present (Stage 3). Other fish examined at this time were in spawning condition (Stage 4) and contained ovaries with mature yolk-filled oocytes. The peak of spawning activity occurred in midsummer (July). Most spawning was completed by September as GSI values dropped and numbers of spawning females were fewer (Table 1). Atretic oocytes were common in September near the close of the spawning period when oocytes that failed to complete yolk deposition underwent resorption. They were observed in 67% of my combined 1977-78 September samples.

Rather than maturing and spawning one mode (size class) of eggs at a time, it seems that females reach spawning condition and then release batches of mature eggs throughout the spawning season. This is likely, as no summer females were observed with ovaries in postspawning (partly spent or spent) condition. Instead, *C. saturnum* oocyte development appears to be a continuous process during the spawning season, as ovaries at all times contained maturing and large numbers of mature oocytes. I have previously observed this pattern (Goldberg 1976) in *G. lineatus* and *S. politus*.

Postovulatory follicles (transitory remnants of the follicle wall from recently ovulated eggs) were seen in only 2% of my combined 1977-78 July samples. Ovaries containing these structures were in spawning condition. This low percentage is not unexpected in view of their rapid degeneration in teleost fishes (Yamamoto and Yoshioka 1964; Hunter and Goldberg 1980).

The spawning cycle of *C. saturnum* is similar to that of *S. politus*, namely, April-August (Goldberg 1976). Spawning in *G. lineatus* occurs November-April (Goldberg 1976) and is thus distinctly different from that of *C. saturnum* and *S. politus*. According to Feder et al. (1974) three other California sciaenids (*Atractoscion nobilis*, *Menticirrhus undulatus*, and *Roncador stearnsii*) are also summer spawners.

Acknowledgments

I thank George Thomas (LADWP) for assistance in obtaining specimens. Barbara Delgado, Barbara Friedman, and Trang Nguyen (Whittier College) assisted in weighing and measuring specimens. Trang Nguyen assisted with histological preparations. This study was aided by a Whittier College faculty research grant.

Literature Cited

EIGENMANN, C. H.
1892. The fishes of San Diego, California. U.S. Natl. Mus. Proc. 15:123-178.

FEDER, H. M., C. H. TURNER, AND C. LIMBAUGH.
1974. Observations on fishes associated with kelp beds in southern California. Calif. Dep. Fish Game, Fish Bull. 160, 144 p.

FITCH, J. E., AND R. J. LAVENBERG.
1975. Tidepool and nearshore fishes of California. Univ. Calif. Press, Berkeley, 156 p.

GOLDBERG, S. R.
1976. Seasonal spawning cycles of the sciaenid fishes *Genyonemus lineatus* and *Seriphus politus*. Fish. Bull., U.S. 74:983-984.

HUNTER, J. R., AND S. R. GOLDBERG.
1980. Spawning incidence and batch fecundity in northern anchovy, *Engraulis mordax*. Fish. Bull., U.S. 77: 641-652.

LIMBAUGH, C.
1961. Life-history and ecologic notes on the black croaker. Calif. Fish Game 47:163-174.

MILLER, D. J., AND R. N. LEA.
1976. Guide to the coastal marine fishes of California. Calif. Dep. Fish Game, Fish Bull. 157, 249 p.

SKOGSBERG, T.
1939. The fishes of the family Sciaenidae (croakers) of California. Calif. Dep. Fish Game, Fish Bull. 54, 62 p.

YAMAMOTO, K., AND H. YOSHIOKA.
1964. Rhythm of development in the oocyte of the medaka, *Oryzias latipes*. Bull. Fac. Fish. Hokkaido Univ. 15:5-19.

