A JAPAN'S VIEW ON CONCEPTION OF SALMON RESEARCH

FOR THE

COMMITTEE ON SCIENTIFIC RESEARCH AND STATISTICS

by

Fisheries Agency of Japan

Ministry of Agriculture, Forestry and Fisheries
1-2-1 Kasumigaseki, Chiyoda-ku, Tokyo 100
Japan

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ABSTRACT

Goals of scientific research of the Committee on Salmon Research and Statistics (CSRS) in the North Pacific Anadromous Fish Commission are to establish the conservation methods for each anadromous stocks, which may be defined as "local population (deme)" or "Mendelian population". The CSRS research should be extensively done in the Convention Area and adjacent waters, where necessary, from ecological, genetic, oceanographic view points.

1. BACKGROUND

Pacific salmon (*Oncorhynchus* spp.) have been important resources for fisheries of the convention nations, and will be expected as valuable marine food protein for the future. Since 1980s their biomass is estimated to be increasing throughout the North Pacific Ocean. According to FAO fisheries statistics, the annual harvest of Pacific salmon in the area averaged 650,000 metric tons during 1981–1988, and in 1989 reached 860,000 metric tons, which exceeded the historical maximum level. Among Pacific salmon, the abundance of pink, chum, and sockeye salmon are especially expanding. The increase of stocks may be explained by improved growth and survival rates which coincident with favorable ocean conditions, and by the increase in number of hatchery fish released. About 5 billion salmon juveniles are annually released from the North Pacific rim nations. Thus Pearcy (1992) estimated that about one third of total salmon catches in 1980s were hatchery origin.

Since many stocks of anadromous salmon from both Asia and North America depend on the North Pacific waters, the carrying capacity of this productive region is an international concern. Possibility of density–dependent individual growth reduction relating to carrying capacity of North Pacific waters has been reported for several salmon stocks (Takagi *et al.* 1981; Peterman 1984; Kaeriyama 1989; Ishida *et al.* 1993). Several scientists indicated importance to assess biological interactions of enhanced and wild salmonids at international symposia held in Norway[1] and Canada[2]. Allendorf *et al.* (1986) also reported that large salmon ranching program has possible problems on the conservation of genetic stocks.

Under such background, desiring to coordinate efforts to conserve anadromous stocks in the North Pacific Ocean, scientific research for the purpose of the conservation of anadromous stocks should be conducted by the convention nations.

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[1]Symposium on Interactions between Cultured and Wild Atlantic Salmon held at Hotel Alexandra, Loen, Norway, April 23–26, 1990. Aquaculture, 98(1991): v–x+1–324.

[2]International Symposium on Biological Interactions of Enhanced and Wild Salmonids held at Coast Bastion Inn, Nanaimo, Canada, June 17–20, 1991.

2. DEFINITION OF "STOCK"

The anadromous "stock" which should be conserved may be defined as a "local population (deme)" that is a local interbreeding group or a "Mendelian population" that is a group of interbreeding individuals sharing a common gene pool.

3. GOAL OF CSRS SALMON RESEARCH

The objective of the North Pacific Anadromous Fish Commission (NPAFC) is to promote the conservation of anadromous stocks in the Convention Area (ARTICLE VIII–2). A goal of salmon research for the Committee on Scientific Research and Statistics (CSRS) are, therefore, to develop the conservation methods for each anadromous stock. The research should be extensively done in the Convention Area and adjacent waters, where necessary, from various aspects such as ecology, genetics and oceanography (Figure 1).

4. CSRS SALMON RESEARCH

(1) Climate change and population dynamics (Figure 2)

Pearcy (1992) suggested that a long–term biomass change of anadromous stocks can be related to the climate change. An intense Aleutian low is usually associated with warm coastal waters, high sea level, and high zooplankton biomass in the Gulf of Alaska (Emery and Hamilton 1985, Brodeur and Ware 1992). The predicted global warming may affect salmonid production. The following research may be useful for evaluation of long–term fluctuation of anadromous stocks.

