

## Chapter 4

# **Achievements and Setbacks in the Commercial Diving Fishery of San José Gulf, Argentine Patagonia**

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*'We should not speak of successes, just of achievements.'*

– Oscar Avilez, artisanal fishers' leader from Chile. From a presentation made at the Biennial Conference of the International Association for the Study of Common Property, Oaxaca, Mexico, August 2004.

## **Introduction**

The management of natural resources is highly demanding of scientific support and therefore applied scientists often become involved in the management process, whether as providers of technical advice for decision-making or as scientists-turned-managers. But scientists, including ourselves, are accustomed to the directed progress of knowledge: we know the process of research and discovery can be meandering, but a sense of progress is always there. It is not surprising therefore if scientists become frustrated with management as it moves forward and backwards, and breakthroughs are too often followed by setbacks. Furthermore, management decisions are not based solely on scientific support, with its emphasis on ecological sustainability, but also have to include societal values and agendas that are inevitably exposed to pressure from politicians, power brokers, and lobbies. Scientists involved with fisheries management tend to be pessimistic, as they perceive this compromise as irrational, setbacks as lack of success, and progress as insufficient.

In this brief essay we discuss a series of 'rounds' in the 40 year history of a small-scale scallop fishery from Patagonia: two were won, two lost, and round five is on. In the terms of Oscar Avilez, fisher and friend, this is not the history of a definitive success, but one of hard-to-attain significant achievements, and some setbacks. On balance, we argue, the achievements set the compass in the direction of success.

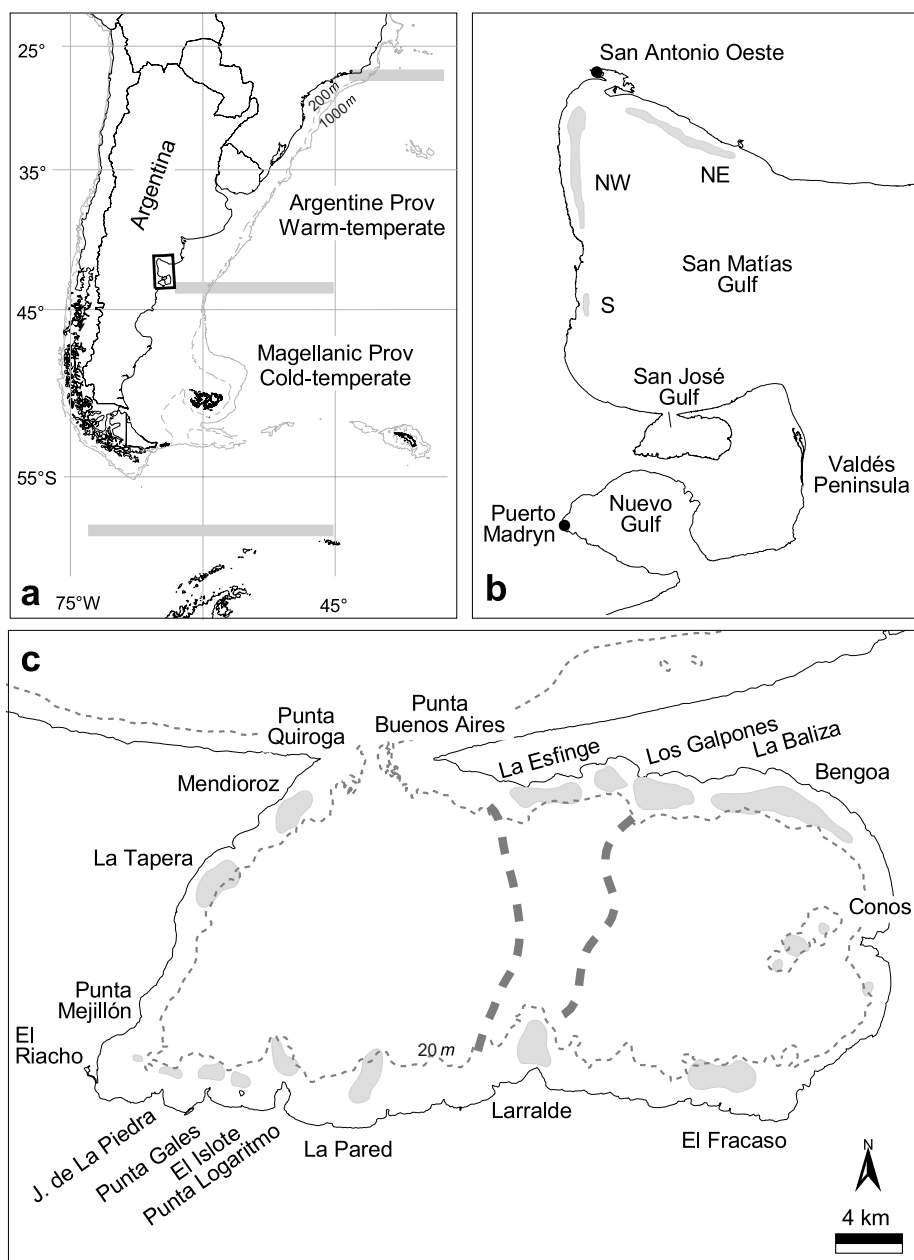
## Settings

### *The gulfs of Northern Argentine Patagonia*

Patagonia, at the southern end of the Americas, is a vast and sparsely-populated region shared by Chile on the west and Argentina on the east (Fig. 4.1a). On the Atlantic side, the Argentine Patagonian coast spreads over 15 degrees of latitude, from the mouth of the Colorado River (approximately 40° S) to the Beagle Channel (55° S). These coasts were pronounced 'wretched and useless' by Darwin (1962), who sailed along as a scientist on board HMS *Beagle* in 1834. He found them describable 'only by negative characters; without habitations, without water, without trees, without mountains'. Yet, 'in calling up images of the past,' he wrote, 'I find that the plains of Patagonia frequently cross before my eyes . . . why have these arid wastes taken so firm a hold of my memory?' and went on to conclude that '... it must be owing to the free scope given to the imagination'. Nowadays, 170 years later, most of the coast continues to be unpopulated, inaccessible, and inhospitable, dotted by just a dozen or so urban areas.