STEPHEN R. GOLDBERG

Department of Biology
Whittier College
Whittier, CA 90608

POPULATION GROWTH AND CENSUSES OF THE NORTHERN ELEPHANT SEAL, *MIROUNGA ANGUSTIROSTRIS*, ON THE CALIFORNIA CHANNEL ISLANDS, 1958-78

The northern elephant seal, *Mirounga angustirostris*, has received considerable attention because of its dramatic recovery from near extinction in the late 19th century. Bartholomew and Hubbs (1960) reviewed the chronicle of the species from 1818 to 1960 and estimated the total population over its then known range at about 13,000 animals. Since 1960, a number of investigators have reported on the reestablishment of elephant seals on progressively northern islands and on the size of its breeding populations. Such information is now available for the islands of the Pacific coast of North America from Isla Natividad, Baja California, northward to the Farallon Islands, Calif. (Bartholomew and Boolootian 1960; Radford et al. 1965; Rice et al. 1965; Carlisle and Aplin 1966, 1971; Carlisle 1973; Frey and Aplin 1970; Odell 1971, 1972, 1974; Le Boeuf et al. 1974; Le Boeuf and Mate 1978; Bonnell et al.[1]). By 1978 the total population was believed to have increased to an astounding 63,967 animals (Bonnell et al. footnote 1).

The northern elephant seal breeding population can be geographically divided into three subpopulations by centers of distribution (Figure 1): Baja California; California Channel Islands, including Islas Los Coronados, Baja California; and Central California (Gogan[2]).

One can trace a rapid increase in size of the California Channel Island subpopulation (hereinafter called the subpopulation) over the last nearly three decades. Rett (1952) reported seeing a single female on San Miguel Island in 1925. Bartholomew and Hubbs (1960) estimated that by 1957 the subpopulation contained 600 individuals. Births were first observed on San Miguel Island in 1958 and on San Nicolas Island in 1959, by which time the total subpopulation included an estimated 683 animals (Bartholomew and Boolootian 1960). By 1964, there were reportedly 2,158 elephant seals on three islands during the winter breeding season[3]: San Miguel (1,922), San Nicolas (197), and Santa Barbara (39) (Odell 1971). Based on cumulative data obtained during 4 yr of research, Bonnell et al. (footnote 1) estimated that by 1978 there were approximately 28,316 elephant seals in the subpopulation.

In this paper we report on counts of northern elephant seals conducted on all the California Channel Islands, including Islas Los Coronados, in February 1972. Using estimated pup production figures from this and other published censuses for the years 1958-78, we then assess rates of growth for each island within the subpopulation and for the subpopulation as a whole. The relative contributions of each island to the subpopulation total are also presented.

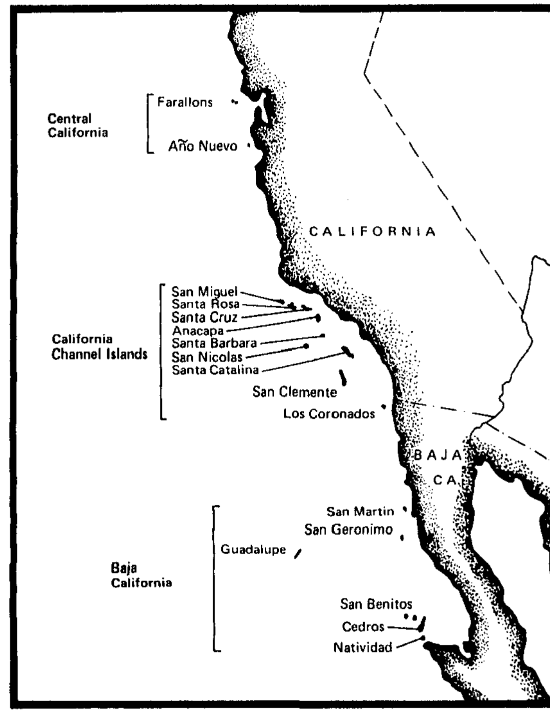

FIGURE 1.—Subdivision of the islands of California and northwestern Baja California into groups, corresponding with designated subpopulations of northern elephant seals (modified from Le Boeuf 1977; Gogan text footnote 2; Bonnell et al. text footnote 1).