- Long–term changes in the intense Aleutian low and global warming,
- Satellite monitoring of the Pacific Ocean environment (such as SST, chlorophyll–a),
- Long–term fluctuation of the zooplankton biomass in the North Pacific Ocean.

(2) Life history pattern (Figure 3)

Although the early life history of anadromous fish before their offshore migration has been well documented by many researchers, little is known about the early ocean life history after offshore migrations except for Hartt and Dell (1986). There is little information about life table of anadromous fish, and the following research is believed to be useful for conservation of anadromous stocks.

- Breeding ecology (such as ascending and spawning behavior of adult Pacific salmon, and evaluation about spawning areas),
- Life history at freshwater period (such as environmental factors controlling development, growth, feeding ecology, and migration pattern of anadromous fish),
- Life history at early marine period (such as seawater adaptability, growth, feeding ecology, migration pattern, and oceanographic factors controlling the distribution of Pacific salmon),
- Life history at ocean period (such as growth, feeding ecology, maturing

mechanism, oceanographic factors affecting the distribution and migration of anadromous fish),

- Life table and intrinsic rate of natural increase (such as survival rates by each developmental stage).

(3) **Population ecology** (Figure 4)

Population growth is regulated by density-dependent feedback which has influence on the processes of birth, death, and migration. In a general population model, the basic density-dependent function is moderated by environmental and genetic properties (Berryman 1985). Structure and function of population system influences the population growth of anadromous stocks. The following should be studied:

- Reproduction (such as evaluation of MSY in Ricker's reproduction curves),
- Density effect (such as changes in body size and age at maturity, mortality, and reproductive effort relating to population size),
- Carrying capacity of anadromous stocks (such as assessing the oceanic carrying capacity),
- Growth model of population (such as drawing a Logistic curve for population growth),
- Population system of anadromous fish (such as elucidating the generalized population model and feedback mechanism to population regulation acting through environment or gene pool).

(4) **Community ecology** (Figure 5)

It has been suggested that pink salmon show trophic competition with coho (Ogura et al. 1990) and sockeye salmon (Krogius 1960) in the western North Pacific Ocean. Welch and Parsons (1993) suggested that the unusual diet such as gelatinous zooplankton of chum salmon may help to reduce direct trophic competition with other salmon during the offshore migration. Moreover, interspecific density-dependent mortalities in the early marine life seemed to occur between chum and pink salmon in Puget Sound (Salo 1988). Thus, research about the community ecology for anadromous fish is extremely important in order to elucidate interspecific interactions. Research contents are as follows:

- Predators and prey of anadromous stocks (such as predator-prey relationship and food chain),
- Interspecific competition and ecological niche of anadromous fish (such as trophic competition, Lotka-Volterra model, and niche overlap),
- Diversity and stability of biotic community (such as diversity and complexity of community, species density or species CPUE, and index of species diversity),

(5) **Population genetics** (Figure 6)

To conserve genetic variation and stability of anadromous stocks, the following research should include:

- Establishing gene map of anadromous stocks,
- Monitoring genetic variation and stability of anadromous stocks,
- Establishing conservation methods for endangered anadromous stocks.

5. Methods required for CSRS scientific research

(1) Stock identification

Stock identification methods should include the following research to improve a precision of the stock identification technology in the North Pacific Ocean:

- Hard tissues analyses (such as scale analysis and otolith analysis),
- Parasitological analysis,
- Genetic identification of anadromous stocks (such as protein electrophoresis and DNA analysis),
- Tagging experiments.

(2) Biological monitoring methods for the conservation of anadromous stocks

To evaluate variation and stability of anadromous stocks, useful information relating to enhancement programs and natural reproduction of anadromous fish is as follows:

- Locations of reproductive rivers and number of escapement by species,
- Breeding and genetic characters (including body size, sex ratio, age, periods of escapement and spawning, fecundity, and egg size, gene frequency, and heterozygosity),
- Biological information relating to juvenile migrating seaward (including number, body size, age, developmental stage, and migrating period) by species.

