minus one.

[b]Statistical significance ($p = .05$) of correlation. Snedecor and Cochran (1967).

[c]Statistical significance ($p = .01$) of correlation. Snedecor and Cochran (1967).

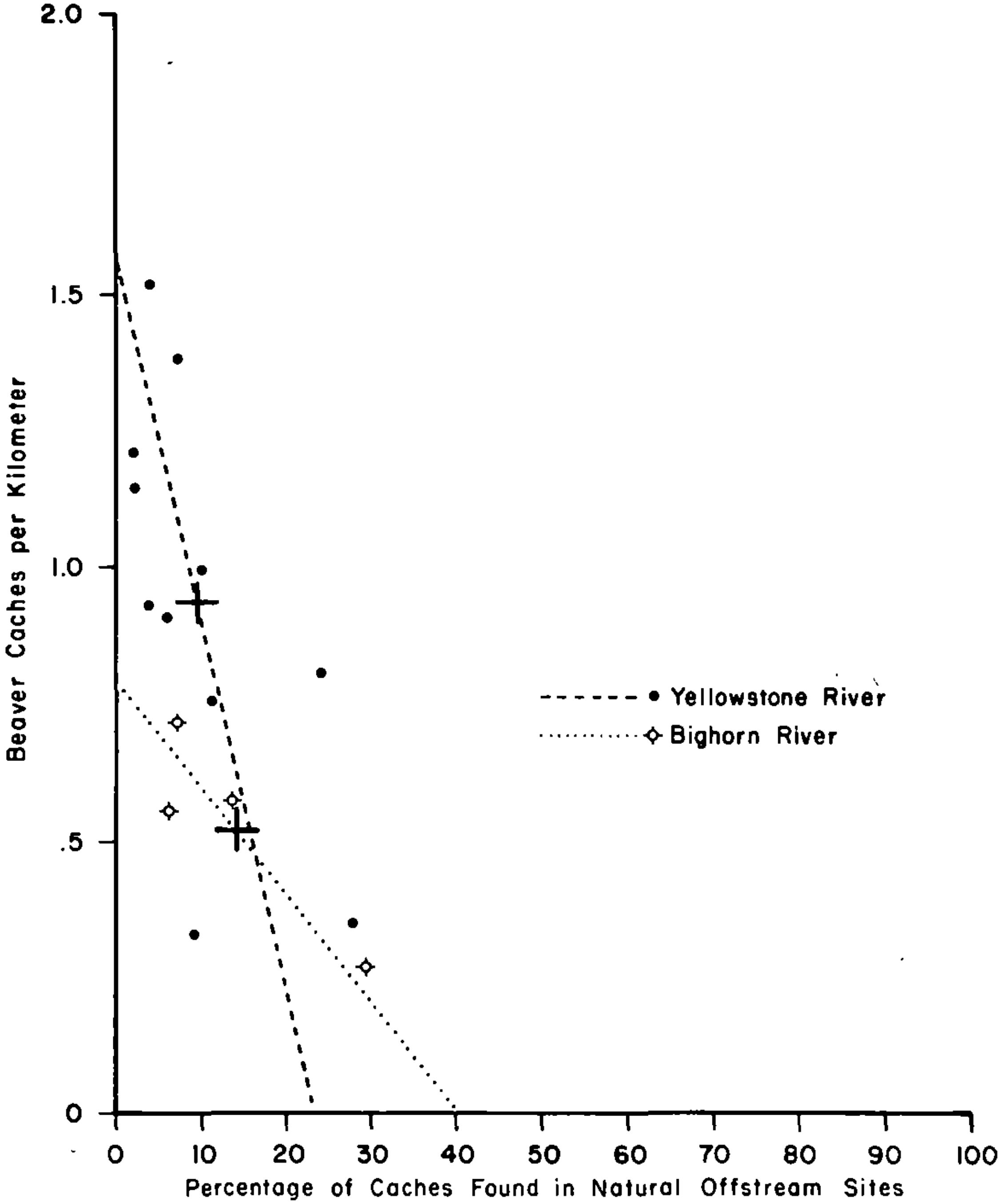

Figure 9. Beaver caches/km vs. percentage of caches found in natural offstream sites on the Yellowstone and Bighorn rivers.

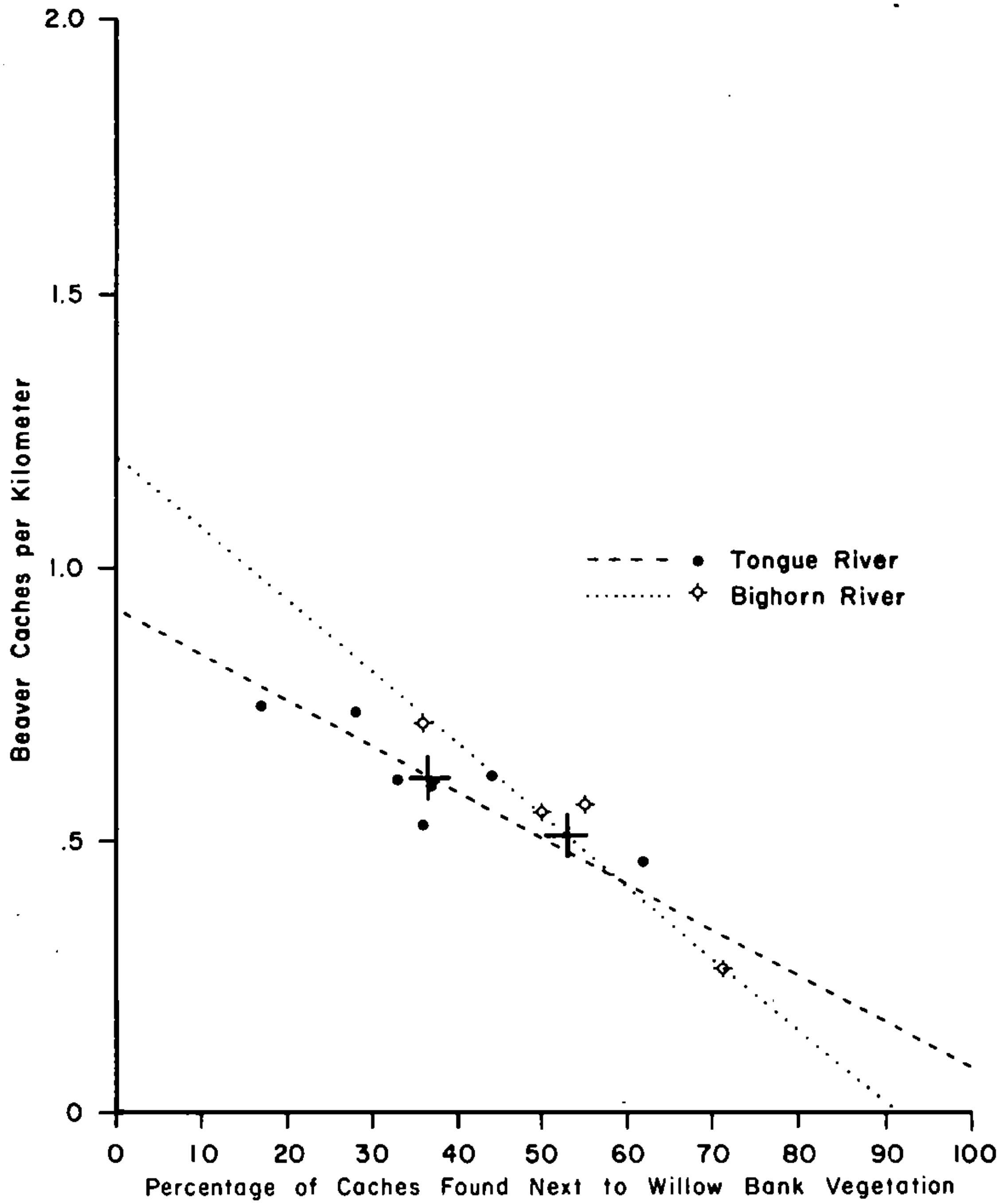

Figure 10. Beaver caches/km vs. percentage of caches found next to willow bank vegetation on the Bighorn and Tongue rivers.

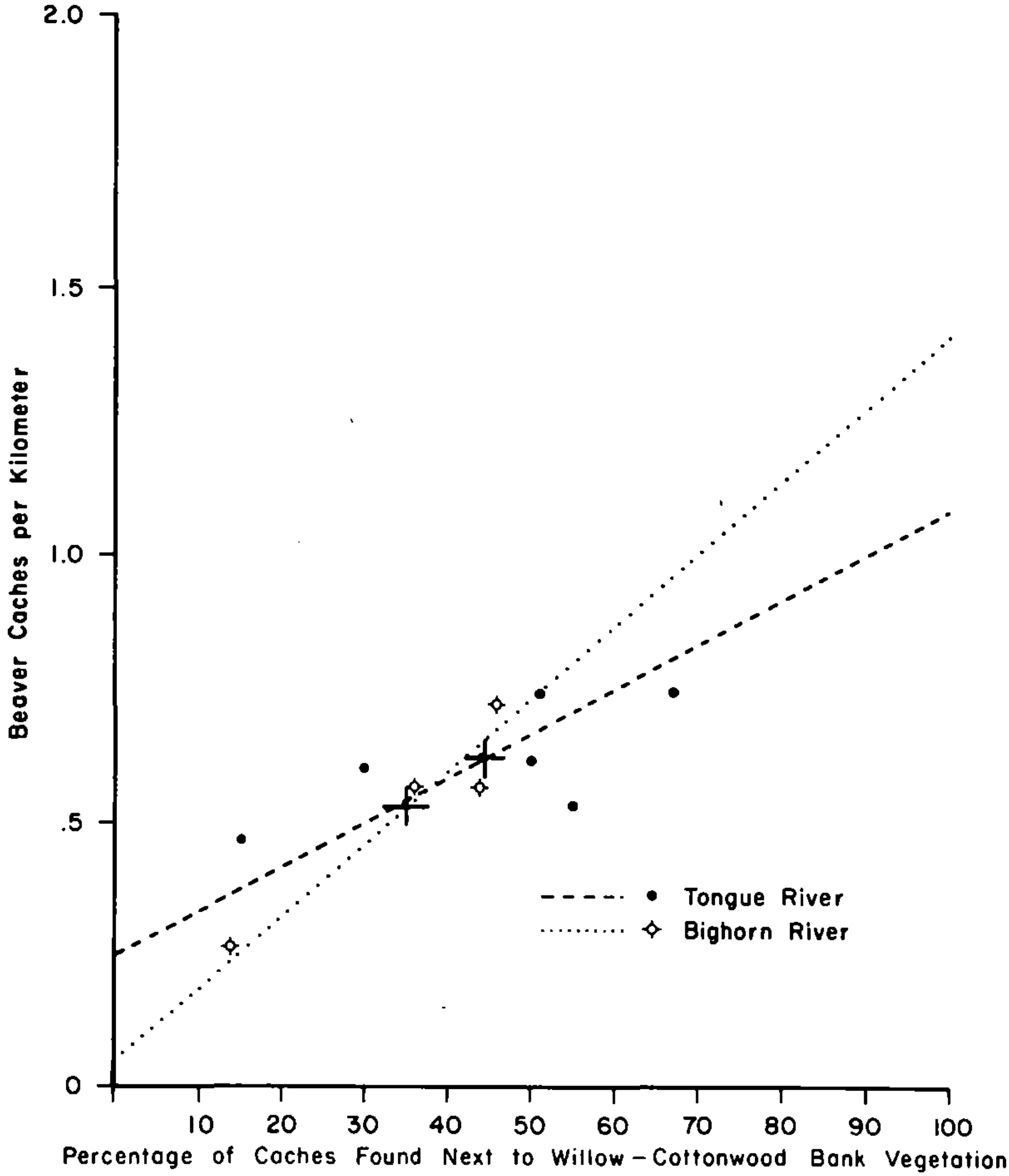

Figure 11. Beaver cache/km vs. percentage of caches found next to willow-cottonwood bank vegetation on the Bighorn and Tongue rivers.

COMPARISON OF HISTORICAL FLOWS WITH POPULATION

The numbers of beaver, mink, and muskrat trapped in Fish and Game Regions 5 and 7 were compared to flows of the Yellowstone River at Billings and Miles City (table 15). Beaver trapped in Region 5 demonstrated the only significant relationships to flow. In each case, except with flows in January, the number trapped was inversely related to the flow; that is, as flows increased, catch decreased. High flows probably affect not only beaver (as described below) but also trappers; access to the river and boat maneuverability may be reduced. The greatest relationship occurred in the comparison of numbers trapped to calendar year flow; even there, however, only 39 percent of the variation could be attributed to flow. Mink relationships were generally negative and not significant. Muskrat relationships, none significant, were negative in Region 5 but positive in Region 7. However, mink are not dependent on the river for survival, and most muskrat were probably not trapped on the river.

The relationship between beaver populations (as expressed by the number of beaver caches) and flows at various times of the year is shown in table 16. The number of caches on the Yellowstone from Columbus to the mouth of the Bighorn River was significantly ($p = .01$) and negatively related to the flow at Billings in February, the winter low-flow month. With an r value of 0.993 ($r^2 = 0.99$), almost all of the variation can be attributed to changes in flow. The number of degrees of freedom (four in this case) is small, but it seems likely that, in this stretch of river, high winter flows are detrimental to beaver populations. Wilsson (1968) reported that winter fluctuations of water levels in the Faxalven River in Sweden were responsible for the loss of many caches and lodges, seriously affecting the beaver population. Flows in the Yellowstone in September, the summer low-flow period, were also negatively related to cache number but not in a significant manner. The high flows in June were positively related (figure 12) to beaver cache numbers, but the degree of relation was small ($r^2 = 0.08$).

The relationship of flow at Miles City to the number of caches between Forsyth and Miles City over an eleven-year period was negative in all instances. The only significant relation (figure 13) occurred during September. Only 35 percent of the relationship could be attributed to the river flow level.

The relationships of flow at Sidney and beaver caches from Miles City to Glendive were all negative and insignificant.

The relationships on the Tongue River were all positive and insignificant. January and June flows on the Bighorn River were negatively related to beaver cache numbers; August and previous water year flows were positively related. None of the Bighorn relationships were at significant ($p = .05$) levels.

It seems apparent that the present flows in the Yellowstone River Basin are not importantly related to the number of beaver. The greatest potential for influence appears to be related to high flows during the winter months. Such flows could dislodge caches, washing away the beavers' food supply, or flood beaver lodges, causing the beaver to die of exposure. Low flows in winter could leave caches and lodges exposed to the elements, making them inaccessible to the beaver and/or making the beaver accessible to predators, including man.

Table 15. Correlation coefficients of linear regression analysis of numbers of furbearers trapped in Fish and Game Regions 5 and 7 compared with various flows of the Yellowstone River at Billings and Miles City.

Region	Prior to Trapping Season		During Trapping Season		
	Water Year[a] (10)[f]	October[b] (15)[f]	Calendar Year[c] (15)[f]	Water Year[d] (15)[f]	January[e] (15)[f]
			BEAVER		
5	-0.605	-0.509[g]	-0.623[h]	-0.488[g]	+0.280
7	-0.210	-0.172	-0.244	-0.471	-0.368
			MINK		
5	-0.389	-0.188	-0.232	-0.314	-0.038
7	+0.089	-0.310	-0.167	-0.154	-0.330
			MUSKRAT		
5	-0.150	-0.328	-0.282	-0.068	-0.158
7	+0.353	+0.203	+0.252	-0.039	+0.193

NOTE: All coefficients not identified by footnotes g or h were not significant.