The operation of artisanal or small-scale coastal fisheries is made difficult by exposure and lack of shelter from the strong prevailing winds, blowing mostly from the southwest. Favorable conditions are found in a few areas, most noticeably the three North Patagonian gulfs: Nuevo, San José, and San Matías (Fig. 4.1b). Several commercial small-scale fisheries operate in the region, gathering shellfish and algae along the intertidal zone, beach seining and long lining for fish, dredging, and commercial diving for shellfish (Table 4.1). Among the latter, the most significant is the Tehuelche scallop (*Aequipecten tehuelchus*). Approximately 200 fishers are currently active in the artisanal fisheries around the Valdés Peninsula, which include San José, Nuevo, and the southern part of San Matías gulfs.

Here we focus primarily on the scallop fishery of San José Gulf, a roughly oval-shaped basin (814 km<sup>2</sup>) connected to San Matías Gulf through a narrow (9 km) but relatively deep (80 m) mouth (Fig. 4.1c). The bottom below 35 m is a flat muddy plain. Circulation is driven by tides that range from 2.9 to 8.7 m between mean neap and spring tides. Strong winds (15 km/h average) blow predominantly from the SW. There are no estuaries or significant human settlements along the coast; average annual precipitation is 180 mm. Surface water temperature ranges seasonally from 9–17°C. The gulf is divided into an east and west half by a recurrent front (Fig. 4.1c). To the west, tidal flows produce a complex eddy system (Amoroso 2004). As compared to the west, water in the east has a longer residence time and is therefore warmer in summer but colder in winter. The spring phytoplankton bloom starts by early October; a second, smaller bloom occurs in late February. Average gross and net annual production have been estimated at 223 and 161 g C/m<sup>2</sup>/yr (Charpy-Roubaud et al. 1982).



**Figure 4.1** (a) The southwestern Atlantic, showing major biogeographic domains. (b) The North-Patagonian gulfs (area shown as a small rectangle in (a)). Shaded areas indicate scallop-fishing grounds in San Matías Gulf. (c) San José Gulf. Light dashed line indicates the 20 m isobath (at low tide). Shaded areas correspond to historical scallop grounds. Heavy dashed lines indicate the approximate range of the front (see text) (modified from Ciocco et al. 2005).

**Table 4.1** Main benthic resources harvested by artisanal fishers in San José Gulf (Argentine Patagonia).

Group	Common name	Scientific name
Gastropod mollusks	Caracol	<i>Odontocymbiola magellanica</i>
	Caracol picante	<i>Buccinanops gradatum</i>
	Caracol chico	<i>Buccinanops globosum</i>
Bivalve mollusks	Ostra puelche (puelche oyster)	<i>Ostrea puelchana</i>
	Cholga	<i>Aulacomya ater</i>
	Mejillón (blue mussel)	<i>Mytilus edulis platensis</i>
	Vieira tehuelche (scallop)	<i>Aequipecten tehuelchus</i>
	Navaja	<i>Ensis macha</i>
	Almeja (hardshell clam)	<i>Ameghinomya antiqua</i>
	Panopea (geoduck)	<i>Panopea abbreviata</i>
Cephalopod mollusks	Pulpito (octopus)	<i>Octopus tehuelchus</i>
	Pulpo Colorado (octopus)	<i>Enteroctopus megalocyathus</i>
Brachyuran crustaceans (true crabs)	Cangrejo nadador	<i>Ovalipes trimaculatus</i>
	Cangrejo buey	<i>Platyxanthus patagonicus</i>

### *A sensitive region for marine conservation*

San José Gulf is at the boundary between the cold- and warm-temperate domains of the southwestern Atlantic, denoted in the biogeographic literature as, respectively, the Magellanic and Argentine biogeographic provinces (Fig. 4.1a). Cold-temperate species predominate in the central and colder basin, and warm-temperate species in the intertidal and shallow subtidal zones. The gulf and neighboring coasts around Valdés Peninsula are ecologically very sensitive due to the presence of large colonies of marine birds and mammals, notably sea lions and elephant seals, but mostly because they are the mating and calving areas of the southern right whale (*Eubalaena australis*) (Campagna and Lichter 1996). Back in 1974, San José Gulf was consecrated by Chubut Province as a provincial marine park (Ciocco 1995), the first of its kind in the southwest Atlantic. UNESCO declared the entire region of Valdés Peninsula and adjacent coastal areas as a Natural World Heritage Area in 1999. A management plan was developed with participation of all stakeholders (DGCAP 1998) and has served as a framework for the implementation of specific conservation-oriented actions.

## ***The Tehuelche scallop***

The Tehuelche scallop is endemic to the Argentine Biogeographic Province, ranging in nearshore areas of the shelf from Rio de Janeiro (Brazil) to Camarones (Fig. 4.1a). The maximum recorded shell height is 102 mm, but specimens larger than 90 mm are uncommon; maximum estimated longevity is 11 years, but survival beyond age eight is exceptional. Analysis of stomach contents indicate that re-suspended micro-phytobenthos is the main component of the diet, the rest being phytoplankton. It is a simultaneous hermaphrodite; spawning has been observed in late spring and late summer, with considerable geographic and year-to-year variation. Larvae stay in the water column for approximately 20 days.