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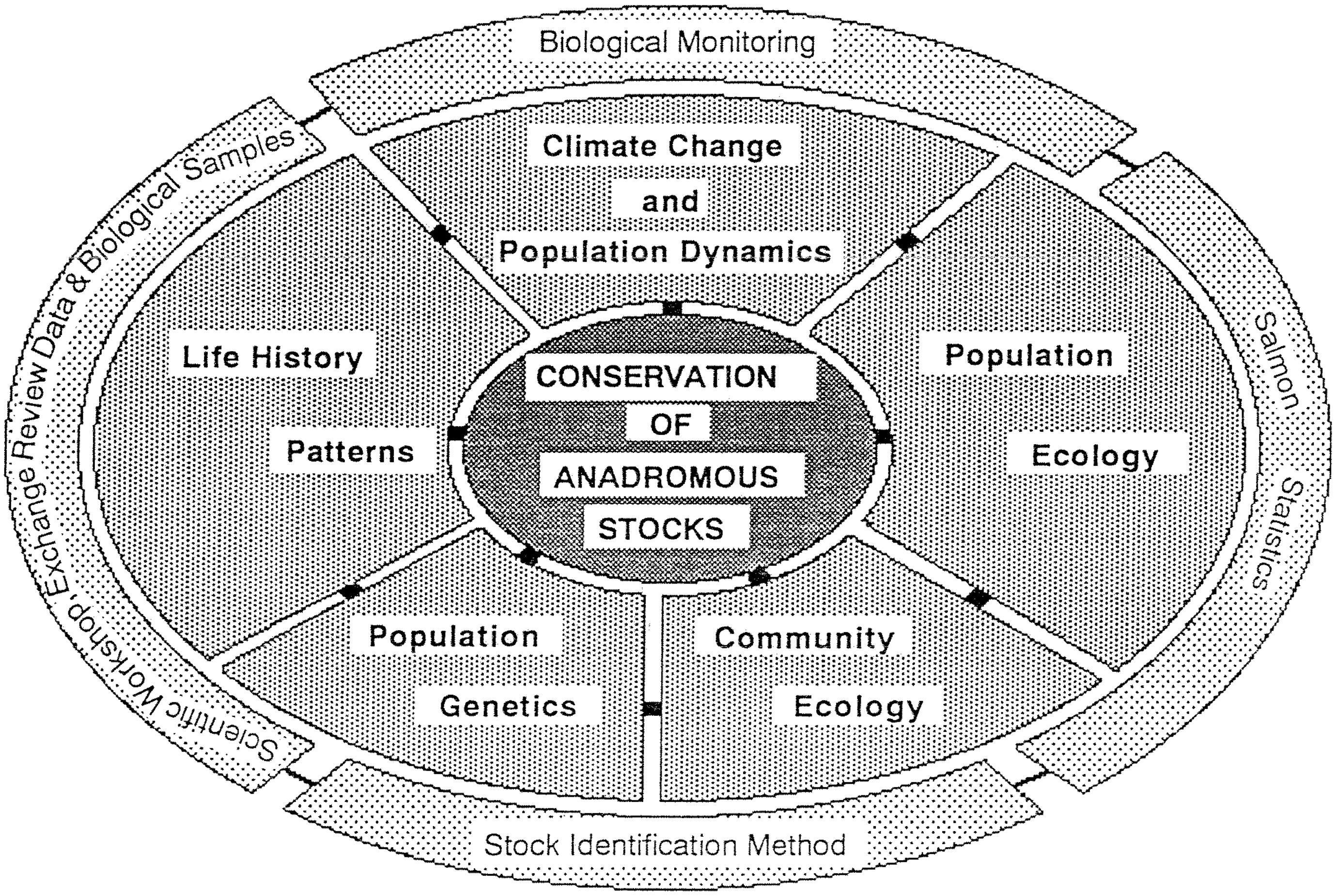

Figure 1. Conception of salmon research
for the Committee on Scientific Research and Statistics.

