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# Norwegian smolt farms reflect higher productivity through intensification

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By Dr. Asbjorn Bergheim

## Production costs decline at greater scale



The Norwegian smolt industry now produces 150 to 200 million smolts annually, with production likely to increase.

Over the last 20 years, the productivity of trout and salmon fry and smolt hatcheries and farms has increased significantly. In Norway, these land-based farms are located along the coast and discharge effluent water directly to the sea. Most farms are single flow-through systems, but a growing number practice partial or "tank-internal" recirculation of water.

In addition to the generally improved quality of feed and fish strains, the



This Norwegian smolt farm uses large, outdoor tanks. Photo courtesy of Pan-Fish, Hyllestad.

introduction of efficient systems for energy utilization and aeration has played an important role in farm intensification. The development of effective vaccines and photoperiod treatments has also contributed significantly to this enhanced productivity.

## Production trends

Data on major production-efficiency parameters at Norwegian hatcheries and smolt farms are presented in Table 1. Annual production at Norwegian hatcheries and smolt farms increased about fivefold since 1985. The average farm production was 934,000 smolts and 310,600 fry in 2000, up from about 360,000 smolts and 190,000 fry in 1990. The biomass produced increased even more, as the present average size of smolts at delivery is 80 to 120 grams, compared to 30 to 50 grams some 15 years ago.

### Bergheim, Productivity in Norwegian smolt farms, Table 1

Parameter	1985/90	2000
Production:		
1,000 smolts/farm/year	100-300	500-2,000
Tons/farm/year	3-15	40-250
1,000 smolts/man-year	Over 150	300

Parameter	1985/90	2000
Feed-conversion ratio	1.8-2.5	0.9-1.2
Water consumption (l/kg/min)	0.5-2.5	0.1-0.5
m <sup>3</sup> /kg produced	1,000-1,700	100-200

Main source: Norwegian Directorate of Fisheries.

Table 1. Productivity in Norwegian smolt farms, 1985/90-2000 (includes fry and smolts).

## Shorter cycles

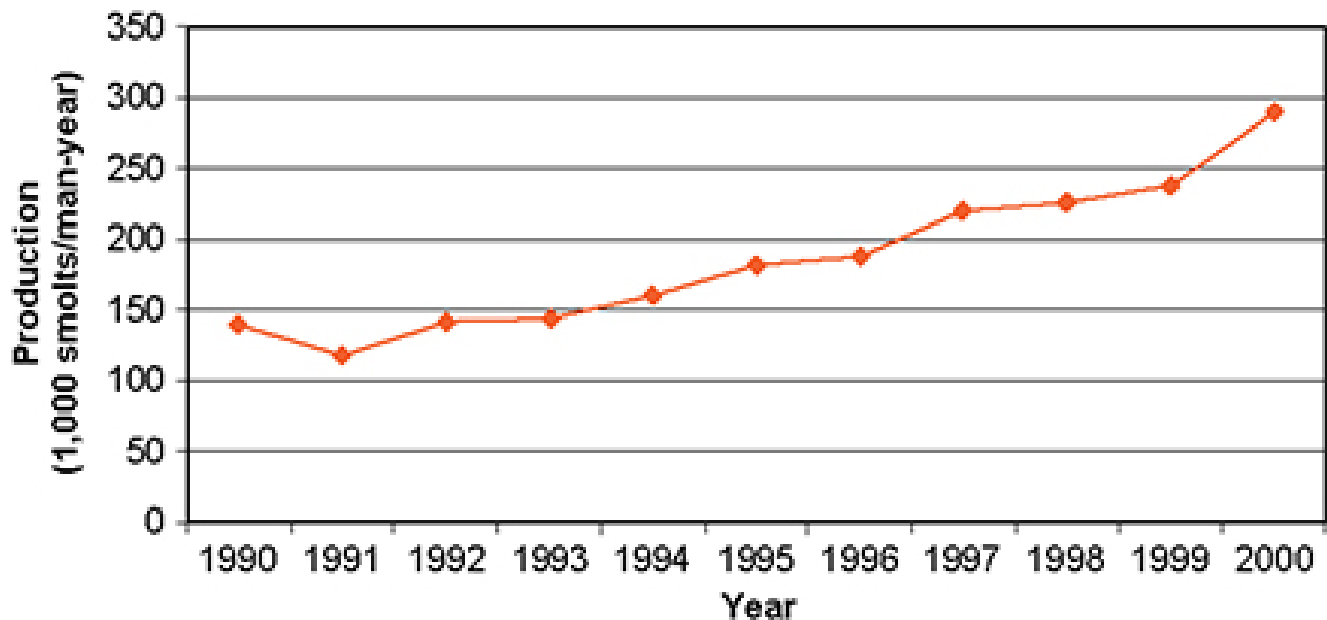


Fig. 1: Total productivity in Norwegian hatcheries, 1990-2000. Source: Norwegian Directorate of Fisheries

Shorter production cycles are a striking trend of the past few years. There are two distinct annual biomass peaks in modern farms: in springtime and late summer or early autumn. The 8- to 10-month-old fish delivered between August and October, characterized as “0-year-old smolts,” comprise a significant portion of the smolts produced today. The so-called “1-year-old smolts” transferred to seawater cages in spring are actually 15 to 18 months from hatching.

## Improved productivity

Intensification efforts have led to improved productivity (Fig. 1). An average of about 300,000 smolts and fry are now produced each man-year.