[a]The total flow for the year beginning October 1 and ending September 30 prior to the beginning of the trapping season.

[b]Total flow for the October immediately preceding the beginning of the trapping season.

[c]Total flow for the year beginning January 1 (in the middle of the trapping season) and ending December 31.

[d]Total flow for the year beginning October 1 just prior to the beginning of the trapping season and ending September 30.

[e]Total flow for January occurring during the trapping season.

[f]Degrees of freedom determined by number of years of compatible data.

[g]Statistical significance ($p = .05$) of correlation. Snedecor and Cochran 1967.

[h]Statistical significance ($p = .01$) of correlation. Snedecor and Cochran 1967.

Table 16. Correlation coefficients of linear regression analysis of number of beaver caches related to flow data on the Bighorn, Tongue, and Yellowstone rivers.

Location of Gaging Station	Degrees of Freedom[a]	Time of Flow			
		Previous Water Year	February/January[b]	June	September/August[b]
YELLOWSTONE RIVER					
At Billings	4	0.552	-0.993[c]	0.287	-0.471
At Miles City	10	-0.364	-0.488	-0.329	-0.588[d]
At Sidney	10	-0.267	-0.318	-0.399	-0.316
TONGUE RIVER					
At Mouth	9	0.127	0.470	0.092	0.265
BIGHORN RIVER					
At Mouth	4	0.243	-0.329	-0.001	0.582

NOTE: All coefficients not identified by footnotes c or d were not significant.

[a]Degrees of freedom--number of years of population data minus one.

[b]For the Yellowstone River calculations, February and September flows were used; for the Tongue and Bighorn calculations, January and August flows.

[c]Significance level ($p = .01$).

[d]Significance level ($p = .05$).

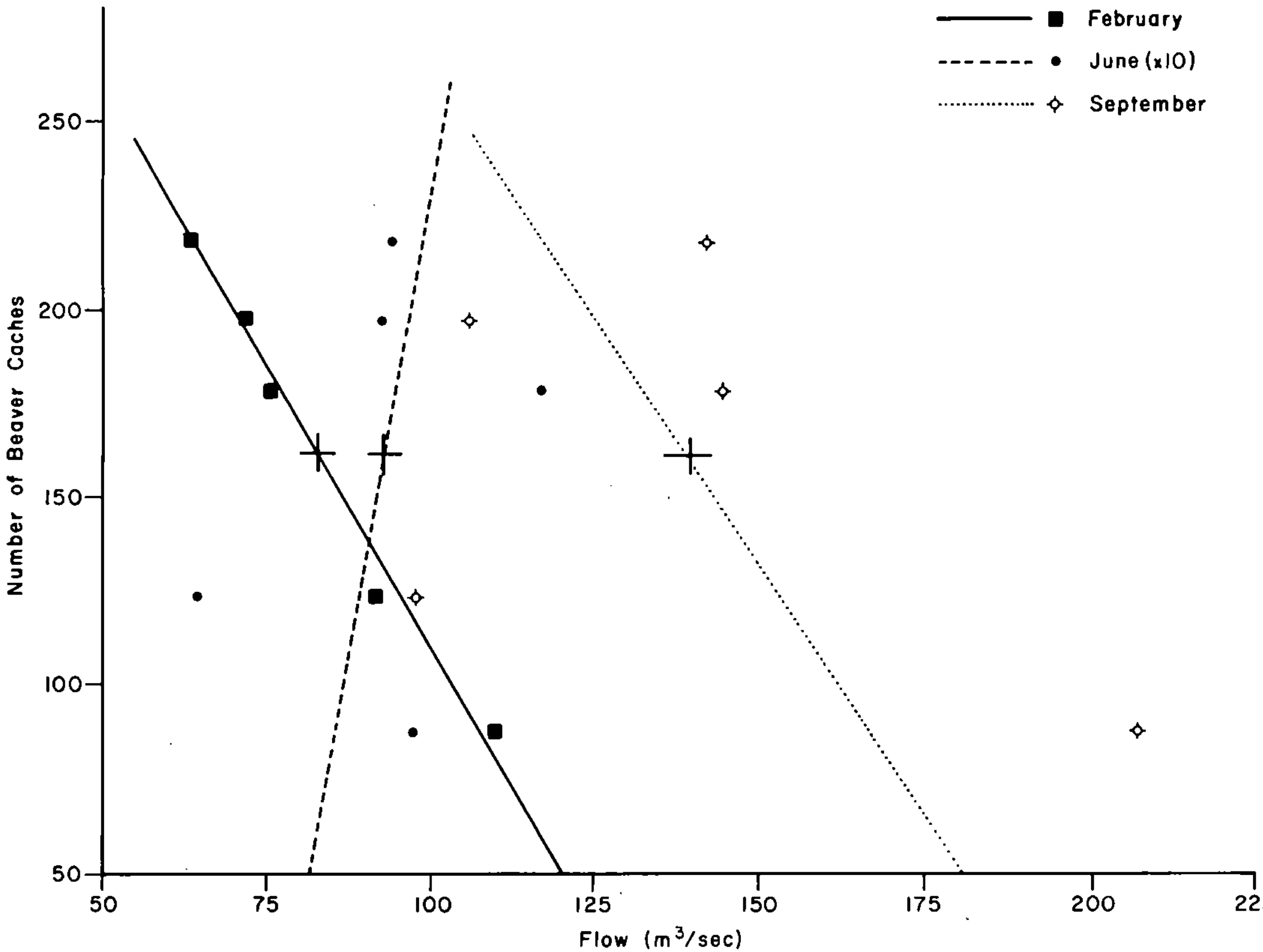

Figure 12. Beaver cache count vs. recorded flows of the Yellowstone River at Billings in February, June, and September.

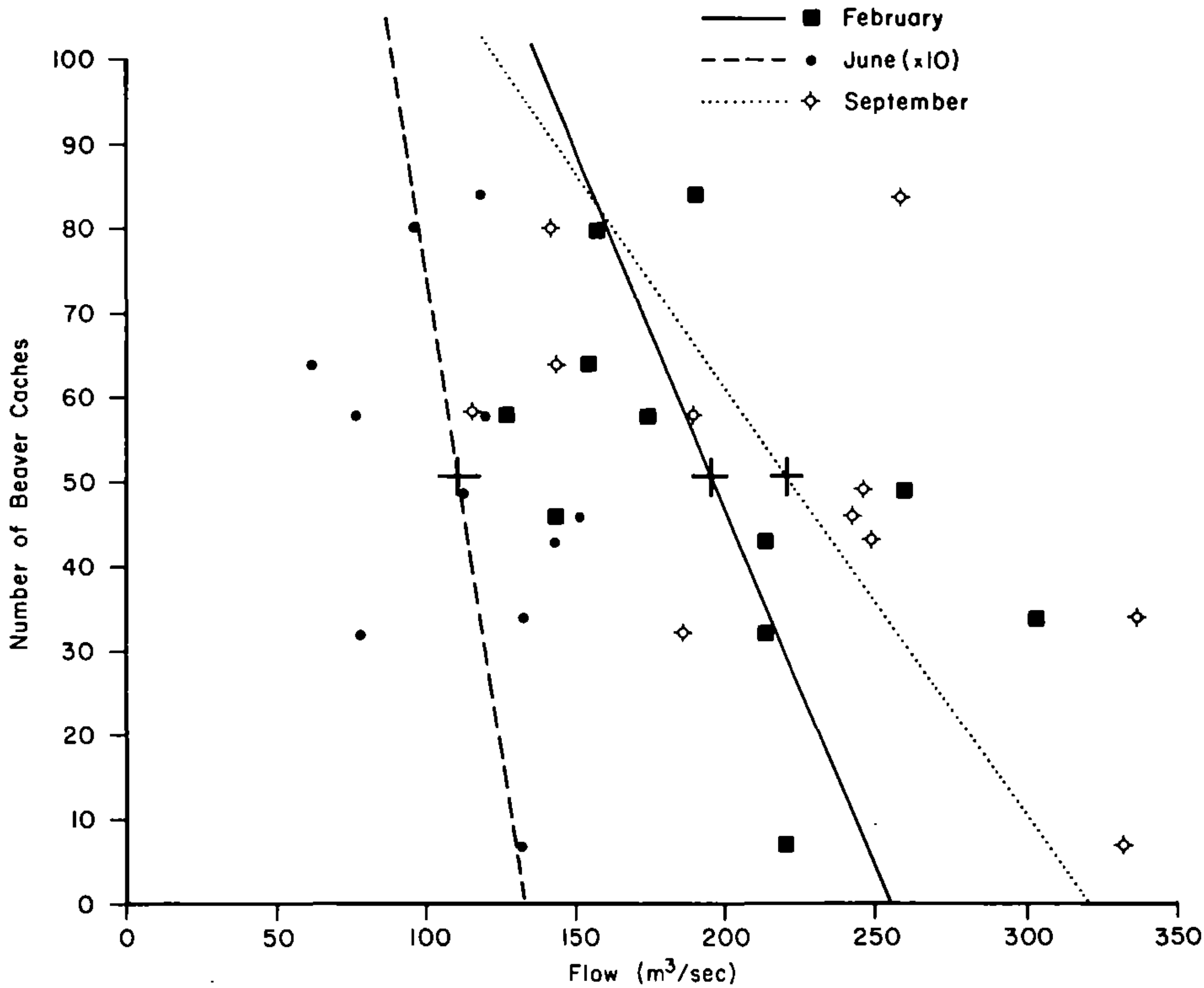

Figure 13. Beaver cache count vs. recorded flows of the Yellowstone River at Miles City in February, June, and September.

TRAPPING INCOME

Nearly $215,900 was introduced into the area economy from the sale of pelts by licensed trappers in the 1973-74 season (table 17). (No license is needed to trap species not officially classified as furbearers--see discussion of classifications on page 15. The value of the pelts trapped by unlicensed trappers is not known.) The average licensed trapper in the study area realized $685. Of this average, mink, muskrat, and beaver pelts accounted for 27 percent; beaver alone accounted for 20 percent. Economically, the most important species was fox (26 percent of the total value of pelts), followed by bobcat (24 percent).

TABLE 17. Total dollars per species and average dollars realized per trapper of each species during the 1973-74 fur trapping season in Fish and Game Regions 5 and 7.

	Region 5		Region 7		Study Area		
	Total Value of Pelts[a] ($)	Average Income Per Trapper of Each Species[b] ($)	Total Value Of Pelts[a] ($)	Average Income Per Trapper of Each Species[b] ($)	Total Value of Pelts[a] ($)	Average Income Per Trapper of Each Species[b] ($)	Percentage of Total Value of Pelts
Beaver	28,158.62	215.60	14,561.52	166.67	42,720.14	191.14	19.8
Muskrat	6,538.00	50.20	1,389.96	25.74	7,927.96	37.97	3.7
Mink	3,560.34	47.33	3,498.66	68.63	7,059.00	57.98	3.3
Weasel	30.60	1.26	37.80	1.71	68.40	1.49	0.03
Bobcat	21,728.07	294.48	29,833.09	419.83	51,561.16	357.16	23.9
Skunk	3,768.00	24.80	2,850.75	31.28	6,618.74	28.04	3.1
Coyote	9,329.62	120.85	8,674.45	156.82	18,004.07	138.84	8.3
Raccoon	13,477.75	88.73	8,162.81	81.71	21,640.56	85.22	10.0
Badger	745.38	17.27	1,995.45	30.21	2,740.83	23.74	1.3
Fox	16,670.94	150.35	38,597.66	409.99	55,268.60	280.17	25.6
Canada Lynx	1,998.97	310.19	289.48	108.56	2,288.45	209.38	1.1
TOTAL	116,006.29	633.91[c]	109,891.63	832.51[c]	215,897.92	685.39[c]	

[a]Number trapped x average pelt price.

[b]Average catch per trapper x average pelt price.

[c]These totals were derived by dividing the total value of pelts by the total numbers of licensed trappers (183 in Region 5, 132 in Region 7, 315 in the study area).

Since the 1960-61 season, beaver have been the most economically important of the primary species studied. The sale of beaver pelts has generated an average annual income of $193 per beaver trapper in Fish and Game Region 5 and $200 per beaver trapper in Region 7 (table 18) since that season. Mink followed with $74 and $88 per mink trapper in Regions 5 and 7, respectively. Muskrat trappers realized an average of $29 each in Region 5 and $20 each in Region 7.

Since 1973-74, the number of trappers in the study area has decreased by nearly 20 percent (table 19). The number of trappers living in towns situated on the mainstem of the Yellowstone has decreased by 10 percent, although trappers in that category have grown from 62 to 69 percent of all trappers living within the study area. In 1975-76, 203 persons bought trapping licenses. Twenty percent (40) of these live in Billings.

From these data it appears that most of the trappers are located in Fish and Game Region 5, most live on the mainstem of the Yellowstone, and more live in Billings than any other single location.

TABLE 18. Total dollars per species and average dollars realized per trapper per species in Fish and Game Regions 5 and 7, 1960-74.

Season	BEAVER				MINK				MUSKRAT			
	Region 5		Region 7		Region 5		Region 7		Region 5		Region 7	
	Total Value of Pelts[a] ($)	Average Income Per Trapper of each species[b] ($)	Total Value of Pelts[a] ($)	Average Income Per Trapper of each species[b] ($)	Total Value of Pelts[a] ($)	Average Income Per Trapper of each species[b] ($)	Total Value of Pelts ($)	Average Income Per Trapper of each species[b] ($)	Total Value of Pelts ($)	Average Income Per Trapper of each species[b] ($)	Total Value of Pelts[a] ($)	Average Income Per Trapper of each species[b] ($)
1960-61	23,324.00	285.72	14,239.00	261.82	11,412.72	124.15	1,660.36	47.55	1,345.50	14.44	192.60	6.66
1961-62	16,569.00	180.68	9,503.00	140.35	7,366.42	78.14	2,240.60	65.90	3,693.60	34.20	557.76	19.92
1962-63	21,462.00	291.27	17,283.00	353.89	11,511.50	124.12	8,830.95	252.56	6,708.42	70.60	972.04	21.13
1963-64	7,795.00	120.98	5,528.77	118.14	16.555.40	166.91	5,821.76	155.04	2,995.74	32.75	1,096.00	24.88
1964-65	6,104.70	127.40	2,163.84	39.06	7,005.63	74.72	2,219.14	92.22	2.340.92	28.55	146.73	8.24
1965-66	5.052.84	132.72	13,438.74	336.48	9.662.08	97.22	2,686.86	103.22	2,669.65	36.59	639.84	31.99
1966-67	8,901.79	155.97	5,234.06	137.48	5,905.20	72.96	1,351.25	64.63	1,412.43	18.56	85.80	5.35
1967-68	11,502.07	173.29	7,522.15	206.78	3.283.38	45.29	1,394.64	58.97	498.00	7.32	227.88	7.99
1968-69	13,332.81	216.55	8,924.38	198.90	4,204.20	79.77	1,921.92	92.09	1,131.63	16.82	984.20	33.74
1969-70	16,999.50	196.35	8,805.10	153.53	3.640.98	44.87	1.659.84	61.26	1.905.30	19.53	1,105.28	27.28
1970-71	8,977.36	179.93	3.108.93	96.99	1,053.15	24.78	612.75	35.48	959.04	16.80	335.67	15.75
1971-72	12,532.35	185.50	8,101.98	236.43	1,069.26	21.08	587.40	32.31	1.539.73	23.75	348.74	14.84
1972-73	28,101.96	243.97	24,392.96	291.99	2,343.09	33.88	3,564.90	102.51	4,110.03	37.54	2,419.22	43.07
1973-74	28,158.62	215.60	14.561.52	166.67	3,560.34	47.33	3.493.66	68.63	6.538.00	50.20	1,389.96	25.74
AVERAGE	14,915.29	193.28	10,200.50	199.53	6,326.66	73.94	2.717.93	83.03	2,703.43	29.12	750.12	20.47

[a]Number trapped x average pelt price.