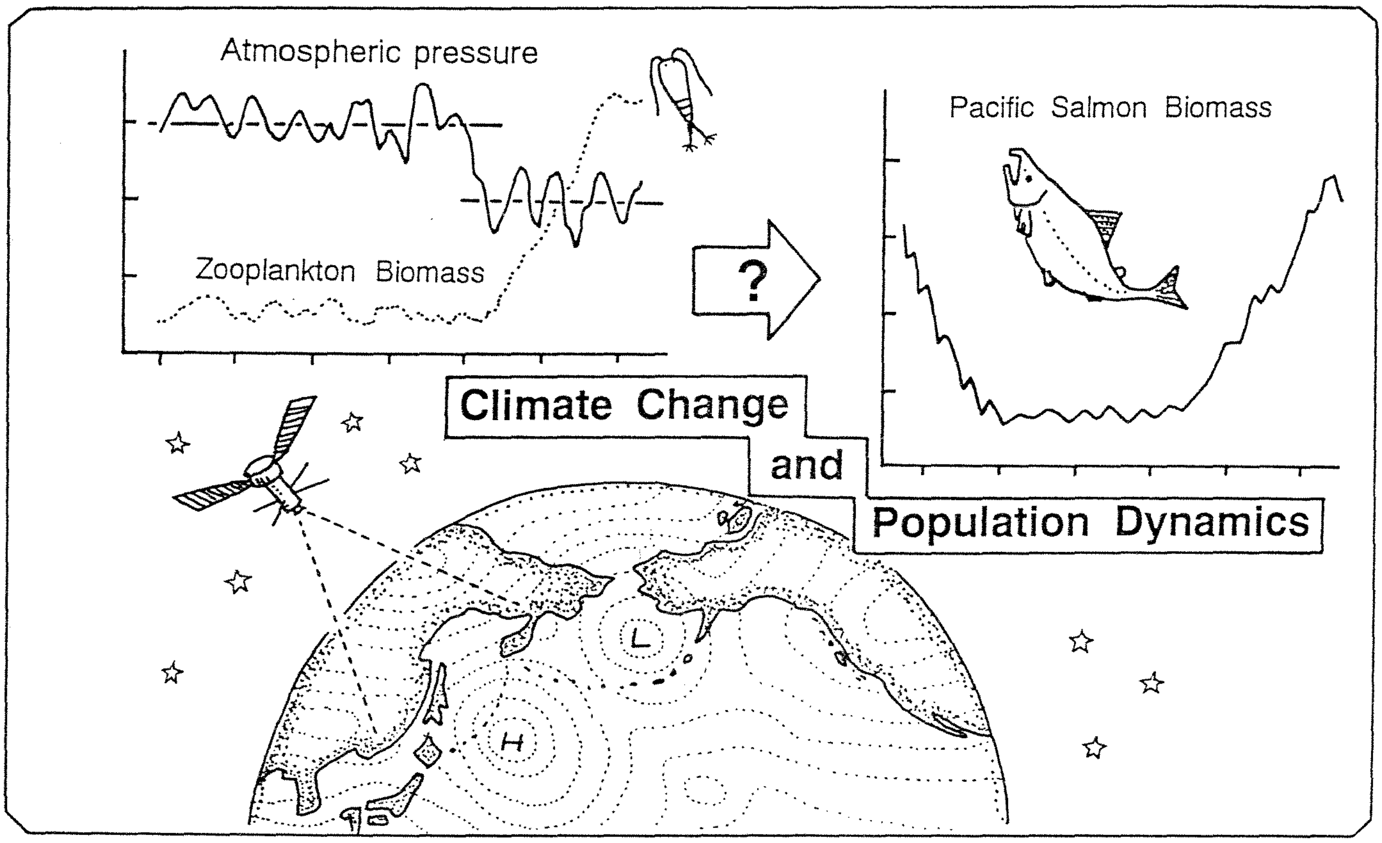

Figure 2. Research on climate change and population dynamics.