Materials and Methods

On 8 February 1972, observers surveyed beaches of all California Channel Islands (except Islas Los Coronados) from U.S. Navy helicopters flying at an altitude of 150 m (500 ft) and a speed of 90 kn, taking large format (9 in × 9 in), near-vertical aerial photographs of all elephant seals seen. Counts of elephant seals were made from glossy black and white prints arranged into mosaics and handled in the manner described by Odell (1971). When possible, animals were differentiated as adult males, adult females, and pups. Counts on the Islas Los Coronados were made from the beach by swimmers dispatched from small boats anchored near shore. All counts represented minimum numbers in the population because an unquantified portion is always at sea (Le Boeuf 1972).

[1]Bonnell, M. L., B. J. Le Boeuf, M. O. Pierson, D. H. Dettman, G. D. Farrens, C. B. Heath, R. F. Gantt, and D. J. Larsen. 1980. Summary of marine mammal and seabird surveys of the Southern California Bight area 1975-1978. Vol. 3-Investigators' Reports, Part 1 - Pinnipeds of the Southern California Bight, 535 p. Univ. Calif., Santa Cruz, Calif., Final Report to the Bureau of Land Management, under Contract AA550-CT7-367.

[2]Gogan, P. J. P. 1977. A review of the population ecology of the northern elephant seal (*Mirounga angustirostris*). Processed Rep., 68 p. Northwest and Alaska Fish. Cent., Natl. Mar. Fish. Serv., NOAA, 2725 Montlake Boulevard E., Seattle, WA 98112.

[3]For descriptions of seasonal fluctuations in numbers of northern elephant seals on land see Le Boeuf (1972) and Odell (1972).

Counts of suckling and weaned elephant seal pups from this and other censuses between 1958 and 1978 were assembled and compared. Because most pups remain on land until late February (Le Boeuf et al. 1972; Reiter et al. 1978) and are highly visible, they are easily counted during February surveys. We believe, therefore, that pup production estimates are the most accurate available means of assessing, from census data, trends in population numbers of elephant seals.

Total pup production estimates were extrapolated from pup counts (Odell 1974) by correcting for date of census using the equation:

$$\frac{Pi}{f} = Pt$$

where Pi = pups counted at time of census,
f = fraction of maximum pup numbers counted at time of census (Odell 1974, fig. 6),
Pt = estimated total number of pups born that year.

This calculation assumes that the temporal pattern of births on all Channel Island rookeries is not significantly different from that reported for San Nicolas Island (Odell 1974). Corrections are not made for neonatal mortality since rookery specific data are not available.

Three indices of population growth were calculated from both pup counts and estimated total pup production: RC = the relative contributions of each island expressed as a percentage of the total pup counts for each census year; $I\bar{r}$ = the estimated average annual rate of increase for each island; and $S\bar{r}$ = the estimated average annual rates of increase for the entire subpopulation. The average rates of increase ($\bar{r}$) were derived from the formula, $N_t = N_0 e^{\bar{r}t}$ where $\bar{r}$ carries no implication that the rate of increase is constant over the time interval, that the age distribution is constant, or that the resources are in superabundance (Caughley 1977). Thus, $\bar{r}$ can be used as a standardized means of comparing the rates of population increase from one census year to the next.

Results and Discussion

Results of the 1972 census are shown for each island, according to elephant seal age/sex class, in Table 1. All 1972 breeding season counts were greater than similar counts reported previously by Odell (1971) and Le Boeuf et al. (1975).

TABLE 1.—1972 breeding season census of northern elephant seals taken 8 February on the California Channel Islands, including Islas Los Coronados (see Figure 1). Unless otherwise noted, counts were made from aerial photographs.

Island	Adult males	Adult females	Total adults	Pups	Total animals
San Miguel	497	1,410	1,907	1,902	3,809
San Nicolas	103	305	408	399	807
Santa Barbara	4	39	43	26	69
Los Coronados[1]	6	27	33	6	39
San Clemente	0	20	20	0	20

[1]Land-based census.

Pup counts and the computed values they support for the indices RC, $I\bar{r}$, and $S\bar{r}$, are shown in Table 2 for the years between 1958 (San Miguel Island), 1959 (San Nicolas Island), or 1964 (Santa Barbara Island and Islas Los Coronados) and 1978. There was little difference in the indices that were calculated from actual pup counts and those from total pup production estimates (Table 2).