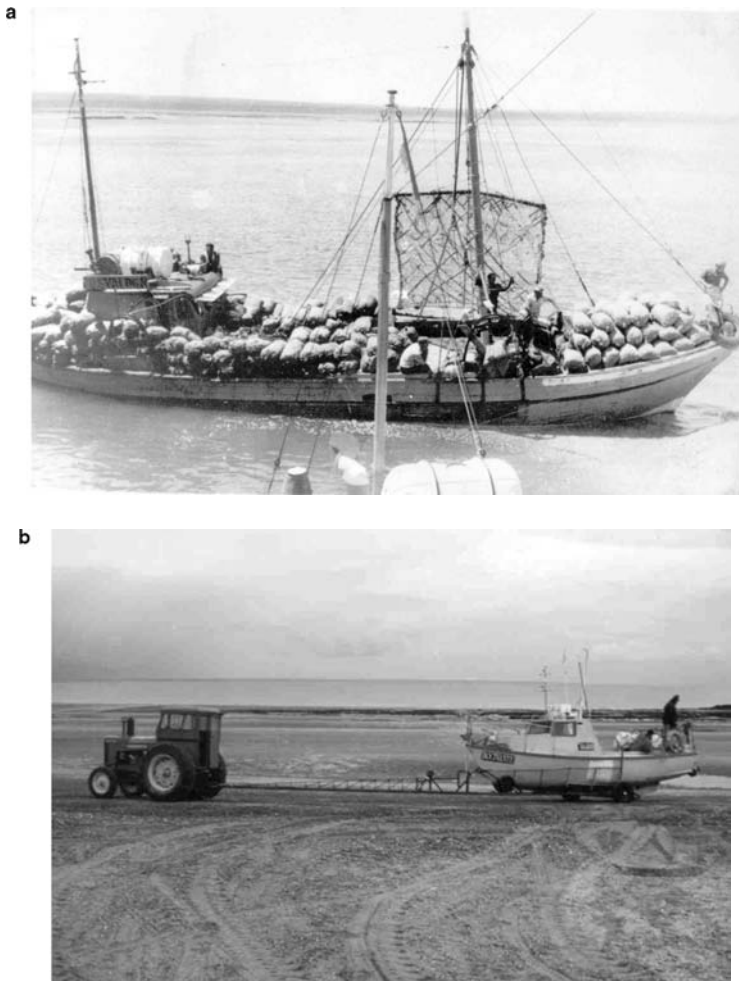
The San José Gulf stock is structured as a metapopulation, with local subpopulations interconnected through larval dispersal (Fig. 4.1c) (Orensanz 1986). Results from a three year study (Orensanz 1986) suggest that at least in the best-studied ground of San Román, growth is density-dependent, with effects being significant above a local biomass of 1 kg/m<sup>2</sup>, where the maximum observed biomass was 1.5 kg/m<sup>2</sup>. Calculations based on primary productivity (Charpy-Roubaud et al. 1982) and two independent population dynamics studies (Orensanz 1986; Ciocco 1991) yielded very consistent results on the production of meat, which is in the range of 360–380 g/m<sup>2</sup>/yr. Recruitment of juveniles also appeared to show compensatory density-dependence. The commercial size of 60 mm is reached at an age of 1.5 to 2.5 years. We refer the reader to Orensanz et al. (1991a) and Ciocco and colleagues (2005) for further information and references on the biology and ecology of the species.

## **Achievements, setbacks, and prospects**

### ***Round 1: Boom and bust of the San Matías Gulf Scallop Fishery (1968–1972)***

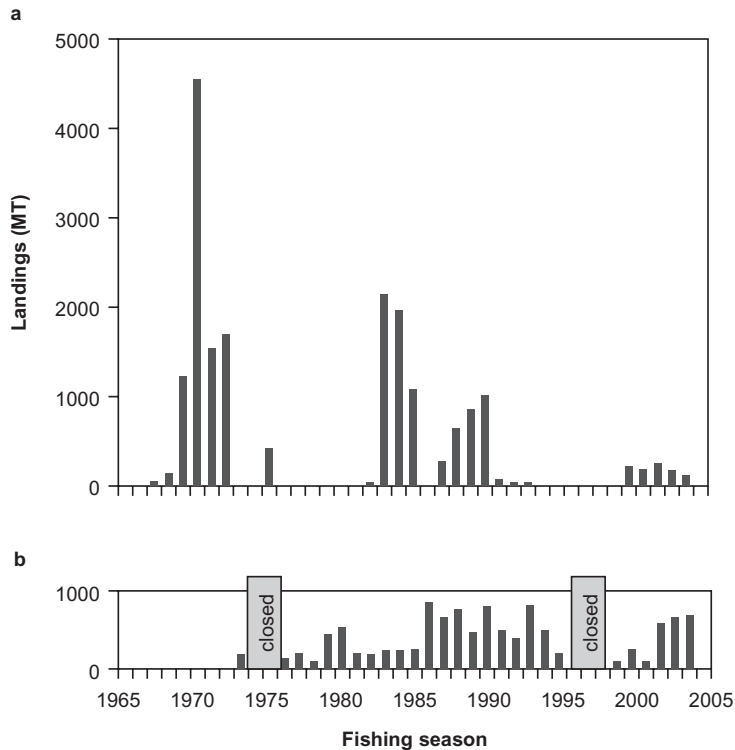
A decline in scallop landings from the Georges Bank, Canada during the late 1960s (Caddy and Lord 1971) sent brokers looking for alternative products. To seize the opportunity, many small-scale scallop fisheries sprouted around the world, among them a dredge fishery for the Tehuelche scallop in San Matías Gulf, Argentine Patagonia (Orensanz et al. 1991a; Ciocco et al. 2005). Starting in 1969, a fleet converged from other harbors of the country on San Antonio Oeste, a small sleepy town in the province of Río Negro, northern Patagonia (Fig. 4.1b). The wooden boats, 12–22 m long, towed a heavy dredge from the side (3 m × 2.5 m, Fig. 4.2a).