[b]Average catch per trapper x average pelt price.

TABLE 19. Residences of Yellowstone River Basin trappers.

	1973-74		1974-75		1975-76	
	Number of Resident Trappers	%	Number of Resident Trappers	%	Number of Resident Trappers	%
MAINSTEM TOWNS						
Billings	42	17	56	23	40	20
Big Timber	22	9	22	9	18	9
Miles City	17	7	14	6	14	7
Glendive	15	6	14	6	12	6
Forsyth	11	4	10	4	12	6
Columbus	11	4	8	3	4	2
Laurel	7	3	5	2	11	5
Hysham	5	2	7	3	6	3
Others[a]	25	10	22	9	23	11
TOTAL	155	62	158	65	140	69
TRIBUTARY TOWNS[b]	96	38	85	35	63	31
REGION 5	157	63	169	70	135	67
7	94	37	74	30	68	33
TOTAL	251	100	243	100	203	100

[a]Trappers were resident in 16 "other" mainstem towns in 1973-74, 12 in 1974-75, and 13 in 1975-76.

[b]Trappers were resident in 39 tributary towns in 1973-74, 32 in 1974-75, and 27 in 1975-76.

Impacts of water withdrawals

PROJECTIONS OF FUTURE USE

In order to adequately and uniformly assess the potential effects of water withdrawals on the many aspects of the present study, it was necessary to make projections of specific levels of future withdrawals. The methodology by which this was done is explained in Report No. 1 in this series, in which also the three projected levels of development, low, intermediate, and high, are explained in more detail. These three future levels of development were formulated for energy, irrigation, and municipal water use. Annual water depletions associated with the future levels of development were included in the projections. These projected depletions, and the types of development projected, provide a basis for determining the level of impact that would occur if these levels of development were carried through.

IMPACT OF YELLOWTAIL DAM ON BIGHORN RIVER

Reservoirs have the potential for causing the most severe detrimental effects on furbearer populations, especially beaver. Settling out of sediments, which results in channel degradation, and elimination of peak flows, which greatly reduces island-forming processes, are the primary factors involved.

As a part of this investigation, aerial photos taken prior to the construction of Yellowtail Dam were compared with photos taken after its construction in order to determine what geomorphological changes had taken place. The methodology and specific results of that study are given in Report No. 2 in this series, The Effect of Altered Streamflow on the Hydrology and Geomorphology of the Yellowstone River Basin, Montana.

Extensive, predictable changes in the structure of the Bighorn River were revealed. The number and area of island gravel bars were substantially reduced. A 77-percent loss in gravel bar area was recorded. The highest losses were in the section closest to the dam, progressing to the lowest loss in the section farthest from the dam. Overall, twenty-three percent of the area of vegetated islands was lost. The number of islands, an indicator of prime beaver habitat, was reduced from 414 to 287, a 31-percent reduction. Combination of small islands into large islands eliminates the intermediate waterways as locations for beaver caches, dams, and lodges. Joining of islands to the mainland has the same effect. Even though the total riparian area remains relatively stable, the quality is greatly reduced for wildlife habitat. When islands become part of the mainland, they become accessible to man and his livestock, and their value as habitat is degraded as protective and escape cover is lost. Controlled flows also encourage clearing of the land for agricultural purposes, which is detrimental to many forms of wildlife, including furbearers.

POTENTIAL IMPACTS OF ALTERED STREAMFLOWS ON FURBEARERS

The impact of altered streamflows on beaver and other furbearers can be direct or indirect. Exact predictions of population declines or increases would be subjective at best. Under any scenario on any river the following statements will generally hold true.

Reduction in flows during winter months can result in beaver caches and muskrat feed beds freezing, making them inaccessible to use. Entrances to lodges and bank dens may become exposed, making the furbearer vulnerable to predation, or frozen shut, meaning death by starvation.

Increased winter flows could wash away food caches, forcing the furbearer to constantly expose himself to the elements and to predators in order to obtain food. It seems advisable, in the interest of furbearers, to maintain stable flows from October, when beaver and muskrat begin construction of their food caches, through March or April, when spring ice break-up is complete.

Low flows in early fall apparently stimulate beaver into building dams (Wilsson 1968). Normally, beaver dams would be impossible to construct on the Yellowstone, Tongue, or Bighorn rivers except in portions of braided channel sections. Extremely lowered flows would encourage dam building by beaver for protection and escape from predators. This activity would entail extensive additional cuttings of cottonwood trees and willow stands, incurring several effects. First, it would decrease the available food supply for beaver. Second, it would weaken bank resistance to erosion by high water during runoff periods. Third, it would reduce habitat for other wildlife species, including deer, game birds, song birds, and raptors, which use cottonwoods and willows for nesting, perching, and protective cover.

Indirect effects are probably more important than direct effects in the long run. The most important of the indirect effects of streamflow alteration is that related to channel morphology. Due to operation of reservoirs, regulated rivers lose peak flows, the primary influence in formation of new islands and gravel bars. The reservoirs, through deposition of sediments in the reservoir, release clear water downstream, resulting in channel degradation. This degradation results in the elimination of existing islands and gravel bars. Then, with no new islands and gravel bars being formed and existing ones being lost, plant succession can continue through the seral to climax stages. Willow is usually the first seral stage to occupy areas of recent alluvium (Hawk and Zobel 1974). However, as finer textured sediments are deposited by successive lower-stage flooding (the results of lower flood peaks), the soil becomes finer textured and the depth to the water table increases. When the flood plain is elevated beyond the normal flood level, the plant communities develop toward climax, and willow, the primary beaver food source in this area, is replaced by mature cottonwood-grassland vegetation. Hawk and Zobel (1974) reported that willow associations were not common in their study area, probably because of recent moderation of streamflow by upstream reservoirs.

Summary

Beaver are almost totally dependent on the river for life functions. Mink and muskrat, while living in proximity to water, are either able to move away from the river or actually prefer to live in marsh habitat and thus are not as dependent on the Yellowstone or its tributaries for survival as are beaver. River otter are dependent upon the fish population and other unknown factors which seem to limit otter numbers more than does the fish population. There are few otter inhabiting the study area.

The Yellowstone River supports a higher density beaver population than does either the Tongue or Bighorn rivers, both of which have major reservoirs. The braided sections of the Yellowstone, with many islands and abundant willow and young cottonwood stands, provide the best beaver habitat. The poorest habitat consists of only one water channel with few or no deciduous trees or shrubs. Recent historical peaks in population numbers seem to have occurred in the early 50's and middle 70's. The present peak is the highest since records have been kept.

Fur harvest studies indicate that beaver pelt prices have no effect on the number of beaver trapped, suggesting that beaver trappers are as interested in recreation as in profit. The two Fish and Game Regions in the study area apparently have nearly equal numbers of beaver. Region 5 had more beavers trapped and more beaver trappers, but region 7 had a higher catch per trapper, a statistic which may be more indicative of population levels than the others.

Mink pelt prices were significantly related to the number of mink trapped throughout the study area. Region 5 apparently has more mink than Region 7 because it showed more mink trapped, more mink trappers, and a higher average catch per trapper, even though Region 7 had a higher average pelt price.

Muskrat pelt price, like that of beaver, was not related to the number of muskrats trapped. Region 5 apparently has more muskrats than Region 7 because it showed the most trapped, the most trappers, and the highest catch per trapper.

Examination of beaver caches built on the Yellowstone, Tongue, and Bighorn rivers in 1975 revealed that willow was the beavers' primary food source. Beaver preferred to build their caches in braided sections of the river and onstream even under the pressure of high population levels. Mixed cottonwood and willow stands were adjacent to the majority of beaver caches, perhaps reflecting the beavers' penchant for building caches next to areas with relatively high banks to provide preferred bank den entrance locations.

Trapping contributed nearly a quarter of a million dollars ($215,900) to the income of local licensed trappers in the 1973-74 season. The average trapper realized $685 that season, of which beaver, mink, and muskrat accounted for 27 percent. Beaver, the most financially important of the water-related furbearers, accounted for 20 percent of the individual trapper's trapping income. Most of the trappers in the study area live in Fish and Game Region 5, most live on the mainstem of the Yellowstone, and more live in Billings than any other single location.

The numbers of beaver, mink, and muskrat trapped in Fish and Game Regions 5 and 7 were generally negatively related to flows of the Yellowstone River at Billings and Miles City. In Region 5, the beaver relationships were significant ($p = .05$), but even the highest relationship was less than 40 percent attributable to flow. Mink relationships were generally negative and insignificant; as mentioned earlier, mink are not closely tied to the river ecosystem. Muskrat relationships were negative in Region 5 and positive in Region 7. Most of the muskrat were probably not trapped on the river.

Beaver population levels were negatively related to flow (significant at $p = .01$) on the Yellowstone at Billings during the winter low-flow period. With $r^2 = 0.99$, almost all of the variation can be attributed to flow. With that exception, the present natural flows in the Yellowstone and regulated flows of the Tongue and Bighorn rivers do not seem greatly related to beaver population levels. Thus, the greatest existing potential for direct influence appears to be related to high flows during winter months, which may dislodge caches, washing away the beavers' food supply, and flood lodges, causing the beaver to die of exposure.

The impacts of altered streamflows on furbearers may be either direct or indirect. Direct influences would occur as altered winter flows froze up or washed away food supplies. Low fall flows could trigger a dam-building response, resulting in overharvesting of willow and young cottonwood trees, which would lower the beavers' future food supply, lead to increased bank erosion, and reduce protective cover for deer and other wildlife species. The indirect effects, resulting from alteration of the morphology of the river channel, would be most important in the long run. The primary indirect effect would be the reduction and eventual elimination of willow stands and young cottonwood trees, the beavers' food supply.

Reservoirs have the potential for causing the most severe detrimental effects on furbearer populations. Report No. 2 in this series assesses the geomorphological changes which have taken place in the Bighorn River since the construction of Yellowtail Dam. The number and area of gravel bars were substantially reduced. The number of islands, an indicator of prime beaver habitat, was reduced by 31 percent. The combination of small islands into large ones and the joining of islands to the mainland both result in the degradation of those islands as furbearer habitat.

Appendixes

Appendix A

TRAPPING DATA FOR BEAVER, MINK, AND MUSKRAT, 1954-74

FIGURES

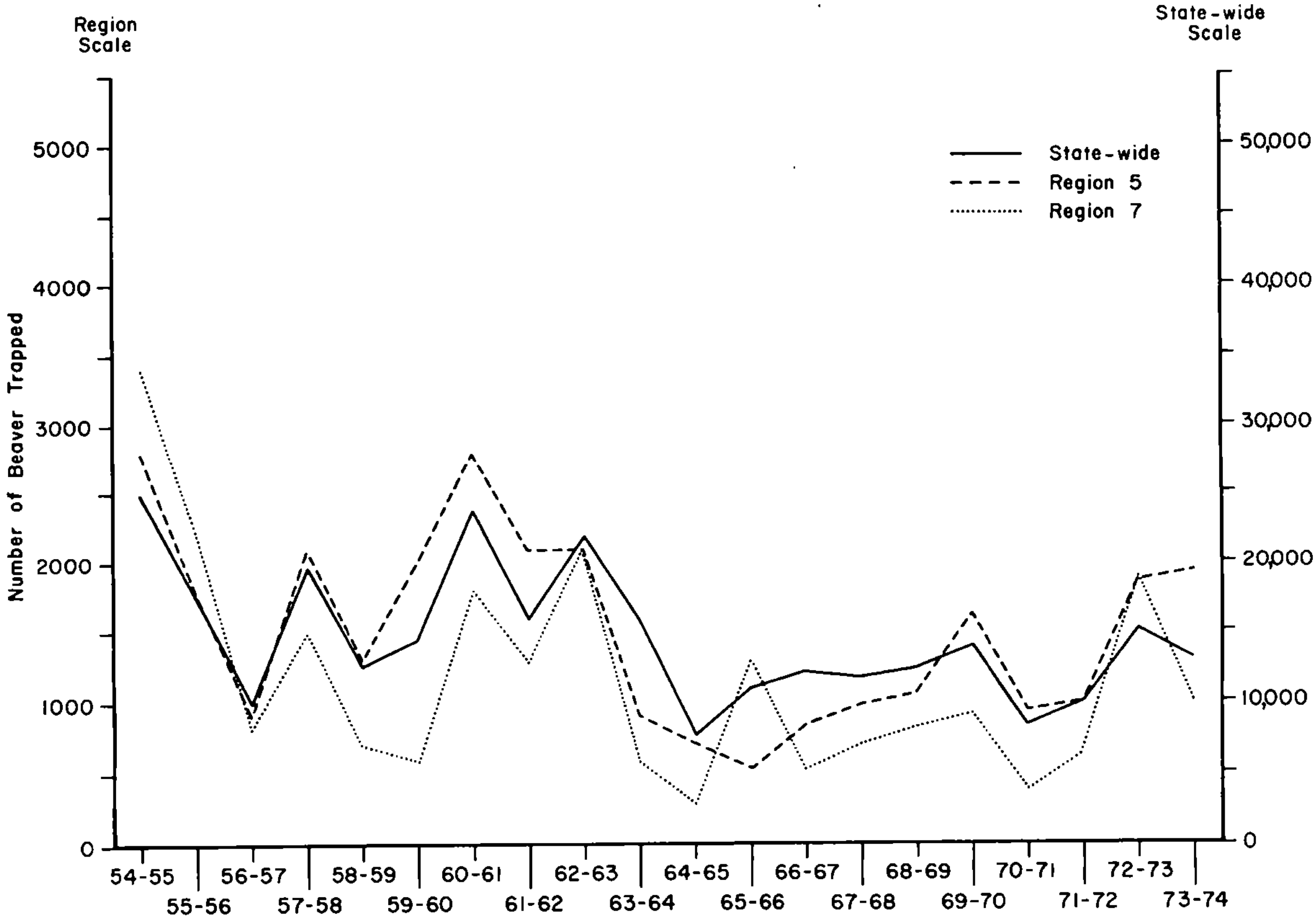

Figure A-1. Estimated number of beaver trapped state-wide and in Fish and Game Regions 5 and 7, 1954-74.