## Water consumption

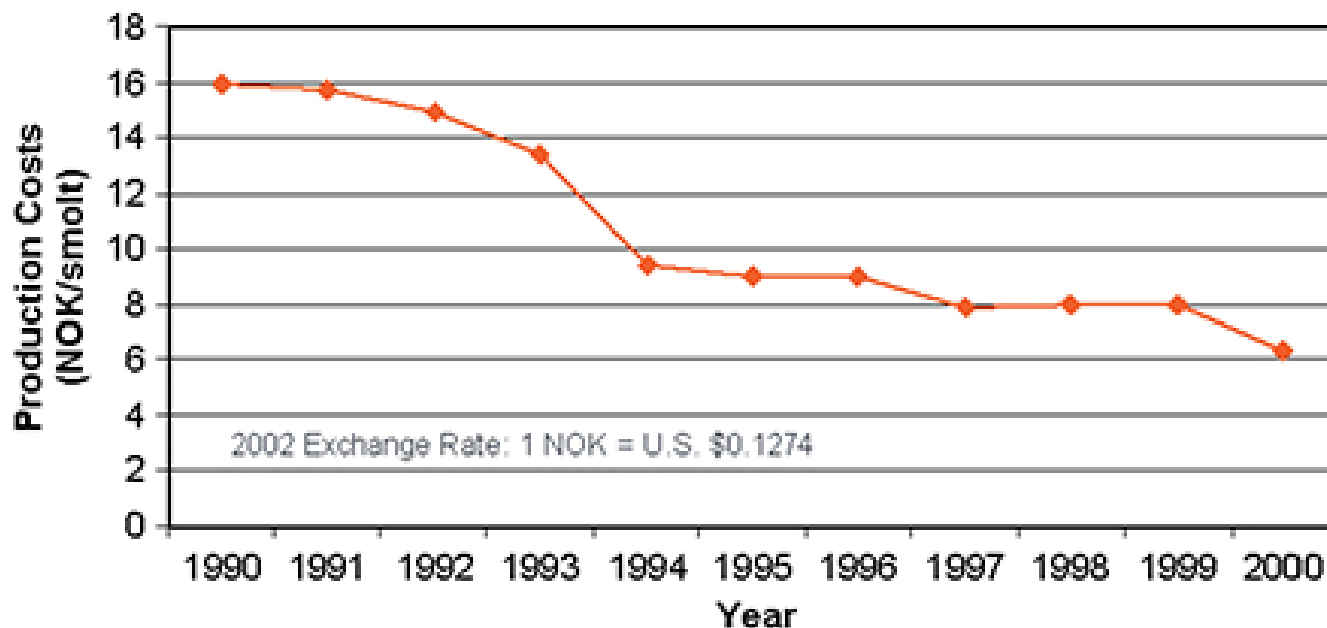


Fig. 2: Total production costs in Norwegian hatcheries, 1990-2000. Source: Norwegian Directorate of Fisheries.

Since the mid-1980s, authorities have required a minimum flow supply of 1.5 cubic meters per 100,000 smolts produced annually. Without oxygenation of the water, flow rates fluctuated 0.5 to 2.5 liters per kilogram per minute throughout the year (Table 1). The addition of pure oxygen then significantly reduced the flow requirements, which are now typically in the 0.3 to 0.5 liters per kilogram range.

According to a new regulation for hatchery licensing, the lowest allowable flow in single flow-through systems is 0.3 liters per kilogram. However, lower water supply is permitted in systems that remove toxic gases ( $\text{CO}_2$ ,  $\text{NH}_3$ ).

Mainly due to the use of oxygenation technology, water consumption at most smolt farms is at now 100 to 200 cubic meters per kilogram fish produced, compared to 1,000 to 1,700 cubic meters per kilogram 15 years ago.

### Shortages

Before delivery of smolts in spring and late summer, hatcheries often experience water shortages. These deficits are a frequent problem in summer, with temperatures over 16 degrees C and reduced river flow. Topical solutions are partial water recycling and stripping of carbon dioxide. Accumulation of carbon dioxide is a potential problem in most intensive farms because of the predominant soft water of Norwegian coastal watercourses.

### Production costs

Corresponding to the improved productivity, production costs for smolts steadily decreased since 1990 (Fig. 2). During the 1991-94 period, costs were reduced by nearly 50 percent. These reduced costs have been of vital importance to the smolt industry. In the early 1990s, selling prices in several regions were lower than production costs. The average cost allocations for 2000 are shown in Table 2.

## Bergheim, Average production cost allocation, Table 2

Feature	Total Cost (%)
Roe and fry	17
Feed	13
Vaccination	11
Electricity	4
Insurance	2
Salary	19
Other operating costs	22
Fixed costs (depreciation and financial)	12

Table 2. Average production cost allocation for 2000.

## Conclusion

The Norwegian smolt industry now produces 150 to 200 million smolts annually, with production likely to increase. Recently published prospects indicate a need for 40 percent more smolts in the next five years. As the number of running hatcheries per smolt farms varied 250 to 270 over the last 10 years, most of the increased production will be met by further intensification of production at existing farms.

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## Author

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### DR. ASBJORN BERGHEIM

Senior Researcher  
Rogaland Research  
N-4068 Stavanger, Norway

[asbjorn.bergheim@rf.no](mailto:asbjorn.bergheim@rf.no) (mailto:asbjorn.bergheim@rf.no)

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