Scallop beds were located at depths greater than 20 m along the northwest coasts of San Matías Gulf (Fig. 4.1b), under the jurisdiction of Río Negro Province. Exploitation had been very light before 1969, when one or two boats supplied a small domestic market. Before the scallop boom, the substratum of the grounds was a



**Figure 4.2** Fishing units. (a) A dredger arrives loaded with unsorted scallop bags to San Antonio Oeste, 1970. Notice the design and size of the dredge (photograph by Dr S.R. Olivier). (b) One of the fishing units that operate in the San José Gulf commercial diving fishery.

mixture of sandy or gravel sediment covered by abundant shell fragments that had accumulated over time. Empty shells provided a suitable substratum for scallop larval settlement and early benthic survival. Four years of intensive dredging, between 1969 and 1972, unselectively removed large and small scallops, also scouring the top shelly substratum of the beds. The catch was not sorted on board but transported in bulk to port. Small scallops and shell hash were discarded. Thousands of tons of shelly material were used during that period to fill lowlands around San Antonio and to construct loading docks. It has been calculated that during a single fishing season, each spot of scallop bed was dredged, on average, seven times (Iribarne et al. 1991). Sequential depletion of the beds proceeded quickly.



**Figure 4.3** Historical series of landings. (a) San Matías Gulf, Río Negro Province, mostly based on dredging. (b) San José Gulf, Chubut Province, based on commercial diving.

The scallop boom was followed by a decade (1972–1981) of virtually no recruitment. In the ensuing two decades there were three harvesting pulses, all supported by sporadic pulses of recruitment, and none of them comparable to the boom years (Fig. 4.3a). Scallop stocks provide many examples of spasmodic dynamics (Caddy and Gulland 1983; Orensanz et al. 1991b, 2006), and it has been suggested that spasmodic recruitment during the three decades that followed the boom of the San Matías Gulf scallop fishery reveals the ‘natural’ dynamics of the population, recruitment hypothetically being controlled by unidentified environmental conditions. However, the age distribution of the catch (Olivier et al. 1970; Olivier and Capítoli 1980) and of a sample retrieved from the shell dumps (Parma and Orensanz unpublished data) indicate that recruitment was rather regular, not spasmodic, during the time that led to the accumulation of the biomass removed during the boom.

In retrospect, several pieces of information suggest that intensive dredging between 1969 and 1972 irreversibly changed the substratum of the beds and the dynamics of the stock. The fact that only four pulses of recruitment occurred during the 35 years that followed the boom of the fishery suggests the possibility of recruitment overfishing. The scallop boom also changed the social dynamics of a

closely-knit community by creating a transient climate of prosperity that vanished with the scallop beds. After the fishery was formally closed in 1972, brokers, processors, and skippers started looking for new grounds. Round 1 was lost.

### ***Round 2: From dredging to commercial diving (the 1970s)***

The existence of attractive scallop beds in San José Gulf, under the jurisdiction of the Chubut Province, had been well known to a few skippers since at least 1968. By 1971, up to five dredgers from San Antonio and Rawson fished in the gulf, but operations were irregular due to lack of logistical facilities; the catch was processed in makeshift camps on the beach. The local market was supplied by the collection of scallops stranded on the beach as a consequence of frequent windstorms. However, after the collapse of the San Matías fishery, with good markets and well-established marketing connections, the area suddenly became attractive for commercial dredging. A few boats started to operate more regularly in San José Gulf during the early 1970s, landing the catch at El Riacho (Fig. 4.1c).

In 1971, a group of commercial divers arrived from Uruguay on board a now legendary ‘black sailboat’, looking for adventure and opportunity. The Picallo brothers, Santiago and Zeito, led the team and claimed that commercial diving for scallops was a habitat-friendly and economically-viable alternative to dredging. Their idea was hard to sell, as commercial diving was virtually unknown in Argentina. Some sport divers occasionally sold their catch locally, but this was a small and irregular activity. The Picallo brothers teamed up with a few local fishers who contributed their boats and rigged them for commercial diving. In February 1973 they were joined by a small group of scientists to conduct a survey of the scallop grounds and investigate the merits of commercial diving (Olivier et al. 1974). Scientists advised provincial managers to ban the use of dredges, and started a research project in November 1974 with the intent of providing better scientific support and, hopefully, identifying a sustainable management option. Concerned because of the collapse of the scallop fishery in the adjacent Río Negro Province and the pressure to allow dredging, the fisheries authority of Chubut Province closed all fishing activities for two years (1974–1975). The commercial diving fishery was formally opened in 1976 and dredging has been effectively banned ever since then.

The fishing units initially geared up for commercial diving were three small wooden side-trawlers, namely *San José Chico*, *Virgen de Luján*, and *Ría de Vigo*, equipped with large compressors to supply up to seven hookah divers. Air supply systems were rudimentary. The operation became commercially viable once the divers designed a bag, locally known as *salabardo*, that allowed them to use both hands when fishing. This modest technological development paved the way for an entirely new way of harvesting the Tehuelche scallop. Fishers quickly tried several types of vessels and gear. The converted trawlers were abandoned because the simultaneous operation of multiple divers was impractical. In 1977, Luigin Isola, a local entrepreneur and boat-maker, developed the basic fishing unit still in use today



(Fig. 4.2b). It consists of an 8 m long boat built of wood or fiberglass, powered by a 35–110 hp outboard motor (Ciocco 1995; Ciocco et al. 2005). Boats are launched from sandy beaches with the help of tractors (Fig. 4.2b).