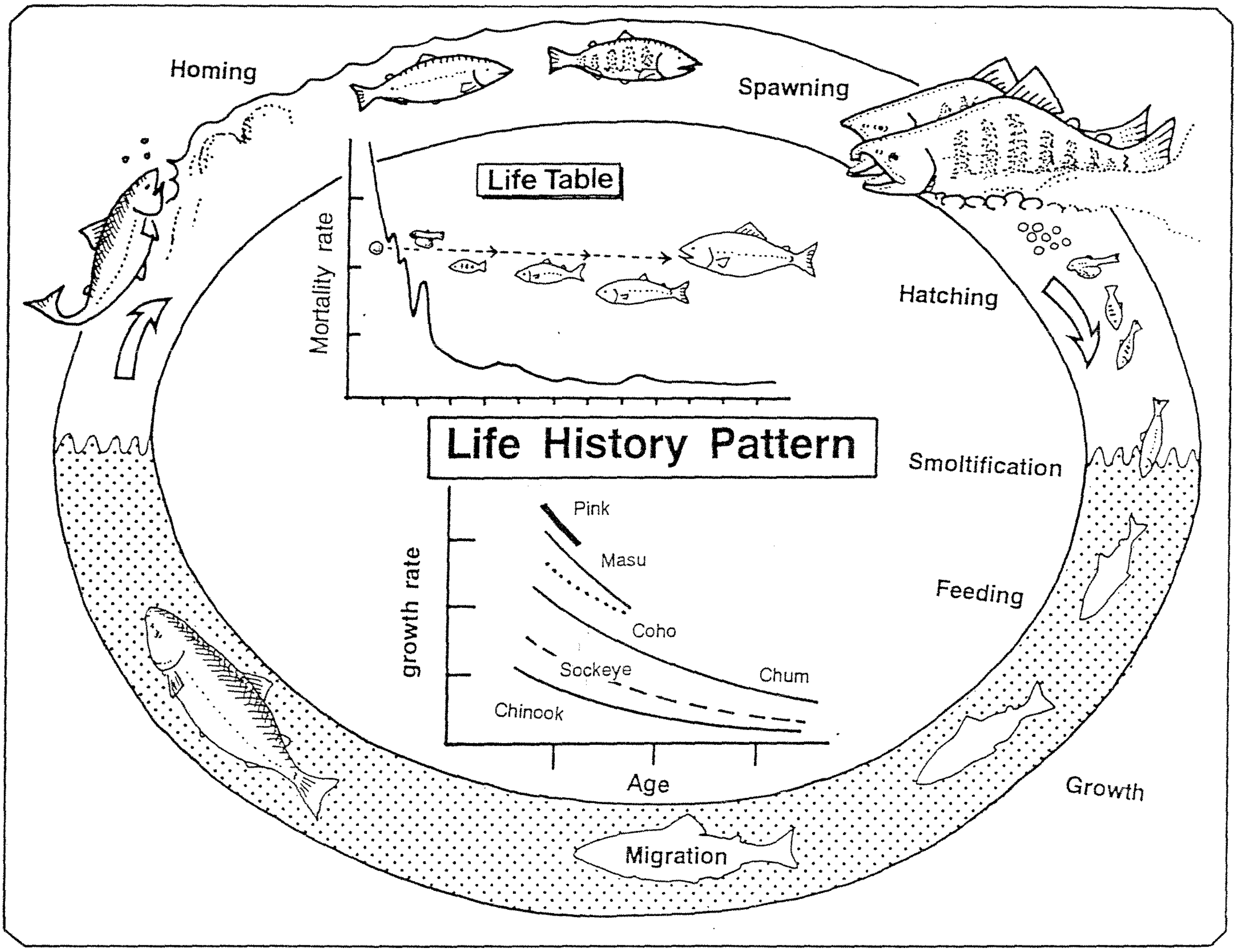

Figure 3. Research on life history pattern

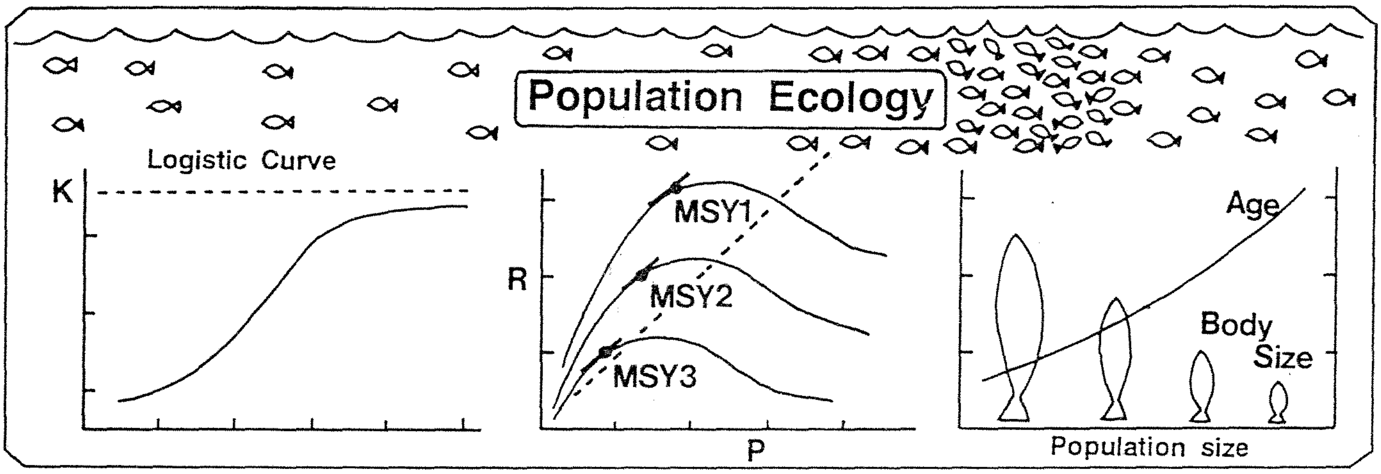