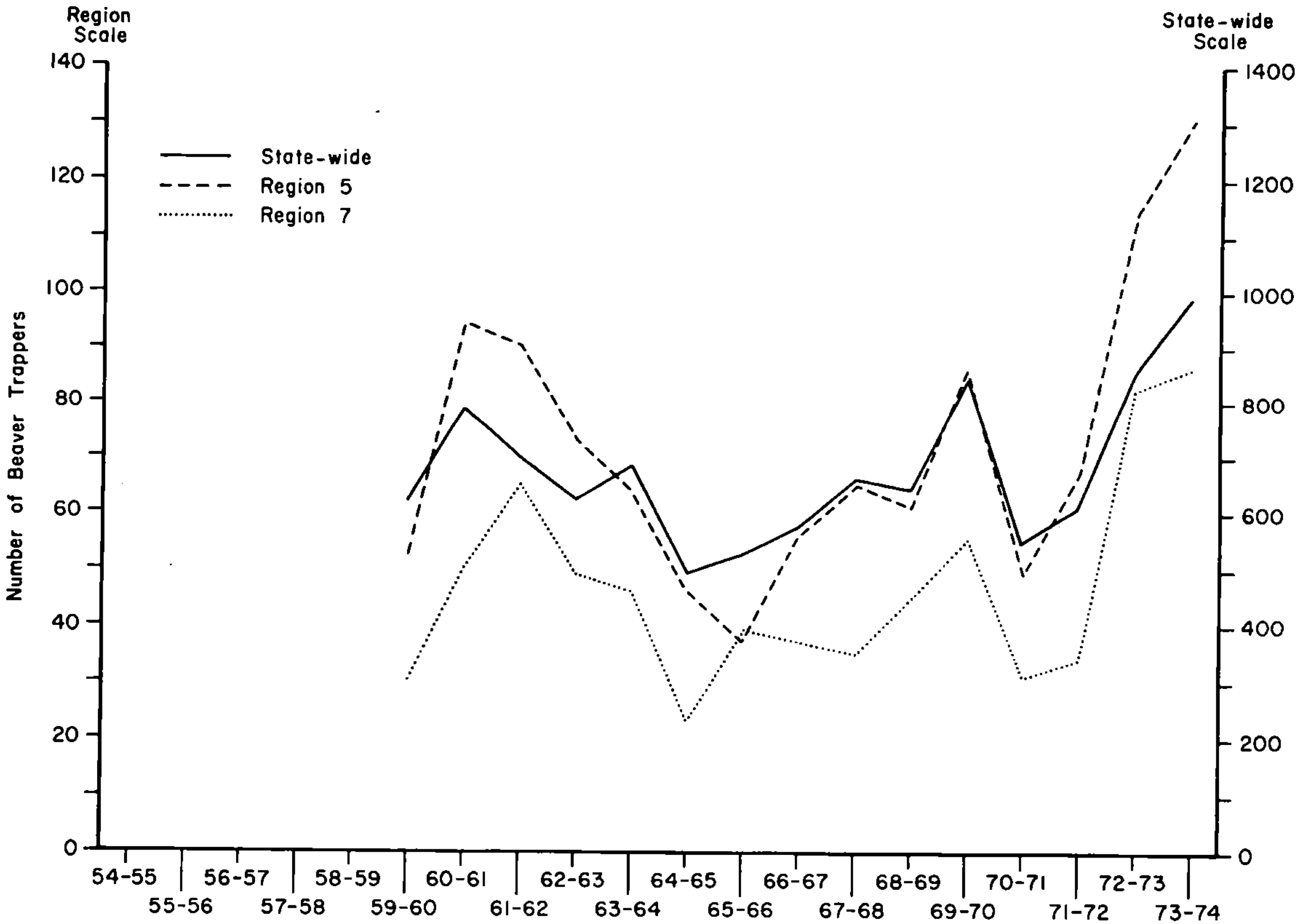

Figure A-2. Estimated number of beaver trappers state-wide and in Fish and Game Regions 5 and 7, 1959-74.

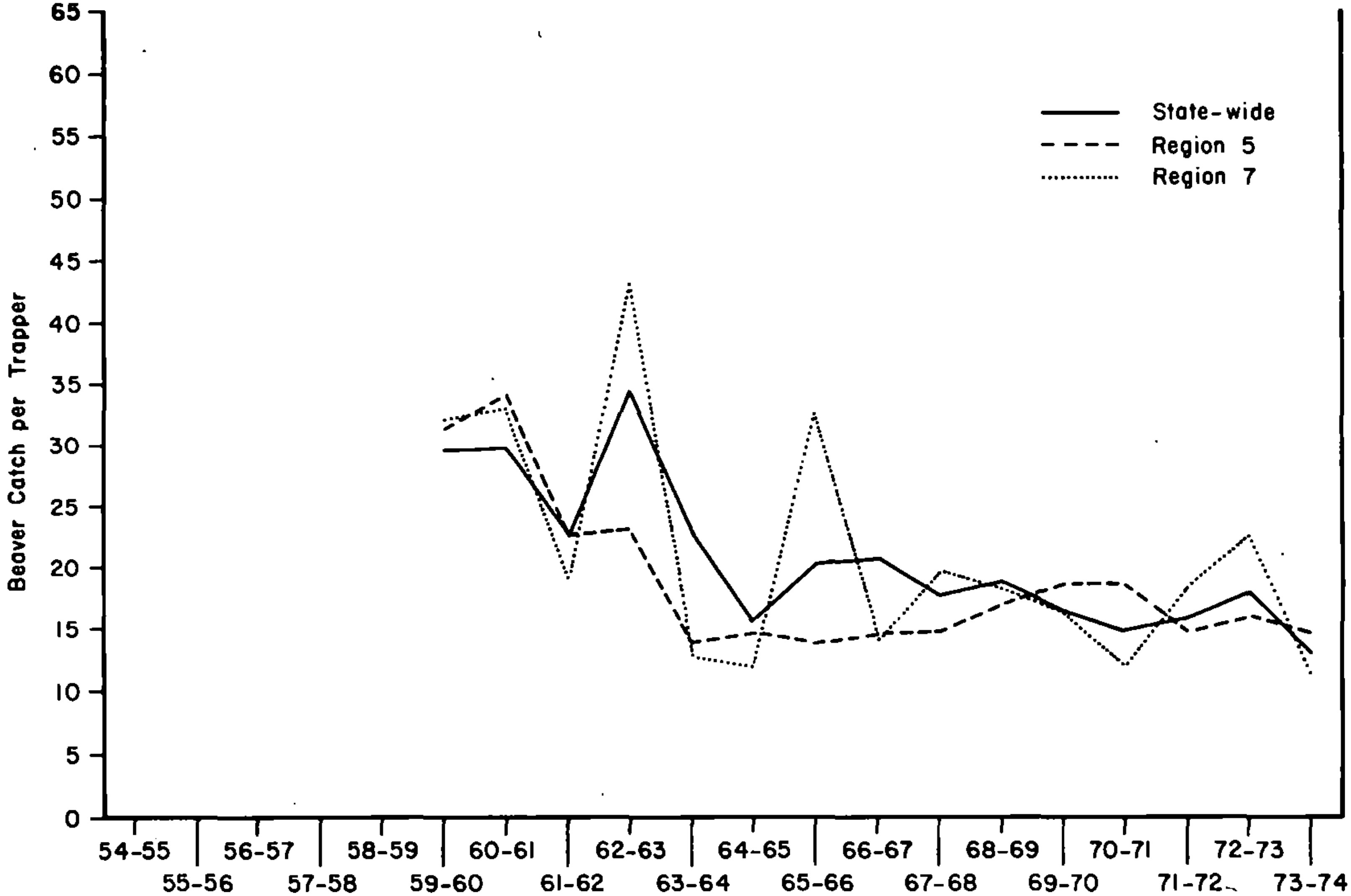

Figure A-3. Average beaver catch per trapper state-wide and in Fish and Game Regions 5 and 7, 1959-74.

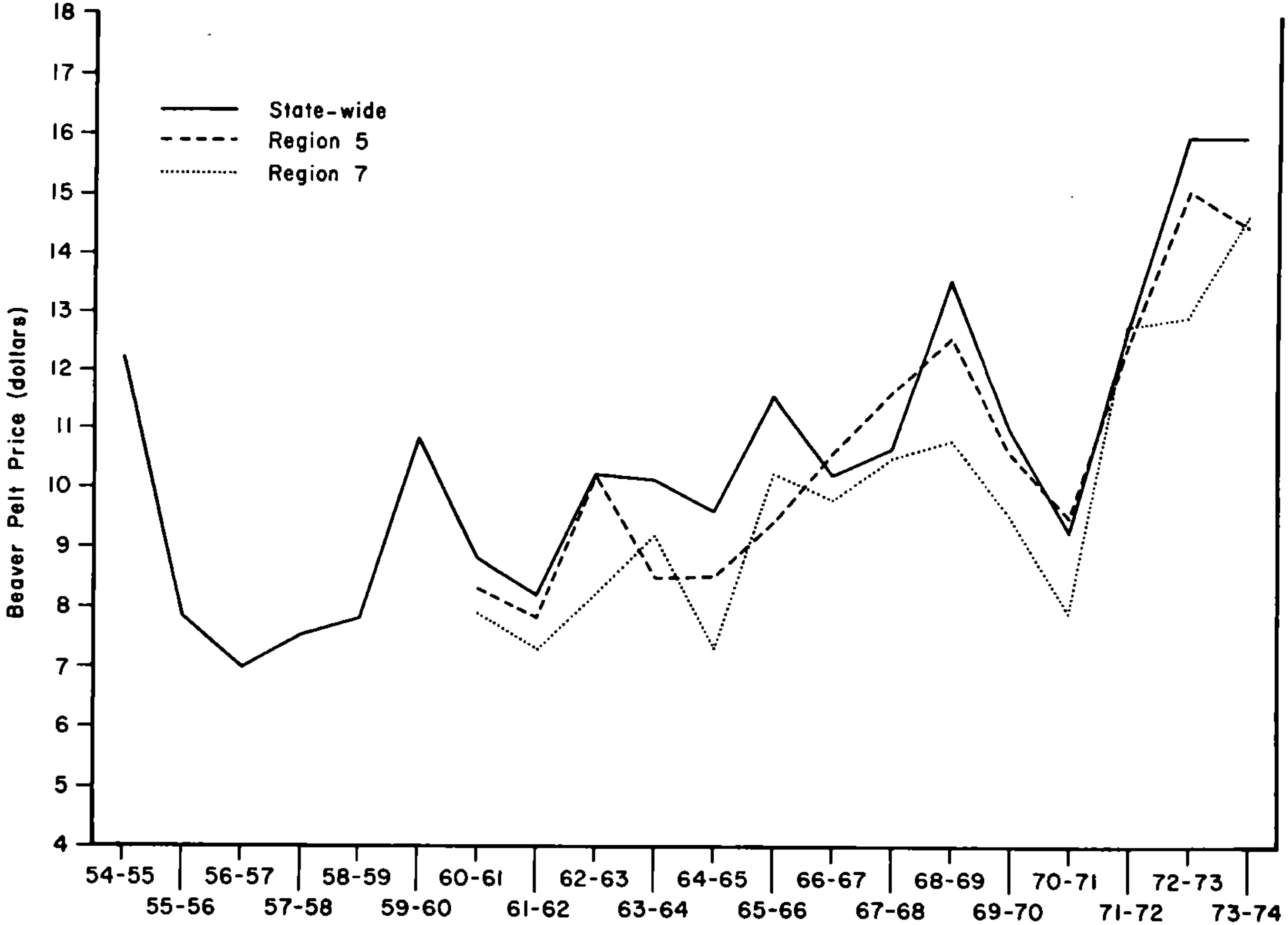

Figure A-4. Average beaver pelt price state-wide and in Fish and Game Regions 5 and 7, 1954-74.

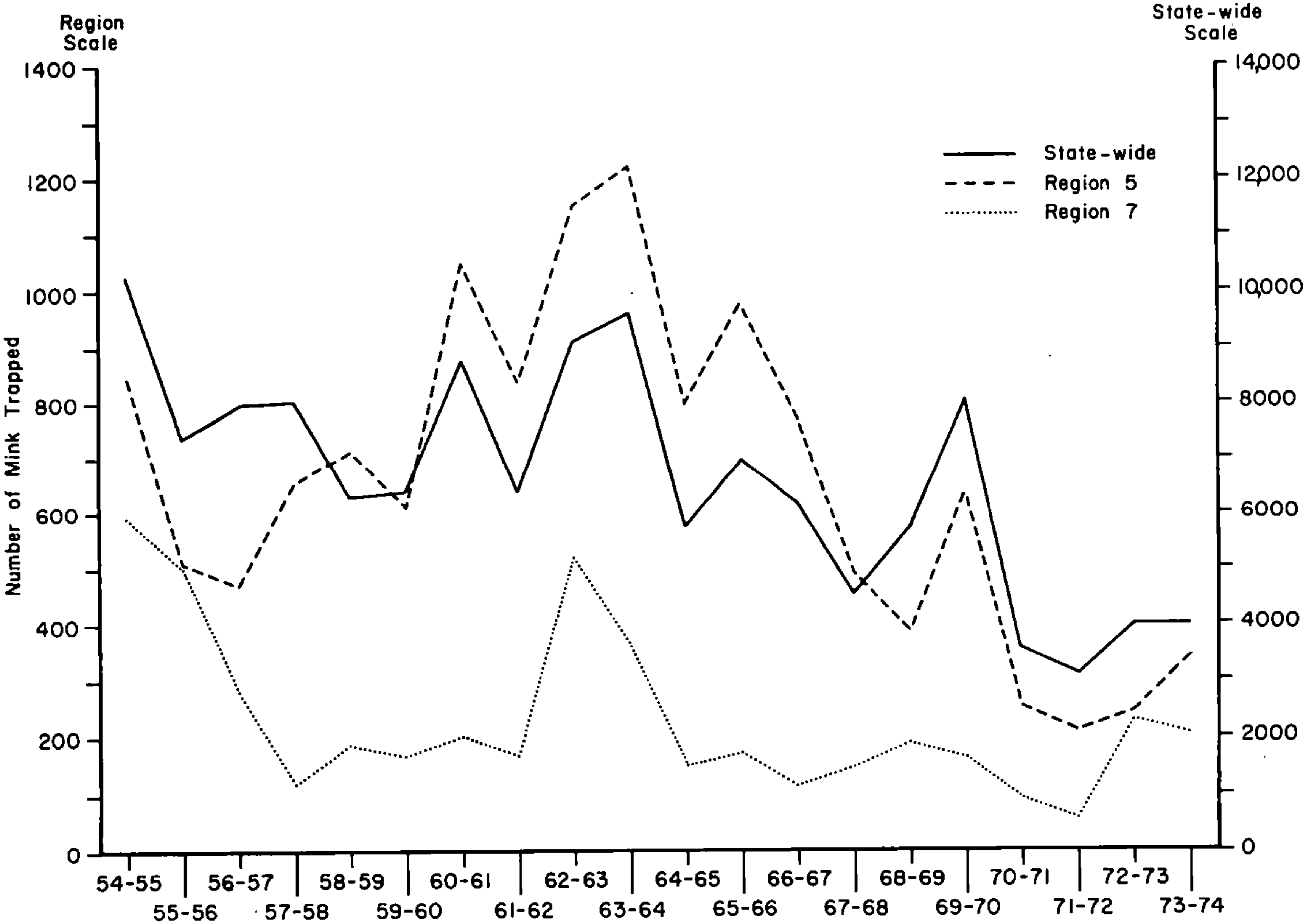

Figure A-5. Estimated number of mink trapped state-wide in Fish and Game Regions 5 and 7, 1954-74.