Although the California Channel Island elephant seal subpopulation as a whole and each of its component island colonies have continued to grow over the last 16-22 yr, the rates of increase and individual island contributions to the subpopulation have varied (Table 2).

Relative Island Contribution (RC)

In general the ranked island contributions relative to the total subpopulation pup counts from highest to lowest have been: San Miguel, San Nicolas, Santa Barbara, and Islas Los Coronados (Table 2). Consistent with that trend, in 1958-59 San Miguel Island contributed 55.9% and San Nicolas Island 44.1% of the known subpopulation. But by 1964, the San Miguel Island population had grown so fast that its pup population was an estimated 10 times greater than the San Nicolas Island population, accounting for 90% of the entire subpopulation. During the subsequent period, 1964 to 1972, the RC values decreased for San Miguel Island (81.5), increased for San Nicolas Island (17.1), and remained about the same for Santa Barbara Island (1.1). From 1972 to 1978 there was generally little change in the RC values for all islands.

Increases in numbers of elephant seals and RC values can reasonably be expected on San Miguel and San Nicolas Islands where there are remaining unused beaches suitable for breeding rookeries (Le Boeuf and Bonnell 1980). However,

TABLE 2.—Counts of northern elephant seal pups in the California Channel Islands subpopulation, including Islas Los Coronados (see Figure 1). Unless otherwise noted, counts were obtained from aerial photographs. Also presented are relative contributions by each island (*RC*) expressed as a percentage of the total pup count and average yearly rates of increase in pup production for each island ($I\bar{r}$) and for the Channel Islands subpopulation ($S\bar{r}$).

Island	Census date	Source	Pup counts		RC		$I\bar{r}$		$S\bar{r}$	
San Miguel	14 Feb. 1958[1]	Bartholomew and Boolootian 1960	[2]80	(81)	[3]62.5	(55.9)				
San Nicolas	23 Jan. 1959[1]	Bartholomew and Boolootian 1960	48	(64)	37.5	(44.1)				
Santa Barbara	Not censused									
Los Coronados	Not censused									
		Total	128	(145)						
San Miguel	9 Feb. 1964	Odell 1971	796	(812)	90.0	(89.8)	[3]0.383	(0.384)		
San Nicolas	9 Feb. 1964		78	(80)	8.8	(8.9)	.081	(.037)		
Santa Barbara	9 Feb. 1964		12	(12)	1.2	(1.3)			[3]0.322	(0.305)
Los Coronados	12 Jan. 1964	Le Boeuf et al. 1975	0							
		Total	886	(904)						
San Miguel	8 Feb. 1972	This study	1,902	(1,941)	81.5	(81.5)	.109	(.109)		
San Nicolas	8 Feb. 1972		399	(407)	17.1	(17.1)	.204	(.203)		
Santa Barbara	8 Feb. 1972		26	(27)	1.1	(1.1)	.097	(.101)		
Los Coronados	8 Feb. 1972[4]		6	(6)	.3	(.3)				
		Total	2,333	(2,381)					.121	(.121)
San Miguel	27 Jan. 1978	Bonnell et al. text footnote 1	4,512	(5,013)	84.6	(84.2)	.144	(.158)		
San Nicolas	29 Jan. 1978		782	(850)	14.7	(14.3)	.112	(.123)		
Santa Barbara	29 Jan. 1978		37	(40)	.7	(.7)	.059	(.066)		
Los Coronados	29 Jan. 1978			[6](45)		(.8)		(.336)	.138	(.153)
		Total	5,331	(5,948)						

[1]The 1958 and 1959 census data averaged and treated as a single census year.
[2]Actual counts, followed in parentheses by total pup production estimates which were corrected for times when less than maximum pup numbers can be counted.
[3]Values calculated from actual pup counts, followed in parentheses by values calculated from total pup production estimates.
[4]Land based census.
[5]Only estimated value reported (Bonnell et al. text footnote 1).

the fact that there is apparently little suitable space available for new elephant seal rookeries on Santa Barbara Island and Islas Los Coronados (Le Boeuf et al. 1975; Bonnell et al. footnote 1) suggests that the numbers on those islands have stabilized and that there will be a concommitant decline in their *RC* values in future years.