Figure 4. Research on population ecology.

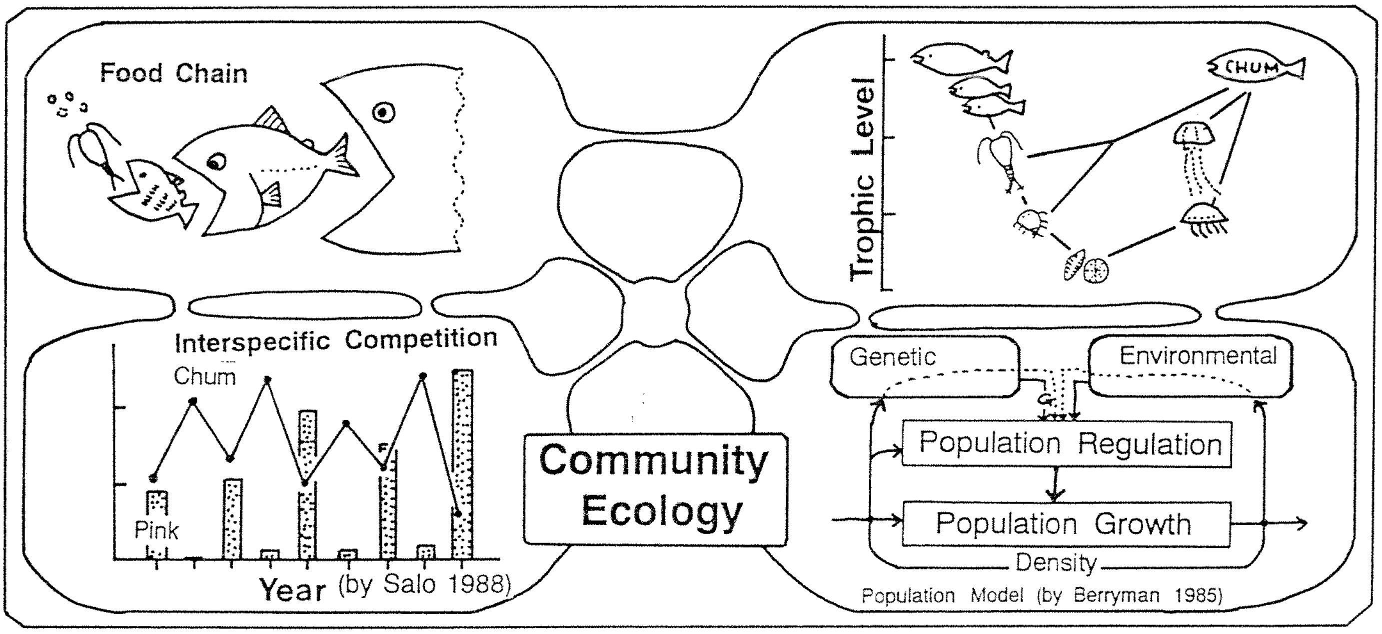

Figure 5. Research on community ecology.