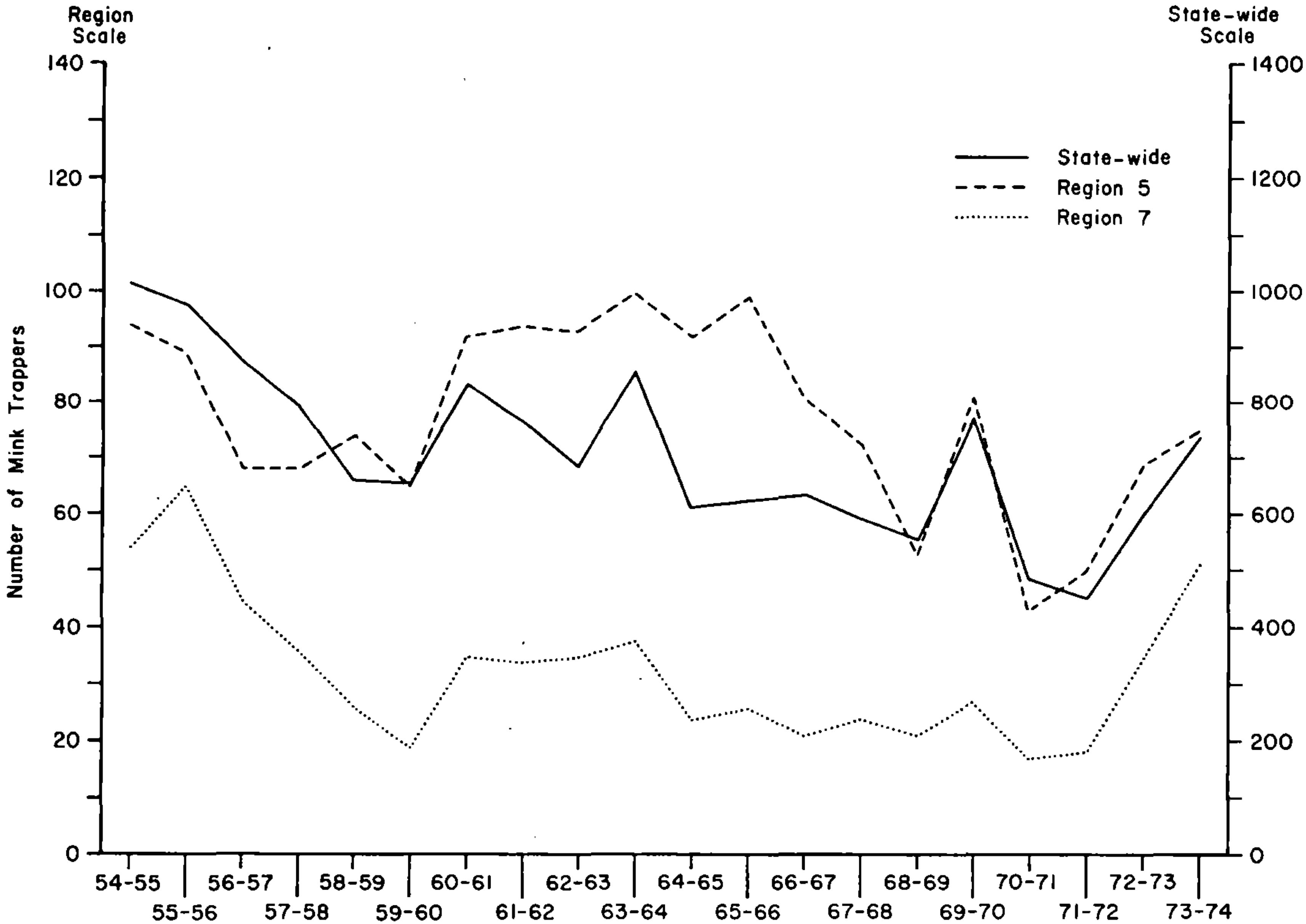

Figure A-6. Estimated number of mink trappers state-wide and in Fish and Game Regions 5 and 7, 1954-74.

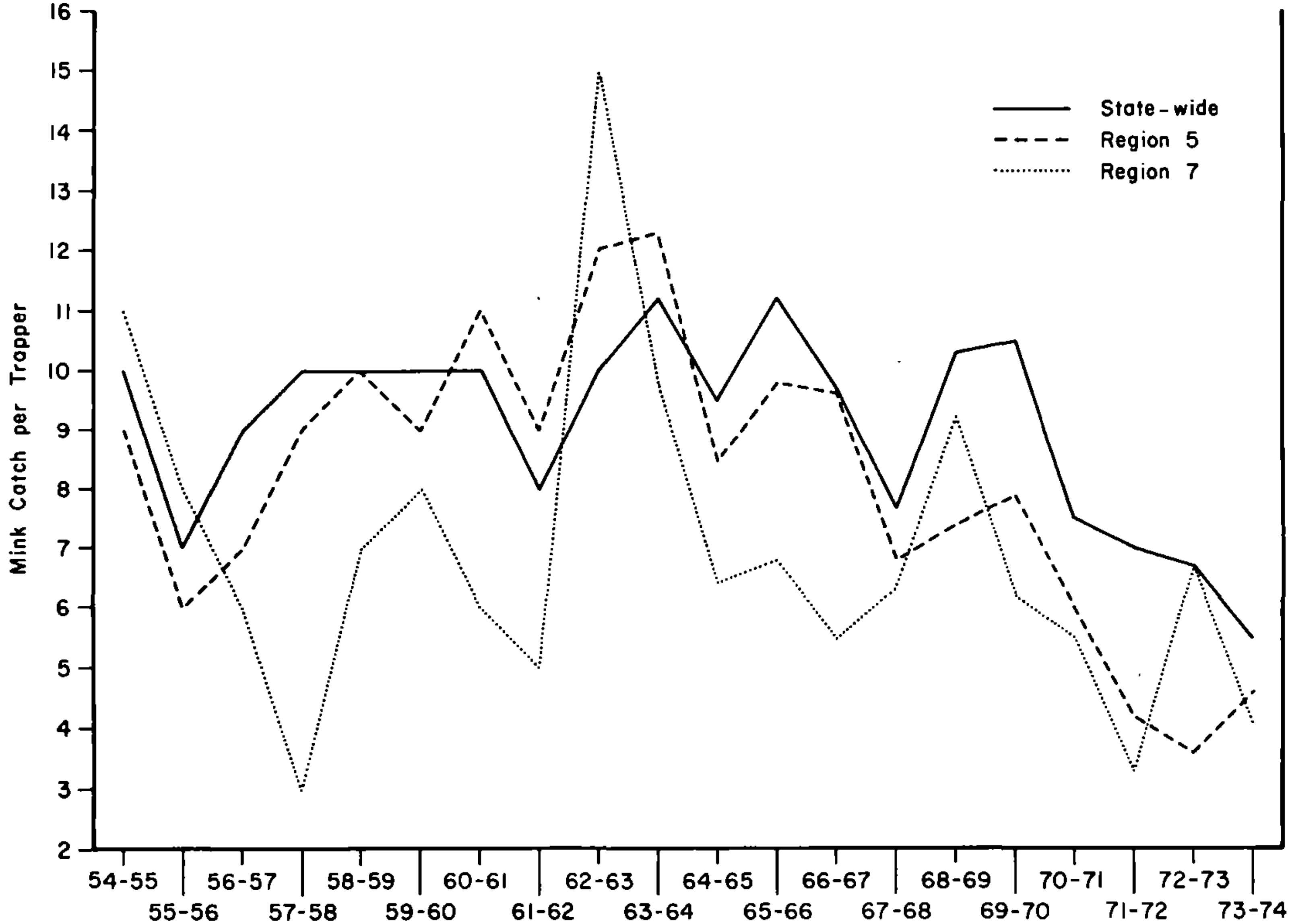

Figure A-7. Average mink catch per trapper state-wide and in Fish and Game Regions 5 and 7, 1954-74.

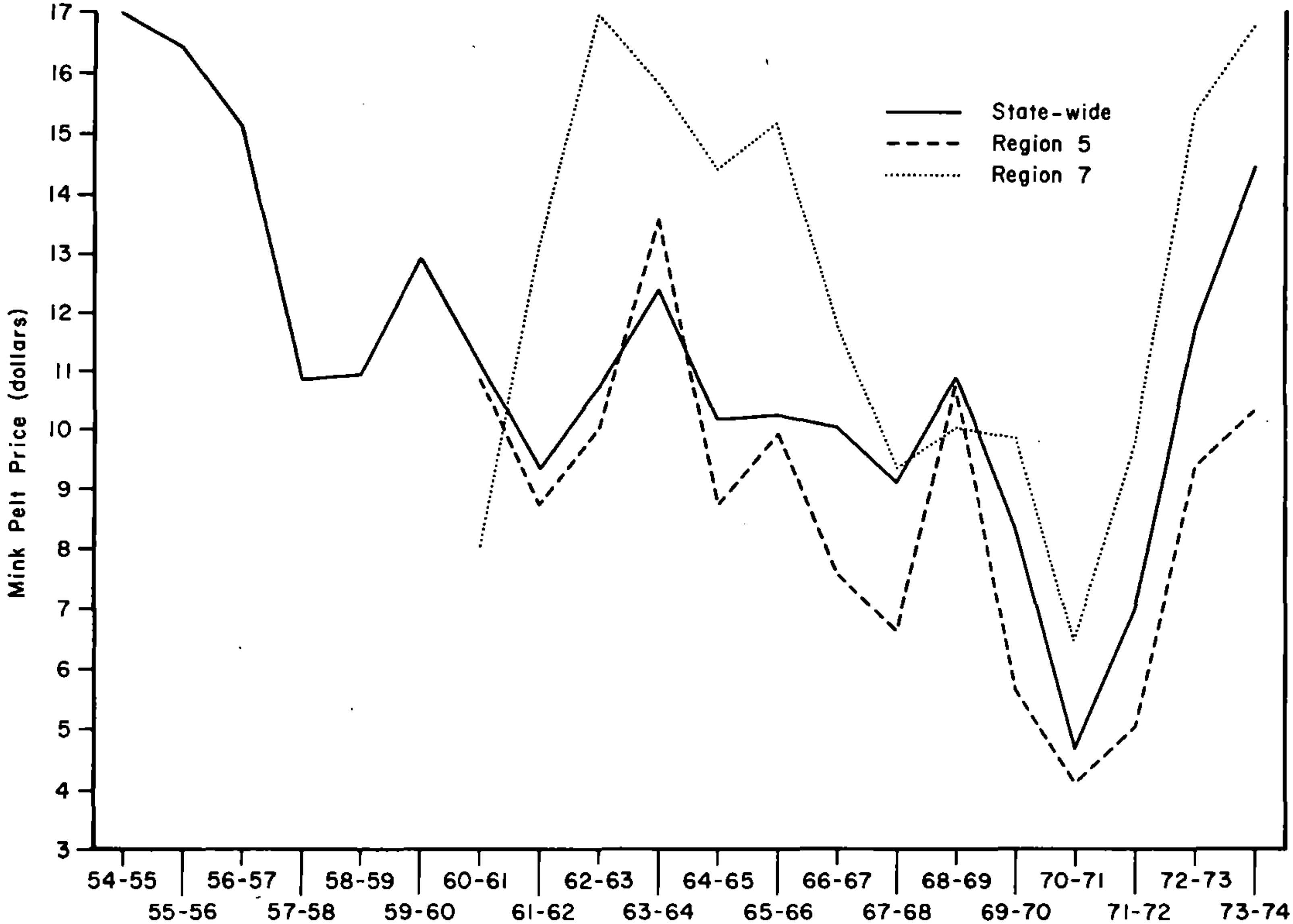

Figure A-8. Average mink pelt price state-wide and in Fish and Game Regions 5 and 7, 1954-74

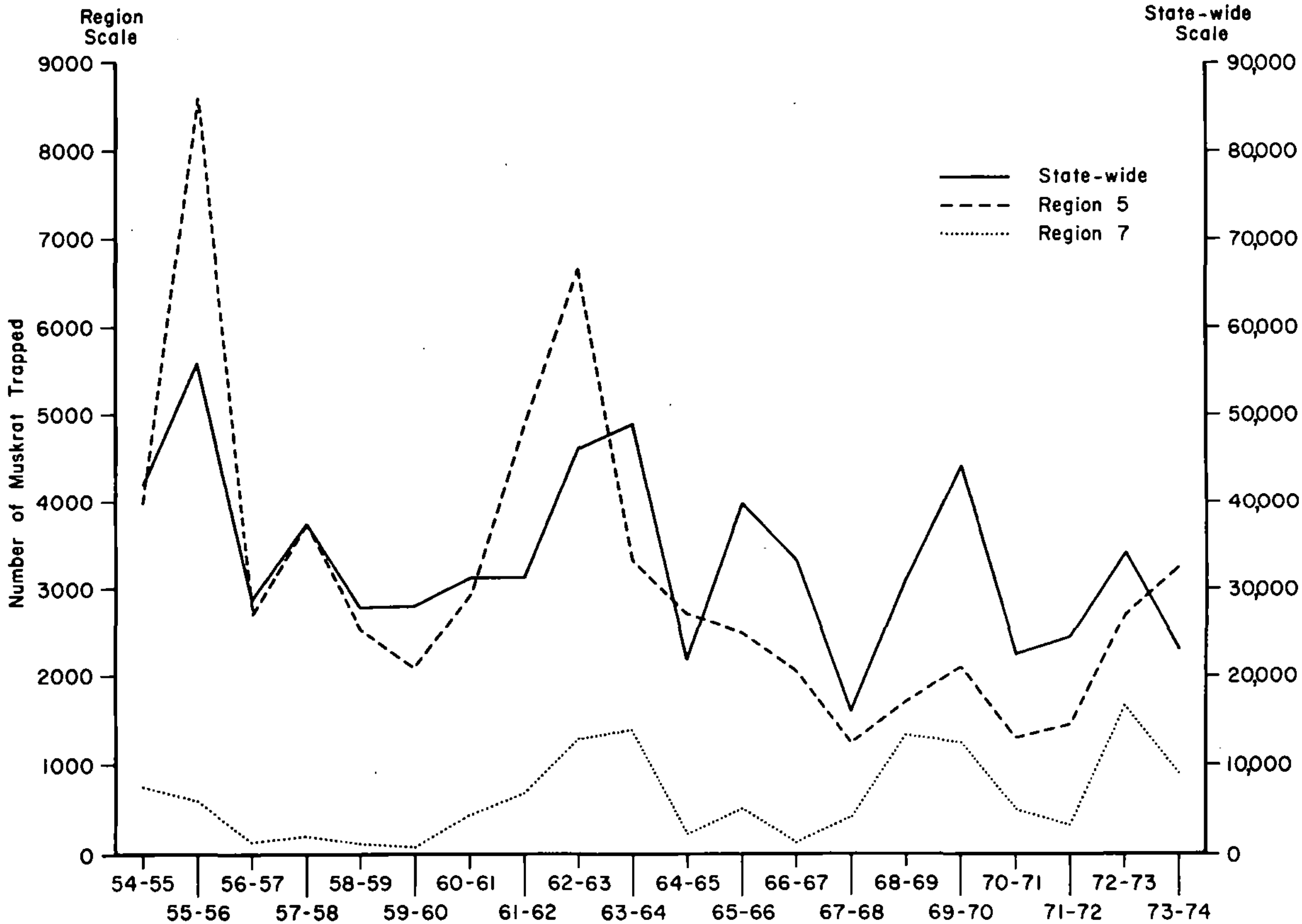

Figure A-9. Estimated number of muskrats trapped state-wide and in Fish and Game Regions 5 and 7, 1954-74.