Estimated Average Annual Rate of Increase by Island ($I\bar{r}$)

The $I\bar{r}$ values peaked between 1958 and 1964 on San Miguel Island and between 1964 and 1972 on San Nicolas and Santa Barbara Islands. Data presented suggest that numbers on Islas Los Coronados probably increased most rapidly between 1972 and 1978. This suggestion is supported by results of a more detailed study of those islands which provide data for intermediate years during this period (Le Boeuf et al. 1975).

Generally for each island, periods of high annual increase in population have been followed by periods of decreasing $I\bar{r}$ values. Such trends in reduction of growth rate can be expected to continue until such time as each island's elephant seal numbers reach stability, a pattern of population growth characteristic of other large marine and terrestial mammals (Fowler[4]). The increase from 1972 to 1978 on San Miguel Island is not surprising for an island where space does not appear to be a limiting factor, and similar increases might yet occur on the other islands where suitable breeding space is available. High rates of increase might also occur on new rookeries as northern elephant seals begin to colonize such areas as San Clemente Island and the mainland (Le Boeuf and Panken 1977; Le Boeuf and Mate 1978). But it is highly unlikely that any of the presently colonized California Channel Islands will ever experience growth periods that will exceed the largest $I\bar{r}$ values presented in Table 2.

Estimated Average Annual Rate of Increase in the Subpopulation ($S\bar{r}$)

The most rapid growth in the Channel Island subpopulation as a whole apparently occurred between 1958 and 1964. During this period, $S\bar{r}$ values reached 0.384 then dropped to 0.121 for 1964-72 and 0.153 for 1972-78. The extremely high rate of increase observed from 1958 to 1964 was proba-

[4]Fowler, C. W. 1978. Appendix C. Non-linearity in population dynamics with special reference to large mammals. *In* C. W. Fowler, W. T. Bunderson, M. B. Cherry, R. J. Ryel, and B. B. Steel. Comparative population dynamics of large mammals: a search of management criteria, p. 174-220. Report to U.S. Marine Mammal Commission, Wash., D.C. (Available Natl. Tech. Inf. Serv., Springfield, VA 22161 as PB80-178627.)

bly the result of recruitment both from the Baja subpopulation and from within the California Channel Island subpopulation (Chapman in press; Gogan footnote 2).

Although the Channel Islands subpopulation as a whole may continue to grow, it is likely that future $S\bar{r}$ values will eventually follow the decreasing trend towards stability which was described above for $I\bar{r}$ values (Fowler footnote 4).

Other California Channel Islands

Breeding colonies were not observed on any of the remaining Channel Islands during the 1972 censuses. The small numbers of animals seen on San Clemente Island included no pups, although there is a more recent indication that breeding/pupping sometimes occurs there. A single female with a pup was observed on San Clemente Island in January 1977 (Le Boeuf and Mate 1978). However, no pups were observed there during the 1978 breeding season surveys from land by Cohen.[5]

Anacapa Island may not offer suitable habitat for elephant seals because of its high cliffs and rocky coastline. The beaches on San Clemente Island are near a naval shore bombardment range and frequent bombing may have prevented the animals from establishing a breeding colony there. However, reasons for the absence of elephant seals on Santa Cruz, Santa Rosa, and Catalina Islands, all of which have some beaches which appear suitable, are not known, although human disturbance may be an important factor (Kenyon[6]).

Acknowledgments

The 1972 photo coverage was provided by the U.S. Naval Missile Center, Point Mugu, Calif. R. L. DeLong, C. H. Fiscus, C. W. Fowler, R. H. Lander, and A. E. York of the National Marine Mammal Laboratory, B. J. Le Boeuf and M. L. Bonnell of the University of California, and B. S. Stewart of Hubbs-Sea World Research Institute reviewed the manuscript.