The fight to keep the ban on dredging in San José Gulf was long, protracted, and coincided with a politically-difficult period: the repressive military dictatorship that ruled Argentina between 1976 and 1983. Pressure from the dredging fleets based in San Antonio Oeste and Rawson was strong and was supported by some local power brokers. At one point, a well-respected skipper entered a highly publicized hunger strike to protest against the ban. To further complicate things, during the late 1970s the ecological effects of dredging and trawling were still far from being an issue of scientific interest, managerial attention, or concern to conservationists. References in the international literature to support the ban were virtually non-existent, in contrast with the numerous articles and reviews published on that subject over the last 15 years.

Under ideal circumstances a controlled experiment should have been conducted to investigate the effects of dredging, but there was an immediate urge to provide a tangible rationale and to make a decision. A short-term project was conducted during May 1976 using a dredging boat geared for both commercial diving and dredging, a sort of spirited contest where an old-time skipper and his crew, a bunch of seasoned divers and a small team of young scientists tried to demonstrate their points. Divers documented photographically the ecological effect of the heavy dredges (Fig. 4.4): scouring of the ground, silting, and incidental mortality of various organisms (Fig. 4.5). Scientists confirmed the complete lack of selectivity of the gear (Fig. 4.6), and the skipper searched in vain for deep grounds that, being beyond the reach of divers, could justify the use of dredges. Pictures taken during the survey (Figs 4.4 and 4.5) provided the powerful and tangible testimony that tilted the balance in favor of the ban.

At the same time, a project conducted between 1974 and 1977 (Orensanz 1986) provided support for management. It was shown that the legal size limit of 60 mm, which had been established years earlier with no sound rationale, was very reasonable: it allowed scallops to go through one or two reproductive seasons, and corresponded to the minimum muscle size required by exporters. Divers quickly developed a search image for commercial size, the result being very high selectivity (Fig. 4.6). Divers concentrated in very dense patches, with a threshold density around 30 scallops/m<sup>2</sup>, and did not have to harvest deeper than 10 m to conduct a profitable activity. It was expected that thinning by divers would release intraspecific competition for food. Scallops below legal size, and those living at densities below the threshold of commercial profitability or in beds deeper than the normal operational range of divers, provided a sizeable reproductive reserve. The commercial diving fishery, it was concluded, had a great potential for self-regulation as long as there were no increases in price that would make deeper or sparser beds worth targeting (Orensanz 1986).



**Figure 4.4** Experimental dredging in San José Gulf, May 1976. This picture gives a sense of the weight of a loaded dredge. Skipper of the FV *Adelante Boca Juniors* (Boca Juniors is a popular Argentine soccer team) was Dn José Fondacaro.

Collaboration between scientists and a group of innovative fishers showed that habitat-friendly commercial diving was feasible, and resulted in the first and still the only dredging and trawling-free area of the southwestern Atlantic. Round two was won.

### ***Round 3: No controls or incentives (the 1980s and 1990s)***

Following the decline and fall of the military dictatorship, developments during the 1980s and 1990s were punctuated by political and economic crises. The scientific team that had conducted the scallop research project had been disbanded in 1978 as part of a purge of the country's scientific community, and it was not until the mid-1980s that a new cohort of young scientists was in place to conduct research on the coastal resources. The San José Gulf commercial diving fishery grew with little regulation apart from the legal size, while institutions, including fisheries management and science, were rebuilt, although often distracted by more pressing matters. There was a license program, but no cap on the number of licenses. By 1992 there were more than 30 teams in operation (Fig. 4.7). In the absence of incentives for conservation, including secure access rights, a 'race for fish' resulted from a 'tragedy of the commons' situation.

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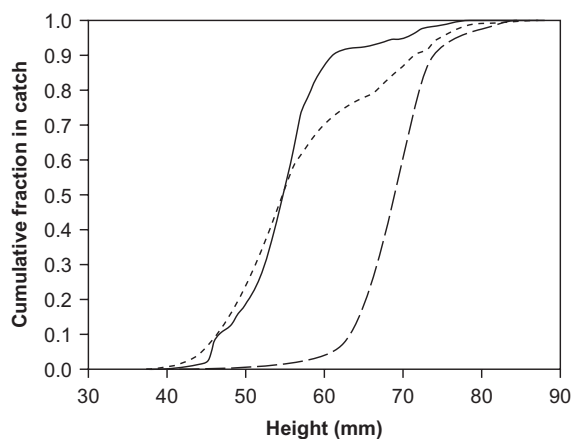
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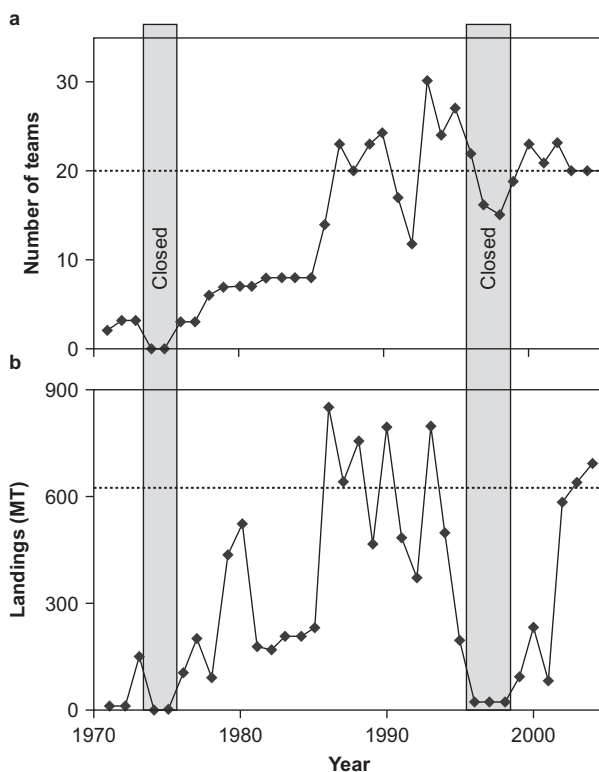
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**Figure 4.5** The scallop dredge in action. (a) View of a dense unfished bed. (b) Scouring of the bottom. (c) Siltation. These are part of a series of pictures that tilted the balance in favor of the banning of dredges three decades ago (photographs by Zeito Picallo).