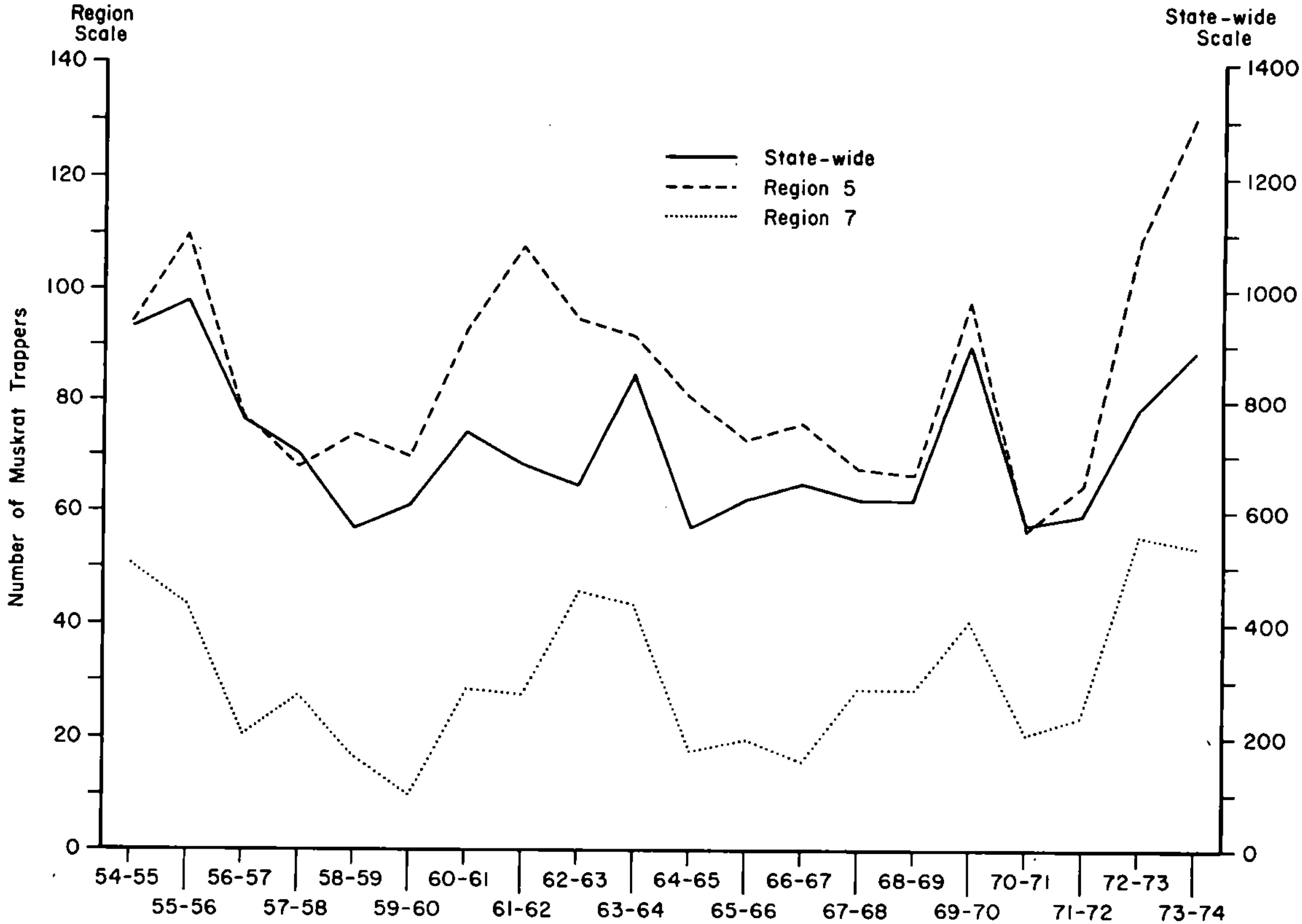

Figure A-10. Estimated number of muskrat trappers state-wide and in Fish and Game Regions 5 and 7, 1954-74

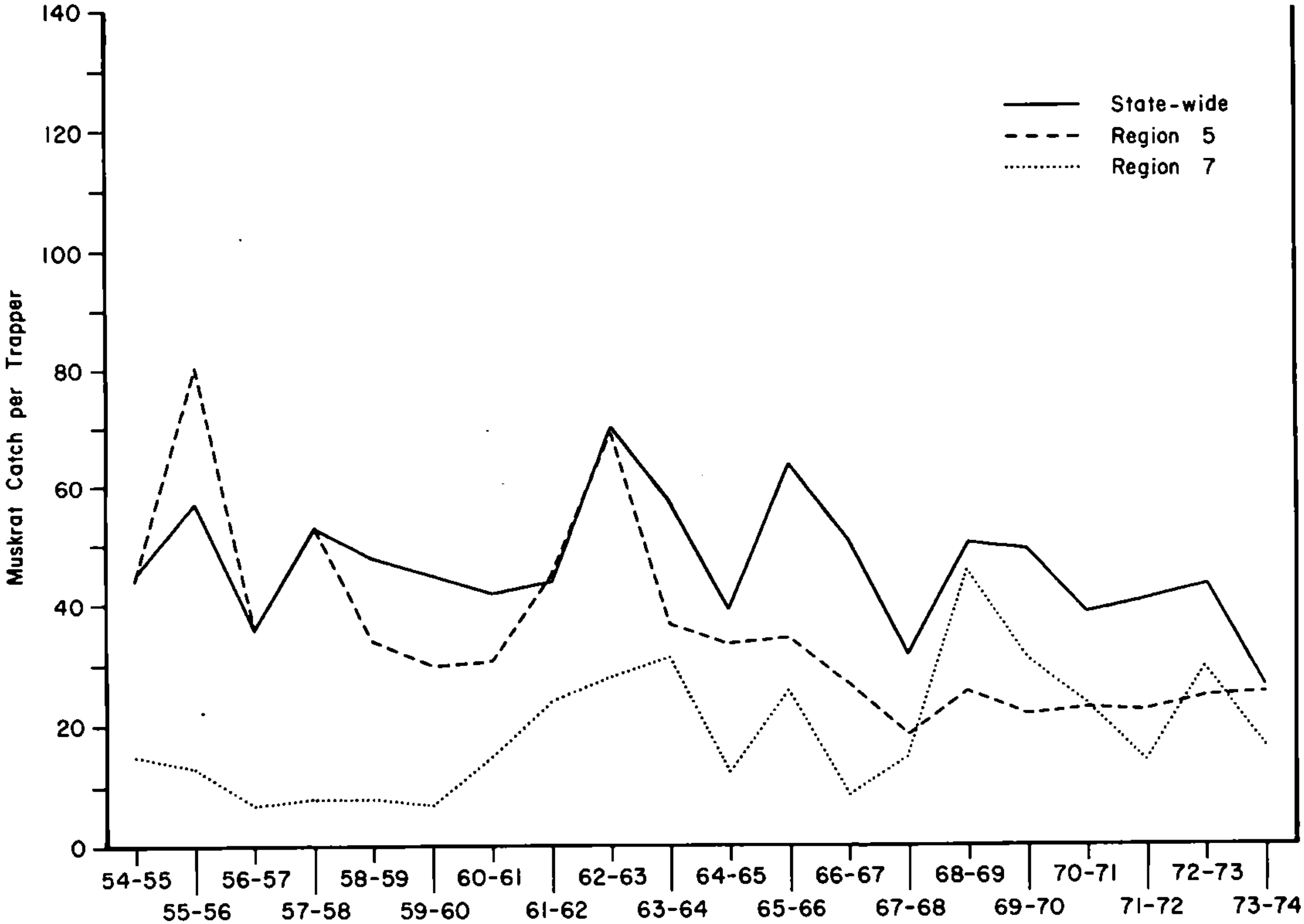

Figure A-11. Average muskrat catch per trapper state-wide and in Fish and Game Regions 5 and 7, 1954-74.

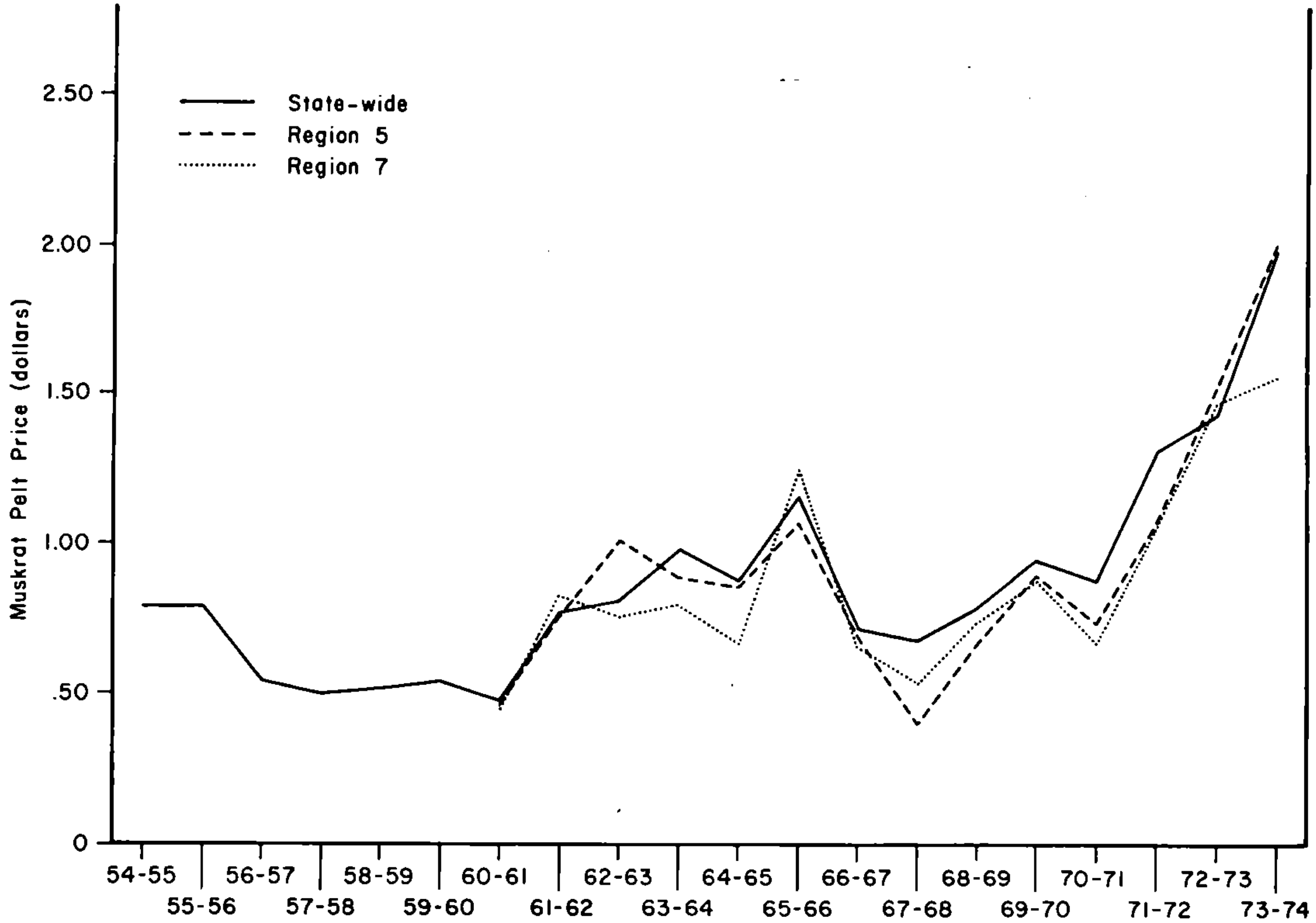

Figure A-12. Average muskrat pelt price state-wide and in Fish and Game Region 5 and 7, 1954-74.

Appendix B

TRAPPING CORRELATIONS AND REGRESSIONS, 1960-74

FIGURES

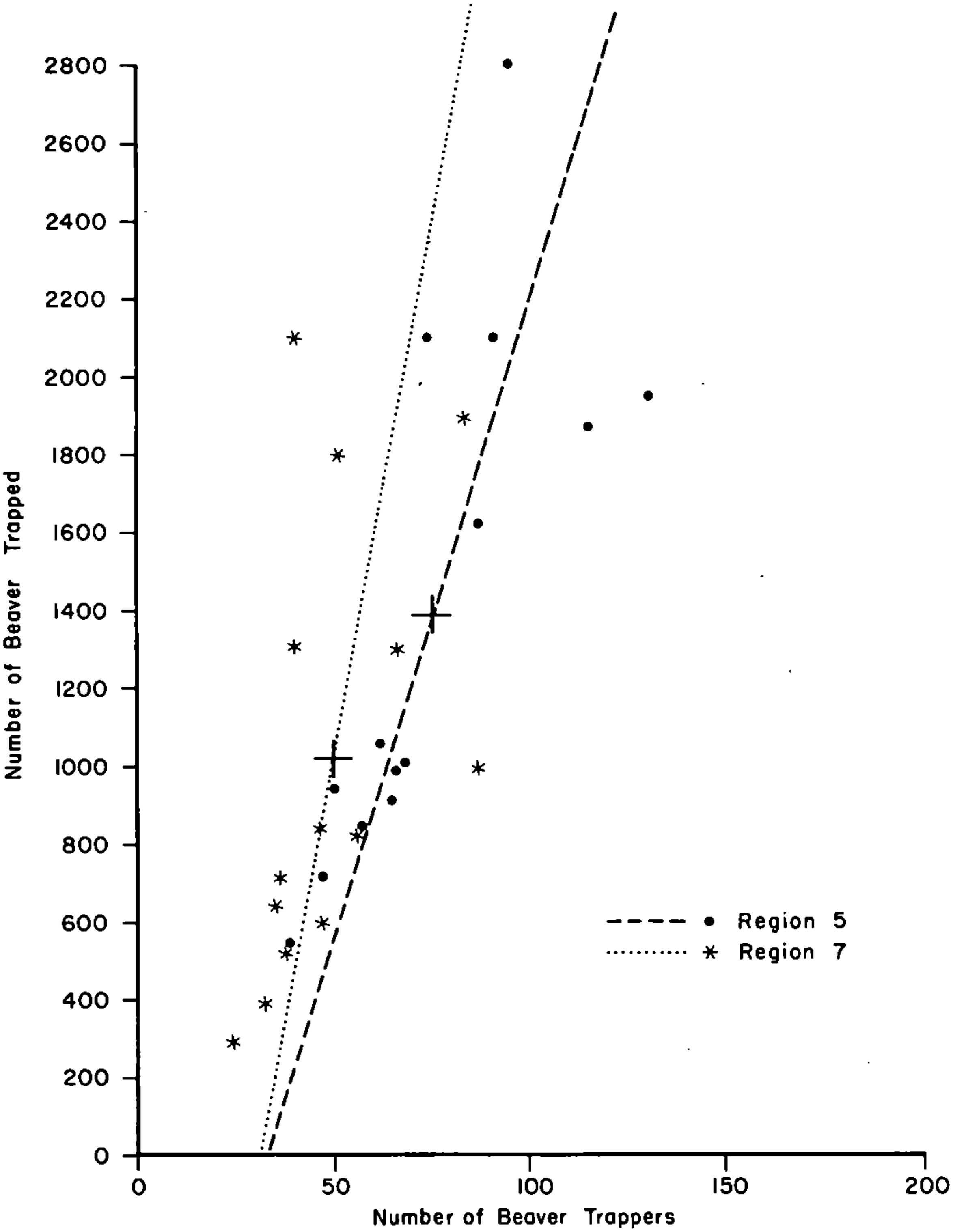

Figure B-1. Beaver trapped vs. beaver trappers in Fish and Game Regions 5 and 7, 1960-74.