[5]Robert H. Cohen, Naval Ocean Systems Center, San Diego, CA 92152, pers. commun. March 1978.

[6]Kenyon, K. W. 1973. Human disturbance of marine birds and marine mammals in wilderness areas of Baja California, Mexico, 10-17 February 1973. Unpubl. manuscr., 16 p. U.S. Dep. Inter., Bur. Sport Fish. Wildl., Div. Wildl. Res., Mar. Mammal Substation, Seattle, Wash. (Available Natl. Mar. Mammal Lab., Natl. Mar. Fish. Serv., NOAA, 7600 Sand Point Way NE., Seattle, WA 98115.)

Literature Cited

BARTHOLOMEW, G. A., AND R. A. BOOLOOTIAN.
1960. Numbers and population structure of the pinnipeds on the California Channel Islands. J. Mammal. 41:366-375.

BARTHOLOMEW, G. A., AND C. L. HUBBS.
1960. Population growth and seasonal movements of the northern elephant seal, *Mirounga angustirostris*. [Fr. abstr. and resume.] Mammalia 24:313-324.

CARLISLE, J. G., JR.
1973. The census of northern elephant seals on San Miguel Island, 1965-1973. Calif. Fish Game 59:311-313.

CARLISLE, J. G., JR., AND J. A. ALPIN.
1966. Sea lion census for 1965 including counts of other California pinnipeds. Calif. Fish Game 52:119-120.
1971. Sea lion census for 1970, including counts of other California pinnipeds. Calif. Fish Game 57:124-125.

CAUGHLEY, G.
1977. Analysis of vertebrate populations. Wiley, N.Y., 234 p.

CHAPMAN, D. G.
In press. Evaluation of marine mammal population models. *In* C. W. Fowler and T. D. Smith (editors), Dynamics of large mammal populations. Wiley, N.Y.

FREY, H. W., AND J. A. ALPIN.
1970. Sea lion census for 1969, including counts of other California pinnipeds. Calif. Fish Game 56:130-133.

LE BOEUF, B. J.
1972. Sexual behavior in the northern elephant seal, *Mirounga angustirostris*. Behaviour 41:1-26.
1977. Back from extation? Pac. Discovery 30(5):1-9.

LE BOEUF, B. J., D. G. AINLEY, AND T. J. LEWIS.
1974. Elephant seals of the Farallons: population structure of an incipient breeding colony. J. Mammal. 55:370-385.

LE BOEUF, B. J., AND M. BONNELL.
1980. Pinnipeds of the California Islands: abundance and distribution. *In* D. M. Power (editor), The California Islands: proceedings of a multidisciplinary symposium, p. 475-493. Santa Barbara, California, Santa Barbara Museum of Natural History.

LE BOEUF, B. J., D. A. COUNTRYMAN, AND C. L. HUBBS.
1975. Records of elephant seals, *Mirounga angustirostris*, on Los Coronados Islands, Baja California, Mexico, with recent analyses of the breeding population. Trans. San Diego Soc. Nat. Hist. 18:1-7.

LE BOEUF, B. J., AND B. R. MATE.
1978. Elephant seals colonize additional Mexican and California islands. J. Mammal. 59:621-622.

LE BOEUF, B. J., AND K. J. PANKEN.
1977. Elephant seals breeding on the mainland in California. Proc. Calif. Acad. Sci. 41:267-280.

LE BOEUF, B. J., R. J. WHITING, AND R. F. GANTT.
1972. Perinatal behavior of northern elephant seal females and their young. Behaviour 43:121-156.

ODELL, D. K.
1971. Censuses of pinnipeds breeding on the California Channel Islands. J. Mammal. 52:187-190.
1972. Studies on the biology of the California sea lion and the northern elephant seal on San Nicolas Island, California. Ph.D. Thesis, Univ. California, Los Ang., 168 p.
1974. Seasonal occurrence of the northern elephant seal, *Mirounga angustirostris*, on San Nicolas Island, California. J. Mammal. 55:81-95.

RADFORD, K. W., R. T. ORR, AND C. L. HUBBS.
1965. Reestablishment of the northern elephant seal (*Mirounga angustirostris*) off Central California. Proc. Calif. Acad. Sci. 31:601-612.