**Figure 4.6** Cumulative size-frequency distributions of experimental fishing on board the *Adelante Boca Juniors*, May 1976. Solid line: dredge; dotted line: scientific diver attempting to pick every scallop along his path; dashed line: commercial diver.

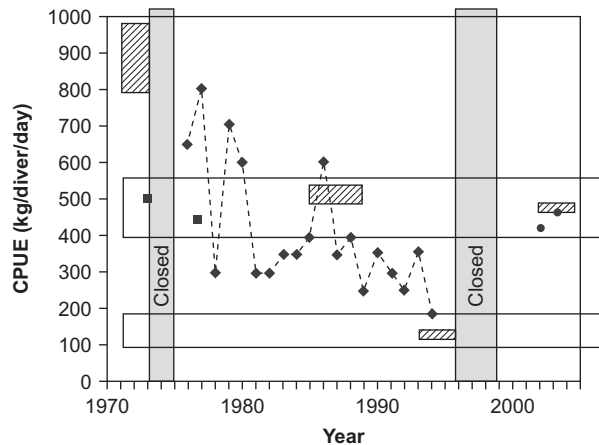


**Figure 4.7** San José Gulf, commercial diving fishery, 1970–2004. (a) Size of the fishing force (number of teams). (b) Landings (MT, closed periods indicated). Dotted lines indicate precautionary levels (20 teams, 600 tons/yr).

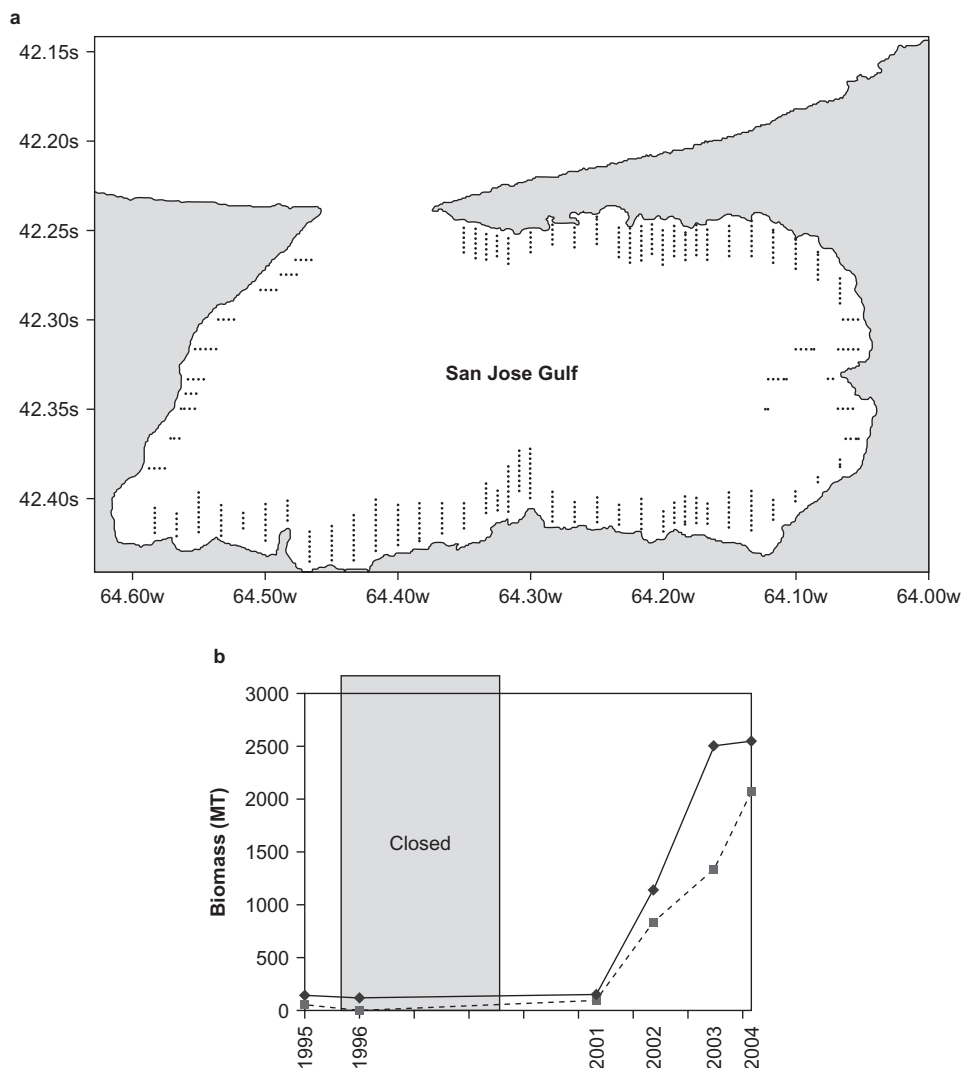
Reported annual landings, which underestimate the real catch, were generally above 600 tons during the period 1987–1995 (Fig. 4.7). To finally precipitate a collapse, a severe economic crisis erupted in 1989; by the middle of the year, inflation was running at a daily rate of 3%, the relative value of the *peso* fell to historically low levels, and the democratic government that replaced the dictatorship collapsed. Since the scallop fishery was export-oriented, the relative value of the product skyrocketed. The threshold density level for profitable operation went down, and divers risked working in deeper water. Commercial divers are habitat-friendly compared to dredges, but they are also tremendously efficient at searching and depleting highly valuable resources. In addition, a new market developed for small-sized scallops, which were used to decorate cans of shellfish stew. All the factors that had previously contributed to maintain a reproductive stock suddenly evaporated.