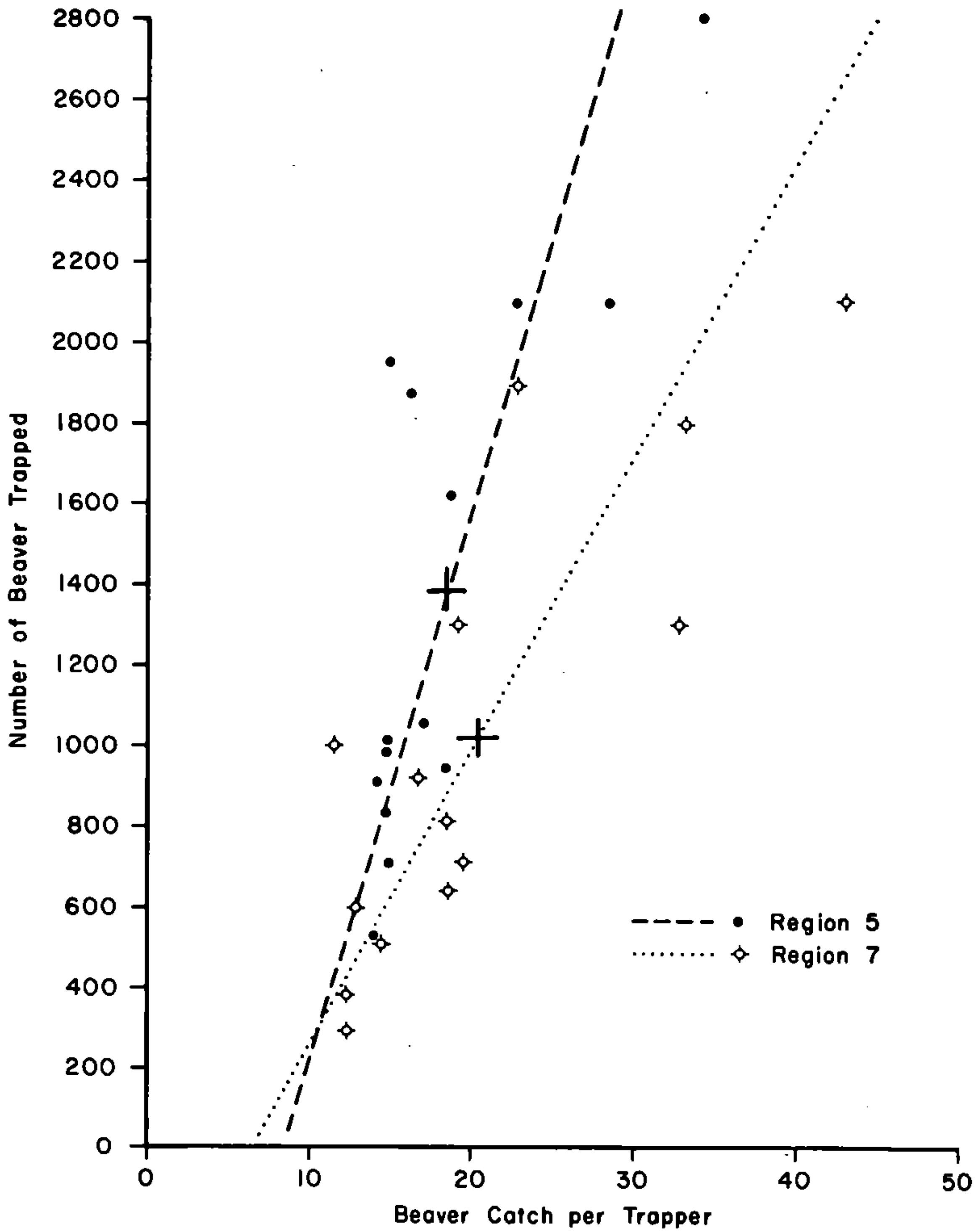

Figure B-2. Beaver trapped vs. average catch per trapper in Fish and Game Regions 5 and 7, 1960-74.

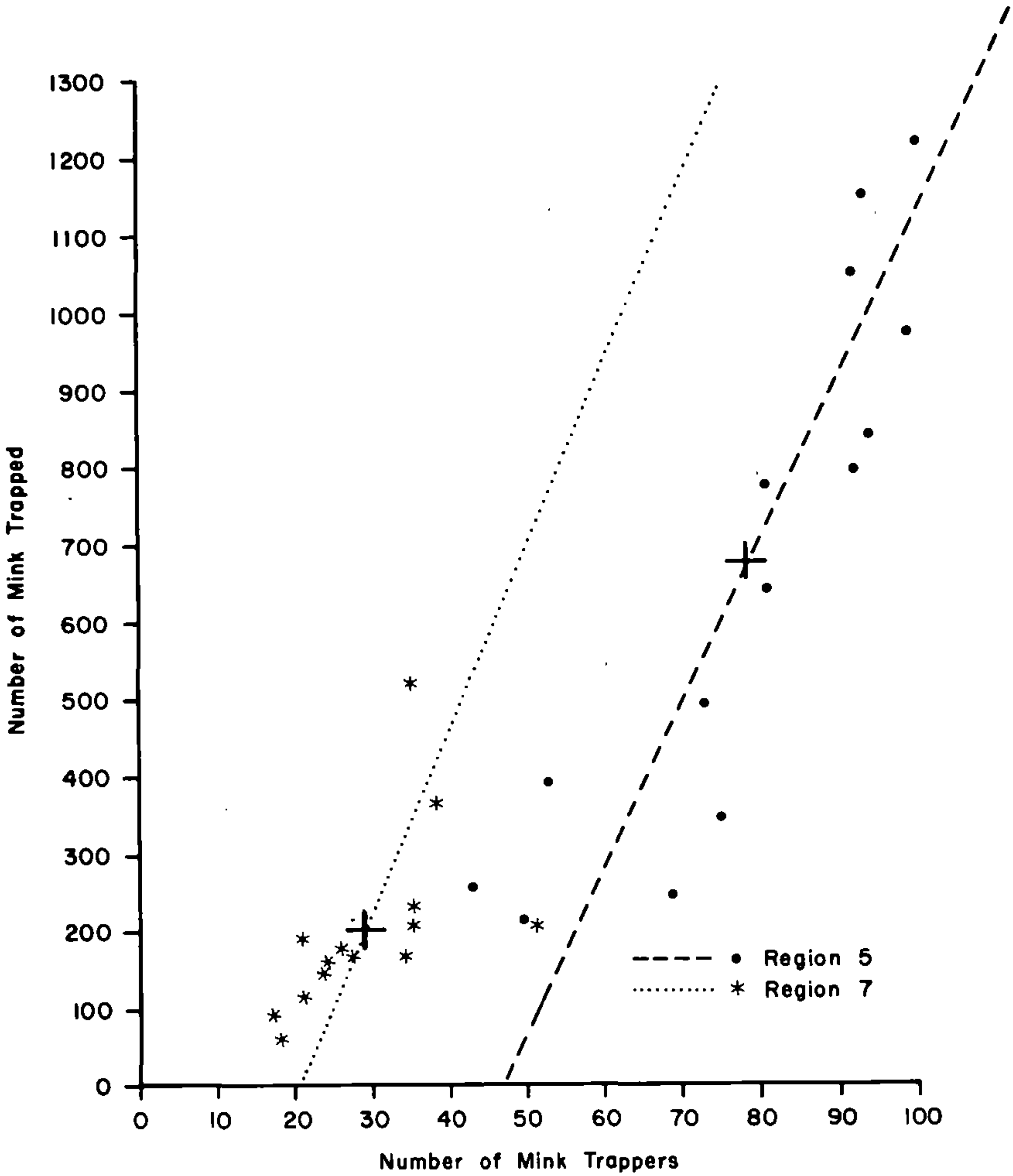

Figure B-3. Mink trapped vs. mink trappers in Fish and Game Regions 5 and 7, 1960-74.

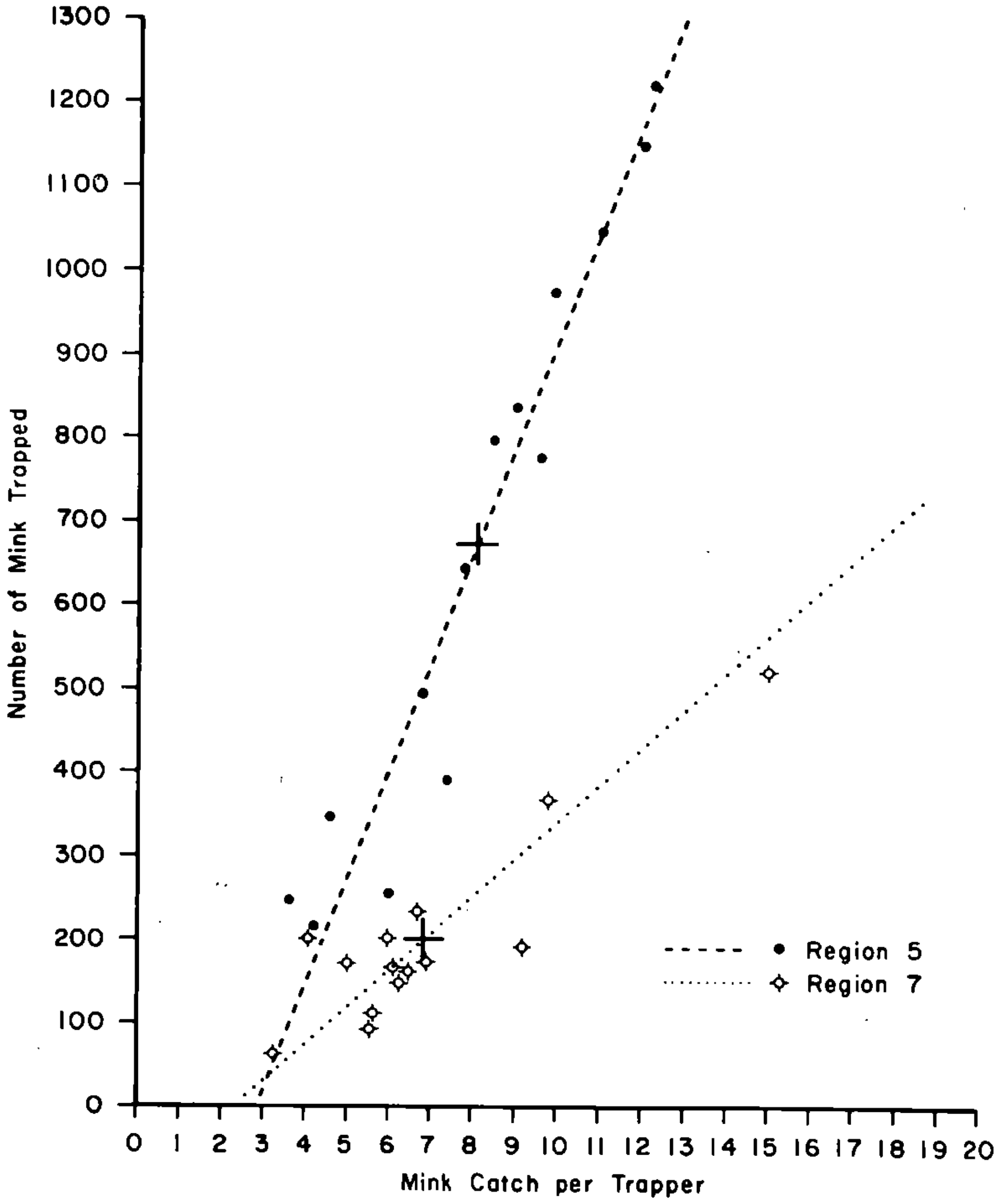

Figure B-4. Mink trapped vs. average catch per trapper in Fish and Game Regions 5 and 7, 1960-74.

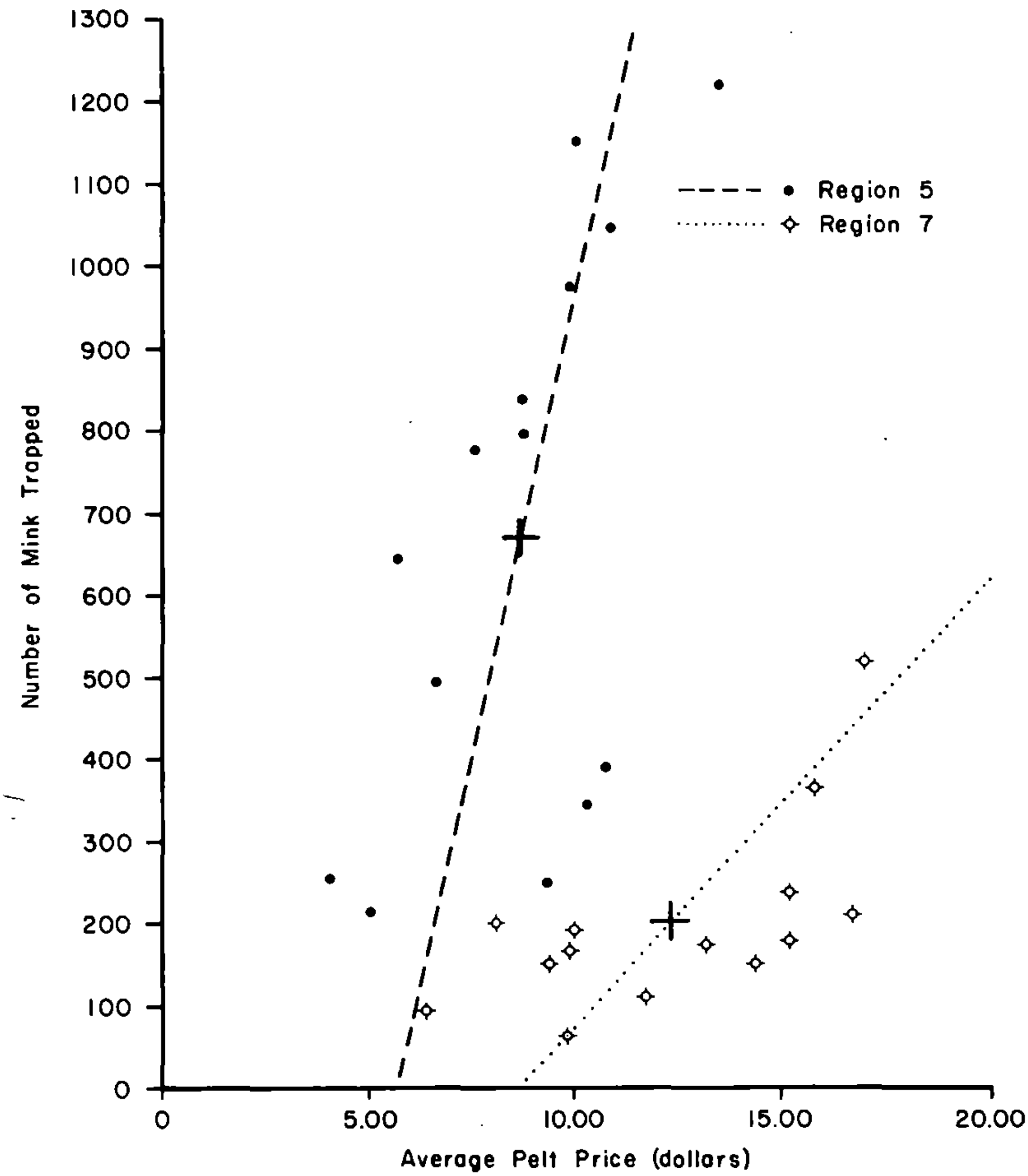

Figure B-5. Mink trapped vs. average mink pelt price in Fish and Game Regions 5 and 7, 1960-74.