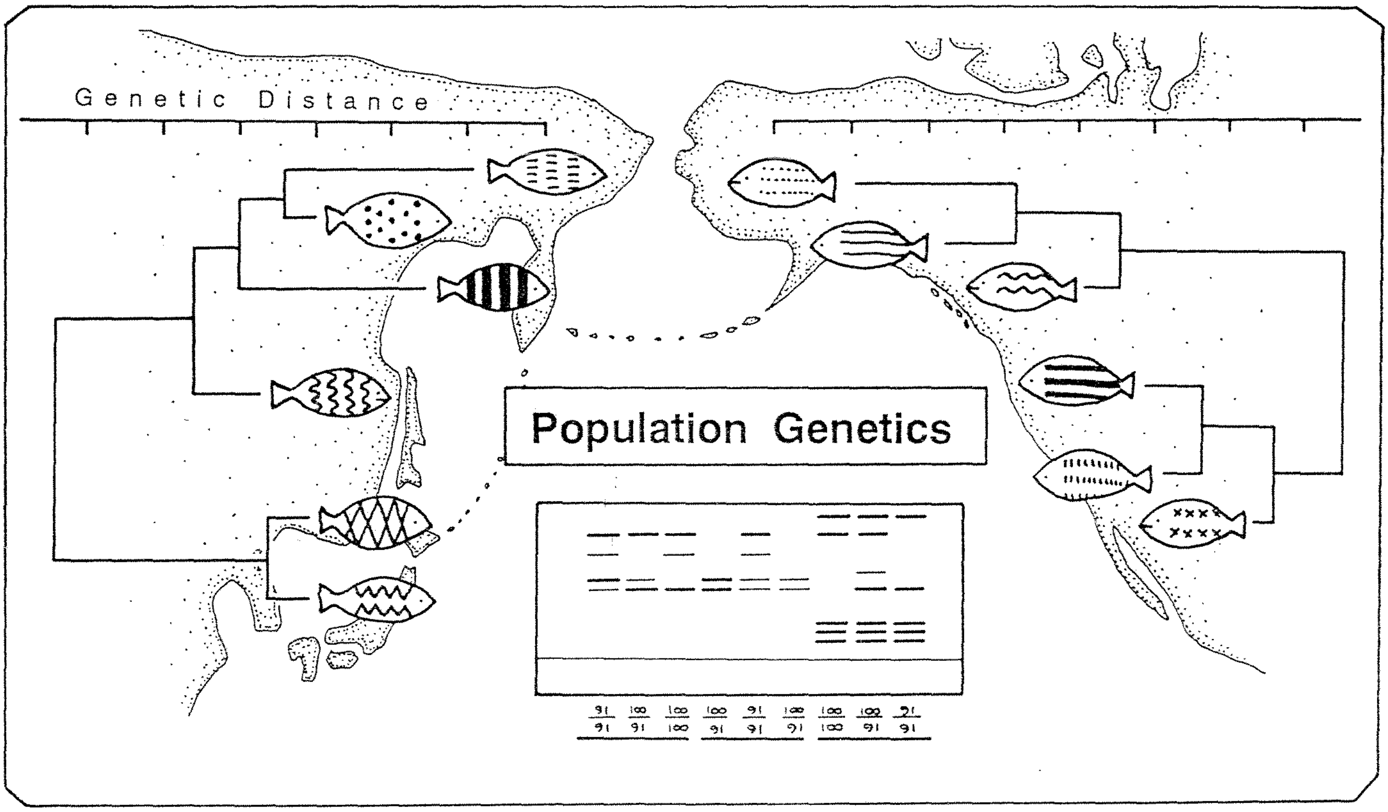

Figure 6. Research on population genetics.