A time series of CPUE assembled by Ciocco (1995) for the period 1976–1994 using data from various sources shows a declining trend, with a historical low in 1994 (Fig. 4.8). Information collected through interviews with old and active fishers confirmed the trend, even if an apparent subjective positive bias increased with the time lapsed (Fig. 4.8). The provincial fisheries administration, concerned by reports from the field, contracted with the National Patagonic Center (a branch of the National Council for Scientific and Technical Research) to survey the grounds in December 1995 and November 1996 (Ciocco et al. 1996, 1997, Fig. 4.9a).

The surveys were done by divers counting scallops along transects, following an adaptive design (Thompson 1994). Their results revealed a grim reality: the scallops left could scarcely support a single team during the fishing season (Ciocco



**Figure 4.8** San José Gulf, commercial diving fishery, 1970–2004. Catch per unit of effort (CPUE), expressed as kg/diver/day. Connected diamonds: series compiled from various sources by Ciocco (1995). (■) Data from Orensanz (1986). (●) Data from logbook program (2002–2003). Cross-hatched rectangles: ranges reconstructed from interviews; older values (early 1970s) are likely to reflect maxima rather than averages due to a positive subjective bias. Horizontal rectangles indicate average ‘good times’ CPUE (500 kg/diver/day) and the low level that preceded the closure.



**Figure 4.9** Recovery of the San José Gulf scallop stock. (a) Survey design. (b) Estimated abundance in six surveys conducted between 1995 and 2004. Solid line: total biomass; dashed line: biomass of sub-legal stock.

and Orensanz 1997). Besides, the concentration profile had changed (Orensanz et al. 1998), partly as a result of divers targeting the densest patches (Ciocco and Orensanz 1997; Orensanz et al. 2006) – the few scallops left were dispersed at very low densities. The fishery was completely closed for three years between 1996 and 1998. Only 15 of the fishing units continued operating during those years, targeting other resources, mostly the southern ribbed mussel or *cholga* (*Aulacomya ater*), or poaching the few remaining scallops. *Cholga* beds, which take a long time to develop, were severely depleted during that period, and have not recovered. In the

absence of monitoring, appropriate incentives, and efficient controls, a fishery that had survived for two decades, in spite of little regulation, collapsed, with devastating consequences for fishers and their families. Round 3 was lost.

#### ***Round 4: Recovery, participatory management, and incentives (2000–2004)***

During the late 1990s, a crisis hit the Argentine industrial fishery, whose backbone is the Argentine hake (*Merluccius hubbsi*). The provincial administration, under pressure to provide alternatives, reopened the scallop fishery in 1999 and 2000 with fixed monthly quota allocations to license holders (10 in 1999 and 19 in 2000); an additional group of teams operated illegally (9 in 1999 and 4 in 2000). Divers soon noticed that the quota were out of proportion with availability: they were unable to reach them even though they were running the risks of fishing at 30 m depth or more. A key element for solving this crisis was the Association of Artisanal Fishers of Puerto Madryn (APAPM), an organization formed in 1993, as the first symptoms of an impending crisis became evident. By 2000 the membership of APAPM included approximately 60% of the fishers, had formal legal status, and played an increasingly proactive role (Santa Ana 2001). It was significant that their charter has a strong commitment to sustainability.

The APAPM made a formal presentation to the provincial fisheries authority questioning the unrealistically high catch allocation for the 2000 fishing season. Managers, uncertain about how to proceed, approached CENPAT (Centro Nacional Patagónico) looking for scientific advice, but scallop beds had not been surveyed in years and thus scientists were unable to recommend a quota. It soon became apparent that because of the uncertainties surrounding the fishery, there was need for discussion of management issues among scientists, managers, and stakeholders. In 2001, the provincial fisheries authority convened a technical advisory board for the commercial fishery of San José Gulf, integrated by technical staff from the administration, scientists from CENPAT and representatives of APAPM (Parma et al. 2003; Orensanz et al. 2005). In 2005, the advisory board was expanded to incorporate representatives of the entity that administers the Natural Protected Area Peninsula Valdés, and the provincial authority of tourism and protected areas that has a management mandate. Participation of different sectors in the advisory board was the first structured co-management experiment in the history of Argentine fisheries.

In November 2000, a group of 15 permit holders, all of whom had survived the three year scallop closure, produced an important document where they proposed a well fleshed-out program that would grant long-term secure rights to a limited number of fishing units and introduce incentives for conservation. Based on the fishers' proposal, the advisory board evaluated the prospects of a limited-entry program (Orensanz et al. 2003). Although the dynamics of the exploited scallop metapopulation is not well understood (Amoroso 2004), historical data and experience suggest that the number of permits should not exceed 20, and the annual

scallop catch should have a precautionary cap of 600 tons (Fig. 4.7). This advice from the board resulted in a moratorium on the number of permits.

Since 2001, scientists from CENPAT, with the collaboration of fishers from APAPM and support from the administration, have conducted annual surveys of the scallop beds leading to annual catch quota recommendations. Data show a sustained rebuild of the stock starting in 2001 (Fig. 4.9b). Since 2002 the fishery has been thriving again. Round 4 was won.