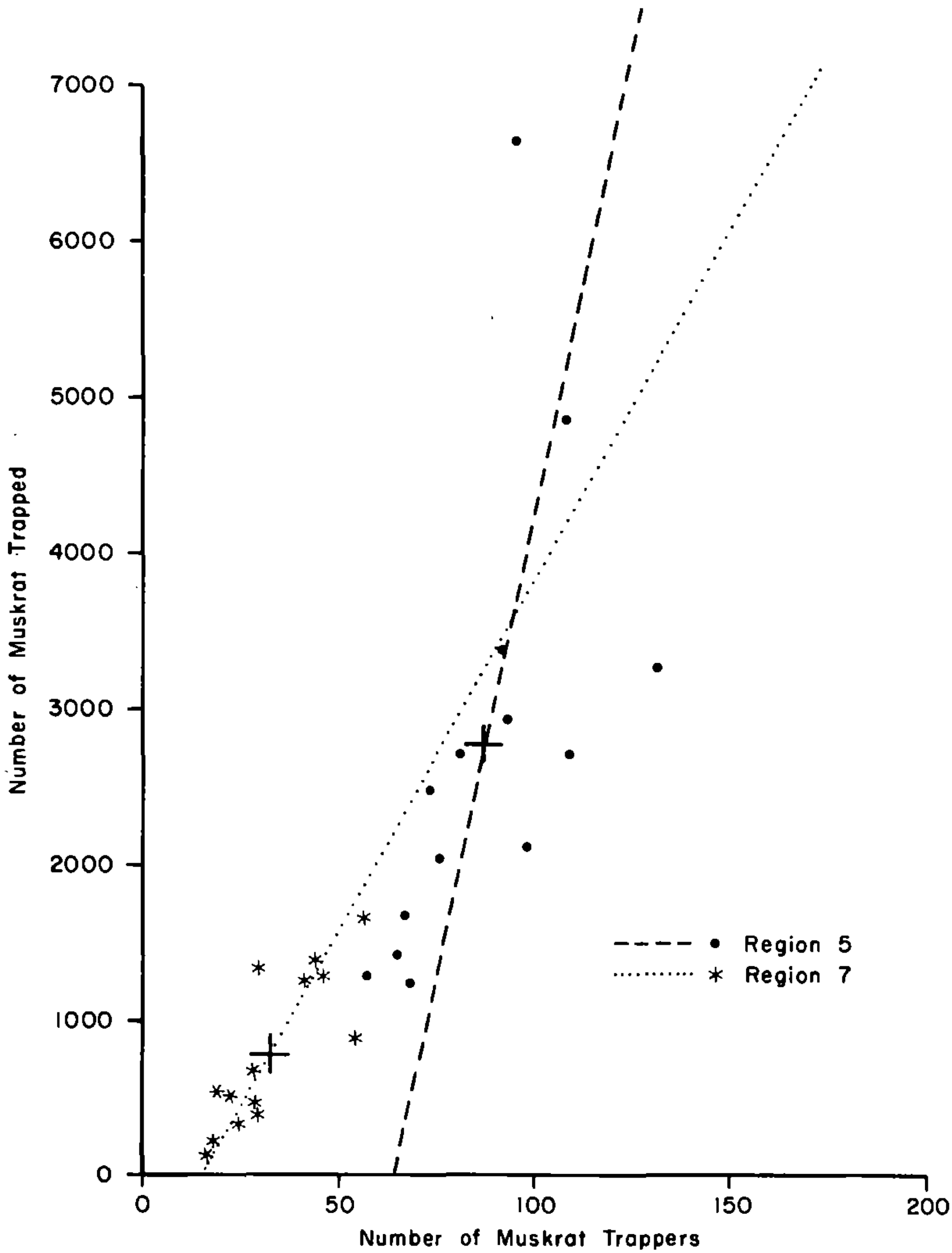

Figure B-6. Muskrat trapped vs. muskrat trappers in Fish and Game Regions 5 and 7, 1960-74.

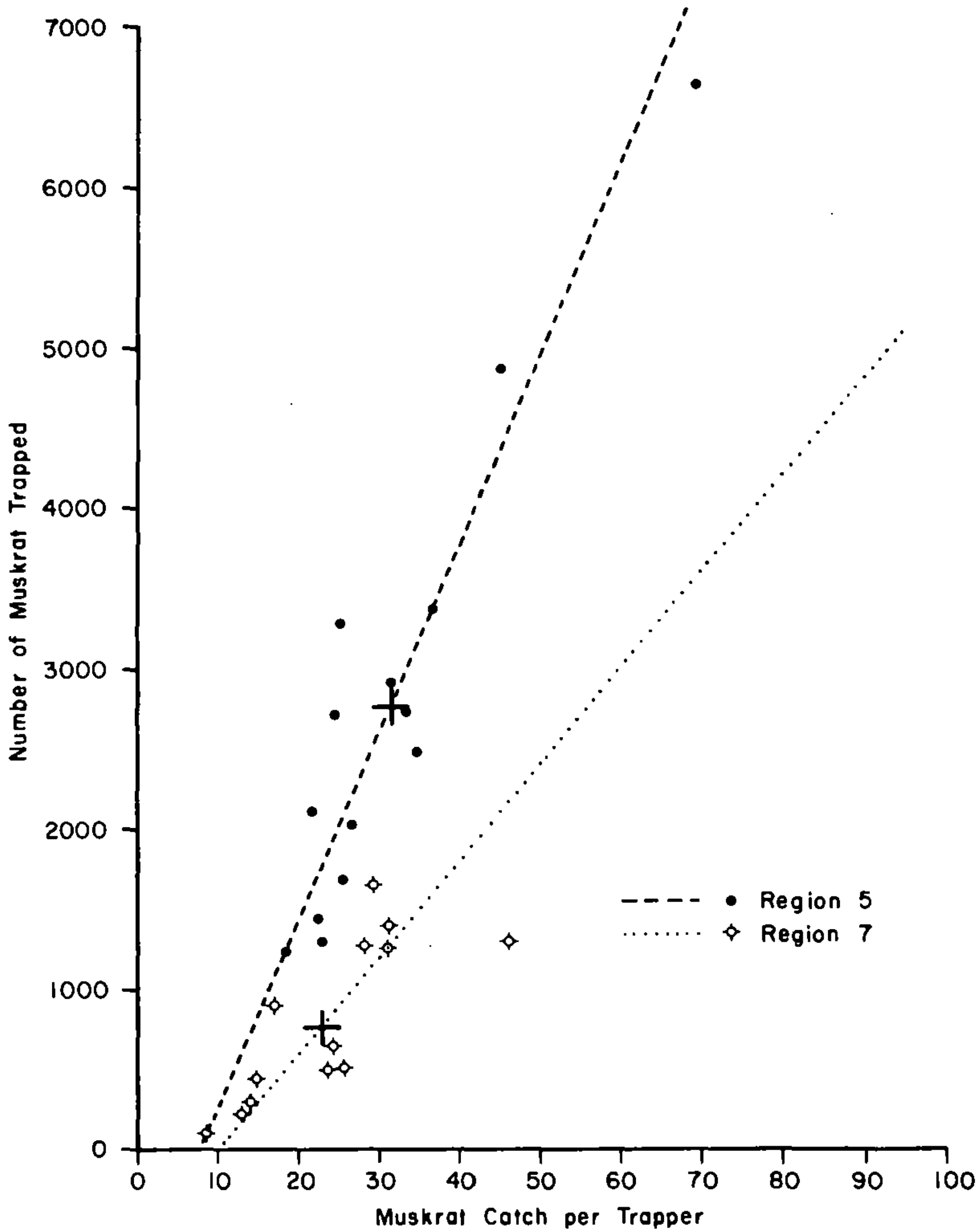

Figure B-7. Muskrat trapped vs. average catch per trapper in Fish and Game Regions 5 and 7, 1960-74.

Appendix C

TRAPPING SEASONS AND RESTRICTIONS IN
DEPARTMENT OF FISH AND GAME REGIONS 5 AND 7, 1960-74

FIGURES

TABLES

NOTE: After the 1961-62 trapping season, District 52 was reapportioned to Region 7. See table C-2.

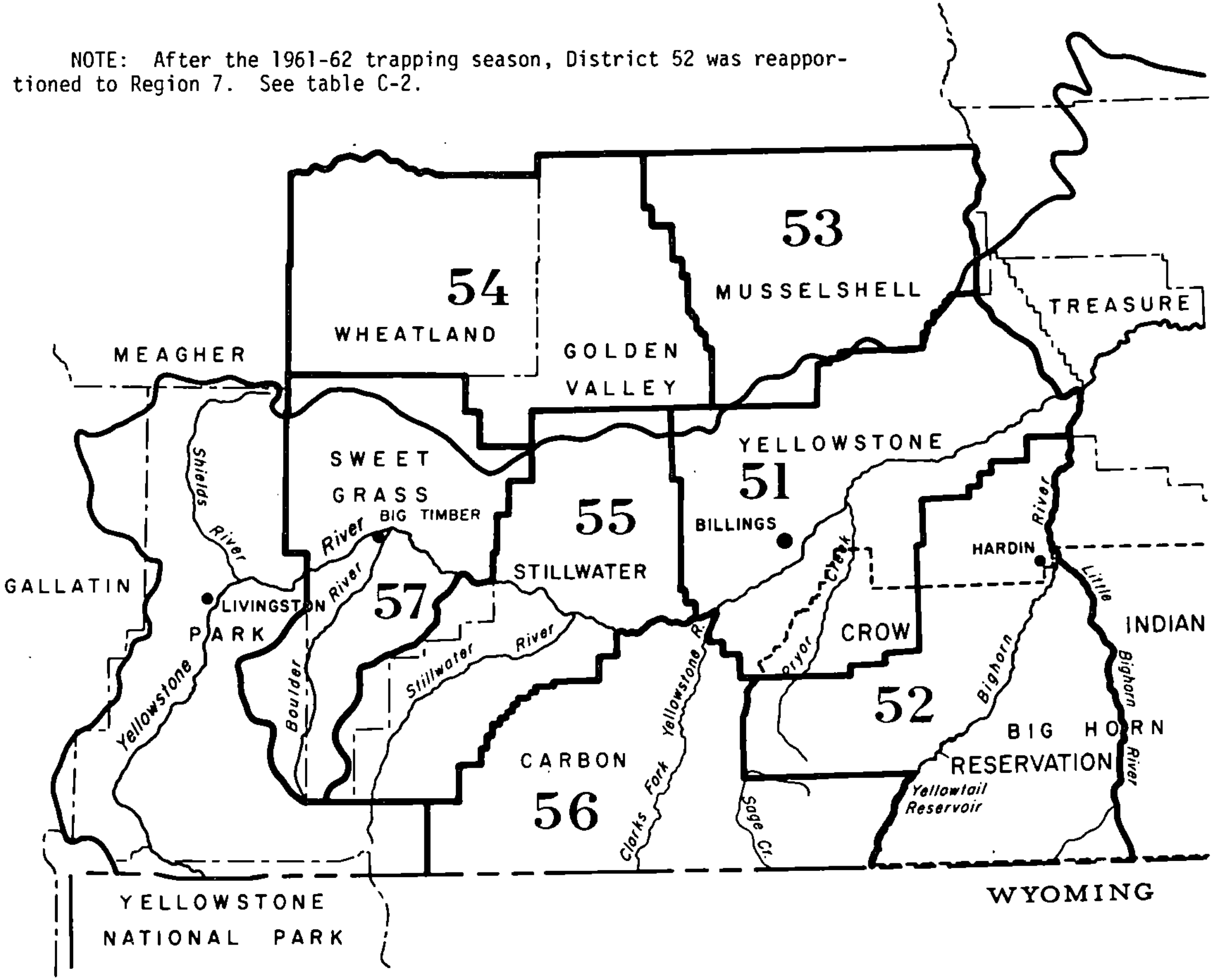

Figure C-1. Trapping Districts within Region 5, 1960-61 through 1968-69 Trapping Seasons.

TABLE C-1. Openings and closing dates of beaver, mink, and muskrat seasons in Regions 5 and 7, 1960-74.

Year	BEAVER Opening Date	BEAVER Closing Date	MINK Opening Date	MINK Closing Date	MUSKRAT Opening Date	MUSKRAT Closing Date
REGION 5						
1960-61	11/10	4/30	11/10	12/31	11/10	4/30
1961-62	10/15	4/30	11/10	12/31	11/10	4/30
1962-63	10/15	4/30	11/10	12/31	11/10	4/30
1963-64	10/15	4/30	11/10	12/31	11/10	4/30
1964-65	10/15	4/30	11/10	12/31	11/10	4/30
1965-66	10/15	4/30	11/10	12/31	11/10	4/30
1966-67	10/15	4/30	11/10	12/31	11/10	4/30
1967-68	10/15	4/30	11/10	12/31	11/10	4/30
1968-69	10/15	4/30	11/10	12/31	11/10	4/30
1969-70	11/1	4/30	11/1	12/31	11/1	4/30
1970-71	11/10	4/30	11/10	12/31	11/10	4/30
1971-72	11/10	3/31	11/10	12/31	11/10	3/31
1972-73	11/10	3/31	11/10	12/31	11/10	4/30
1973-74	11/10	3/31	11/10	12/31	11/10	4/30
REGION 7						
1960-61	11/10	4/30	11/10	12/31	11/10	4/30
1961-62	11/10	4/30	11/10	12/31	11/10	4/30
1962-63	11/1	4/30	11/1	12/31	11/1	4/30
1963-64	11/1	4/30	11/1	12/31	11/1	4/30
1964-65	11/1	4/30	11/1	12/31	11/1	4/30
1965-66	11/1	4/30	11/1	12/31	11/1	4/30
1966-67	11/1	4/30	11/1	12/31	11/1	4/30
1967-68	11/1	4/30	11/1	12/31	11/1	4/30
1968-69	11/1	4/30	11/1	12/31	11/1	4/30
1969-70	11/1	4/30	11/1	12/31	11/1	4/30
1970-71	11/10	4/30	11/10	12/31	11/10	4/30
1971-72	11/10	3/31	11/10	12/31	11/10	3/31
1972-73	11/10	3/31	11/10	12/31	11/10	4/30
1973-74	11/10	3/31	11/10	12/31	11/10	4/30

NOTE: Beaver, mink, and muskrat trapping during these seasons was affected by quotas and other restrictions. See tables C-2 and C-3.

TABLE C-2. Beaver trapping quotas[a] in Region 5[b], 1960-69[c].

	District in Region 5[d]						
	51	52[e]	53	54	55	56	57
1960-61	800	350	400	500	400	300	800
1961-62	800	NL	NL	NL	500	250	800
1962-63	600	--	NL	NL	500	300	NL
1963-64	600	--	NL	NL	500	300	NL
1964-65	600	--	NL	NL	500	150	200
1965-66	200	--	100	200	100	150	200
1966-67	200	--	100	200	100	150	200
1967-68	100	--	100	200	100	150	100
1968-69	150	--	100	250	100	150	100

NOTE: NL = no limit

[a]Each trapper could apply each year for assignment to only one district. In those districts with set quotas, the limit per trapper was set by dividing the beaver quota among the applicants.

[b]Of the two Fish and Game regions included in the study, 5 and 7, only Region 5 had beaver quotas during the years examined.

[c]In the 1969-70 through 1973-74 trapping seasons, no quotas were set in any region east of the Continental Divide, including Region 5.

[d]Region 5 was divided into numbered districts (51-57), each with a separate headquarters and warden. Boundaries of these districts varied: see figure C-1.

[e]After the 1961-62 trapping season, district 52 was reapportioned to Region 7, and the number was dropped. See figure C-1.

Table C-3. Restrictions on beaver, mink, muskrat, and otter trapping in Regions 5 and 7, 1960-74.

1960-61	For this season only, beaver could be taken in Region 7 by either trapping or shooting. In Region 7 for all other years investigated and in Region 5 for all years investigated, beaver could be taken only by trapping.
1960-61 through 1973-74	In all years investigated for this study, each trapper was allowed to take and possess only one otter.
1965-66 through 1968-69	Closed to otter trapping: all of Region 5.
1968-69 through 1971-72	Closed to beaver trapping in Region 7: the Yellowstone River from the new Myers bridge downstream to the Highway 12 bridge at Forsyth.
1972-73 and 1973-74	Closed to otter trapping: the Yellowstone River from the Yellowstone National Park boundary to the North Dakota border.

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YELLOWSTONE IMPACT STUDY

Furbearers

6

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