REITER, J., N. L. STINSON, AND B. J. LE BOEUF.
1978. Northern elephant seal development: The transition from weaning to nutritional dependance. Behav. Ecol. Sociobiol. 3:337-367.

RETT, E. Z.
1952. The northern elephant seal on San Miguel Island, California. J. Mammal. 33:109.

RICE, D. W., K. W. KENYON, AND L. B. LLUCH.
1965. Pinniped populations at Islas Guadalupe, San Benitos, and Cedros, Baja California, in 1965. Trans. San Diego Soc. Nat. Hist. 14:73-84.

GEORGE A. ANTONELIS, JR.

National Marine Mammal Laboratory
National Marine Fisheries Service, NOAA
7600 Sand Point Way NE.
Seattle, WA 98115

STEPHEN LEATHERWOOD

Hubbs-Sea World Research Institute
1700 South Shores Road
San Diego, CA 92109

DANIEL K. ODELL

University of Miami Rosenstiel School of Marine and Atmospheric Science
4600 Rickenbacker Causeway
Miami, FL 33149

GROWTH CHARACTERISTICS OF YOUNG-OF-THE-YEAR WALLEYE, *STIZOSTEDION VITREUM VITREUM*, IN JOHN DAY RESERVOIR ON THE COLUMBIA RIVER, 1979

The walleye, *Stizostedion vitreum vitreum*, is becoming increasingly abundant in many of the large reservoirs of the Columbia River (Durbin[1]). Although the origin of this species in the Columbia River system is not entirely clear, Durbin (footnote 1) reported that walleye was introduced into the upper Clark Fork River, Idaho (a tributary of the Columbia River drainage), in the late 1940's (Figure 1). The large impoundments of the Columbia River, with turbid water conditions occurring through most of the spring and early summer, are providing walleye with suitable habitat. Scott and Crossman (1973) reported that walleye, throughout its range, reaches its greatest abundance in large turbid lakes and slow moving rivers.

[1]Durbin, K. 1977. News column. Oreg. Dep. Fish Wildl., Portland.

The increase in walleye population has generated considerable interest among sport fishermen throughout the Columbia River area (Harbour 1980). Because of its value as a game fish, some envision a significant new fishery similar to the historic fisheries of the Great Lakes region. Fisheries managers responsible for the survival of juvenile salmon, *Oncorhynchus* spp., and steelhead, *Salmo gairdneri*, are viewing the increase in walleye population with alarm, fearing that because of its highly piscivorous habits, it may become a significant salmonid predator.

Turbine intake gatewells at major dams in the Columbia River system are sampled each year to monitor the juvenile salmonid migrations (Raymond 1979). John Day Dam, a large hydroelectric project on the Columbia River, was completed in 1968 and created a reservoir (Lake Umatilla) 122 km long (Figure 1). Juvenile walleye was first observed in the gatewells at John Day Dam in 1973, and small numbers continued to be taken through 1978. In 1979, a large increase in the number of young-of-the-year walleye in the gatewells at John Day Dam was observed.

Information yielded by monitoring these young-of-the-year walleye in John Day Reservoir is presented in this paper. A comparison between growth of walleye in this reservoir and walleye populations from other areas is also given.

Methods

A large dip net, similar to that described by Bentley and Raymond (1968), was used to collect juvenile walleye from the turbine intake gatewells at John Day Dam. Young walleye were captured incidentally to the juvenile salmonid monitoring operation at the dam. A sample consisted of a 24-h composite catch removed daily from the gatewell via the dip net. Sampling extended from 1 March through 18 December 1979. All fish taken were measured for total length (TL) to the nearest millimeter and weighed to the nearest 0.1 g. Age was determined from scale samples taken in the manner described by Eschmeyer (1950). Scales were removed and examined from all specimens ≥100 mm TL to confirm that they were in fact young-of-the-year fish.

Results and Discussion

In 1979, the number of walleye entering the turbine intake gatewells at John Day Dam in-