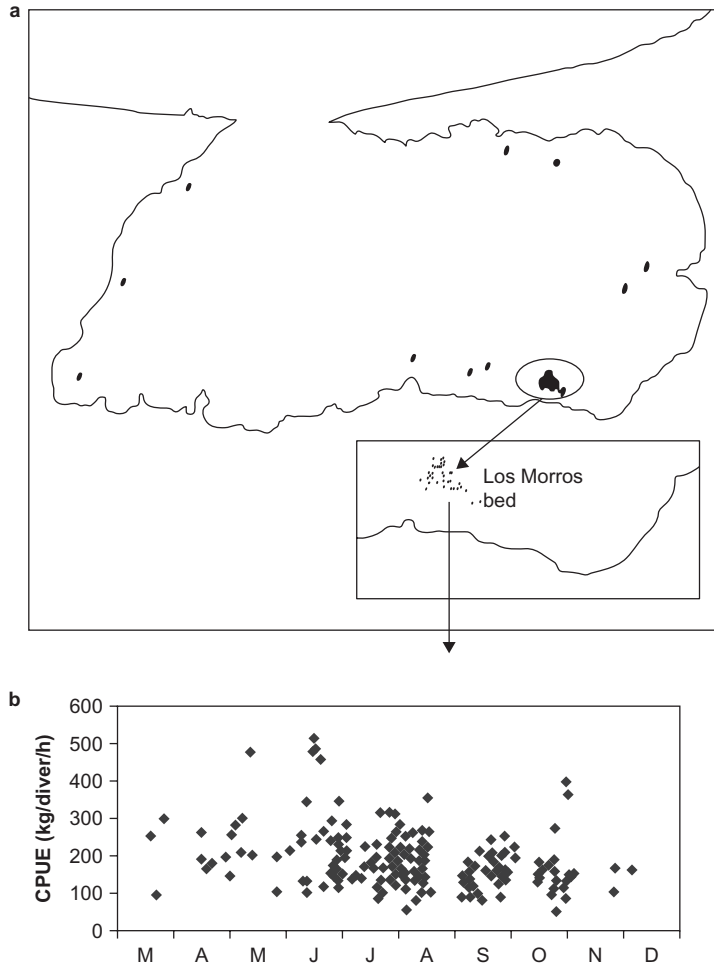
### ***Round 5: New challenges (2005–?)***

Recovery of the resource has brought pressure to increase the number of licenses, posing the risk of a ratchet effect (Hennessey and Healey 2000) – it is easy to increase the number of permits when the stock goes up, but difficult to cut them back when the stock goes down. Some managers in the provincial fisheries authority have, however, suggested that the number of permits could be adjusted to track stock abundance. Besides the feared ratchet effect, one well-documented problem with this policy is that it creates a disincentive for conservation when the resource is at a low level. Fishers that stay in the fishery have no incentives to be conservative if the rebuilt stocks are to be shared with new entrants (Hilborn et al. 2005). In addition, one cannot expect an honest collaboration in data gathering and monitoring when the number of fishing permits is pending on the assessments.

Limited-entry programs are usually preceded by a moratorium (Charles 2001), but the transition between the two is a delicate matter. Functional limited-entry systems offer appropriate incentives for responsible fishing (Heizer 2000), provided they are accompanied by effective disincentives for non-compliance, generally in the form of effective enforcement and penalties. The latter may prove to be the Achilles heel of the San José Gulf commercial diving fishery. Conditions for enforcement are favorable – it is supported by most fishers – transit of shellfish from landing sites to processing plants must go through a bottleneck that is the single road that runs through the isthmus (Fig. 4.1b), and the region is a protected area. However, legal constraints, lack of coordination between agencies, and a weak judiciary system conspire to make enforcement ineffective. This became clear during the 2004 season, when, according to available evidence, there was an unprecedented gap between real and declared landings.

Equity or social sustainability issues also require serious attention. Currently, there are no clear rules for the cancellation of a permit in the case of non-compliance, nor a system for ranking prospective permit-holders waiting to take the place of dismissed non-compliers. There is, however, agreement on general criteria: years and continuity in the fishery, compliance with regulations, and being the son of a retiring fisher. Also, there is agreement on conditions that have been a point of contention in other limited-entry systems: permits should not be transferable, permit-holders should be physically engaged in fishing activities, and a one permit per permit-holder policy.





**Figure 4.10** San José Gulf commercial diving fishery, 2002. Results from the logbook program. (a) Spatial allocation of fishing effort. Notice the concentration of effort in a single fishing ground (Los Morros). (b) Trends in CPUE (kg/diver/h) in the Los Morros fishing ground.

It has become clear that the technical support for management must be upgraded, particularly with regards to the fishing process. A voluntary logbook program was started in 2002 with the active participation of several fishers under a confidentiality agreement (Cinti et al. 2003). The value of this information is well illustrated with data from the 2002 season (Fig. 4.10), when most of the effort concentrated in a single bed, namely Los Morros. Fine spatial resolution made it possible to understand fishers' behavior and to interpret CPUE data (Fig. 4.10b) at an appropriate scale and attention to sources of variation. Round 5 is on, and the clues required for winning are becoming clear.

## Summary

A decline in scallop supplies from the Georges Bank during the late 1960s created a market for alternative products. Many small-scale scallop fisheries sprouted to seize the opportunity, among them a dredge fishery for the Tehuelche scallop in San Matías Gulf, Argentine Patagonia. After the fishery collapsed in 1971, dredgers turned their attention to dense grounds discovered in San José Gulf, an ecologically sensitive area that had just been designated as a provincial marine park. Factual evidence and common sense suggested that the collapse of the San Matías fishery was due to the use of a fishing gear that was unselective and disruptive of the benthic ecosystem.

Collaboration between scientists and a group of innovative fishers showed that habitat-friendly commercial diving was feasible, and this resulted in the first commercial diving fishery of Argentina. Subsequently, the fishery was neglected and grew unregulated during a period of political and economical uncertainty. The commercial diving scallop fishery collapsed in 1996 and was closed for three years. The fishers that survived the crisis developed a substantive proposal for recovery, its backbone being a limited-entry program that would introduce appropriate incentives and put a cap on effort. A co-management program, involving scientists, fishers, and managers was put together to provide guidance. The fishery subsequently recovered, and is thriving again. Recovery of the resource brought pressure to increase the number of licenses, posing the risk of a ratchet effect on effort. A new round is on, but this time fishers, scientists, and managers have learned important lessons and know how to work together. The direction for continued achievement is now clearer.

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