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Oceanographic research vessels: Defining scientific winches for fisheries science biological sampling manoeuvres

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ABSTRACT

Studies on scientific winches installed on oceanographic/fisheries research vessels (ORVs and FRVs, respectively) are distinguished by the winches' unique design features and the important role they play with scientific experiments. It is impossible to draw general conclusions when analysing scientific winches used for fisheries sampling experiments on recently built ORVs. Few vessels are built each year and their dimensions and mission vary greatly. Thus, to consider the concept of traction factor and the possible ways in which equipment on fishing trawlers could be arranged and manoeuvred, a statistical analysis was carried out on newly built and refitted vessels from Spanish shipyards. The starting point was a sample of 125 boats, to which linear regression models were adjusted to explain the relationship between total traction and the traction for the fishing winch. As a result, three regression models-one for each kind of arrangement-were obtained. The next step involved analysing and modelling the dependence of the auxiliary winch traction on fishing winch traction.

1. Introduction

1.1. General considerations - oceanographic research vessels

Research fleets are crucial in meeting scientific objectives and completing the tasks that enhance understanding of high sea processes. For this reason, oceanography depends on a mobile platform to carry out the experiments necessary for its research activity: the oceanographic research vessel (ORV).

Adler (2014) studies how the research vessel has evolved in its role as a scientific instrument. He argues the ORV has gone from being a mere tool to reaching an intermediate stage in which it served as a laboratory vessel. In its current state, it is an invisible technician "whose mission is to deploy remote sensing equipment and collect data, which will not be analysed on board". Its mission is vital to oceanography. In turn, the ORV plays an essential role in supporting this work and the full range of research procedures, except for those needing satellite back-up (Carral et al., 2015b).

Research vessels can be roughly divided into three main groups: those used for physical or chemical oceanography research, fisheries research vessels (FRV) for biological oceanography and vessels for geological oceanography. On the whole, these vessels have general oceanographic research capacities and then simply do specialised work in a particular field for a set time period, according to the needs of the countries and/or universities that hire them (Carral et al., 2015b). Moreover, their building and running costs are high. For this reason, optimisation and functionality objectives are taken into account when these vessels are being designed and operated (Oliveira et al., 2014). The end result is a versatile vessel designed with extremely multipurpose features (García del Valle, 2007).

One factor to take into account includes the requirements of the scientific equipment they have. Other factors will also define the characteristics of FRVs, depending on the scope of their activity. For example, there is the number of scientists and crew members on board and the range required. These data determine the classification information found in Table 1.

In all three ORV categories found in Table 1, mounted and portable scientific winches make it possible for research instruments to be manoeuvred with lines. For this reason, this equipment is of vital importance (Carral et al., 2015b).

Scientific winches are electrically or hydraulically powered. They have drums to handle towlines, nets or umbilical cables with measuring sensors. A characteristic common to all these kinds of equipment is that they handle extensive lengths of line with a high degree of accuracy to

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Table 1
FRV classification according to operational and fisheries research capacities.

Type	Global	Oceanic	Regional
Fisheries research possibilities	Any fishing ground.	Offshore fishing grounds.	Inshore fishing grounds.
Range (days)	50	40	30
Scope (km)	2500	2000	1500
Length(m)	70–90	55–70	40–55
Crew (per.)	+30	+25	+20

Source: author's own based on (Oliveira et al., 2014).

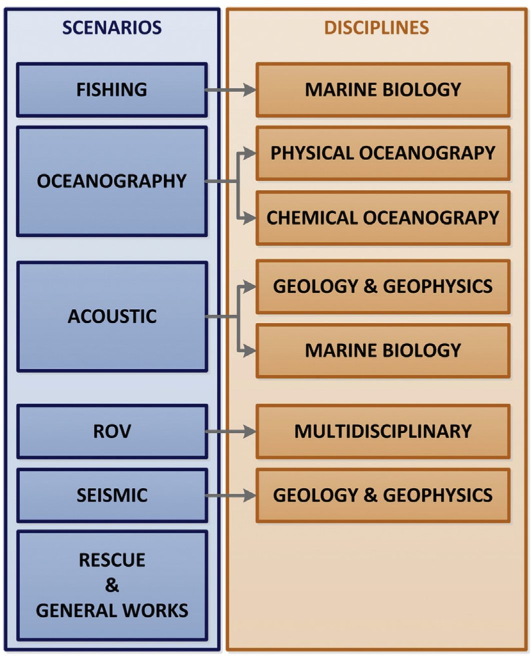

Fig. 1. Scenarios faced by the ORV, according to the field of research carried out.
Source: author's own based on (Carral et al., 2015b).

adjust the rendering and hauling speed. Moreover, stowage and handling can be carried out with great care to perform a unique function: working with the coaxial cables that transmit data (Carral et al., 2015b). As for its arrangement on board, all this equipment is normally found in a winch room with a common drive unit instead of individual operating systems (García del Valle, 2007).

1.2. Scenarios and scientific missions

In the case of the multipurpose approach mentioned earlier, vessels take on specialised functions in varying scenarios for a limited period of time. In this way, they can take part in research campaigns across several fields (Fig. 1). In one branch of oceanography, marine biology, (Oliveira et al., 2014), the work involves collecting and analysing phytoplankton, zooplankton and fish; taking benthic and pelagic samples and carrying out an integrated study of ecosystems as well as fisheries research.

García del Valle (2007); Oliveira et al. (2014) point out that research work within the marine biology environment entails adapting the vessel's equipment and services to scientific activity. In a study on increasing operational versatility and diversifying the characteristics of their facilities, Oliveira et al. (2014); Rosenblatt (1960); ECORYS (2014) define the common requirements for designing these vessels so that state of the art devices and research procedures can be used. One requirement that stands out is that these vessels must have winches and cranes with high functionality.

When considering fishing gear and fisheries research from a practical point of view, it is useful to distinguish between trawling gear involved in work along the ***seabed*** and the gear used in mid-depth, ***pelagic*** waters. This study will focus on *benthonic* species lying along the seabed, *demersal* ones living near the ocean floor or *pelagic* ones, which live in intermediate depths. At the same time, a wide range of variants come into play in bottom trawling, depending on depth and type of manoeuvre being carried out (Carral et al., 2015a; Santos and Núñez, 1994).

1.3. Objectives

The aim of this work is to analyse how winches were arranged on deck within a sample of 125 fishing vessels, either newly built or refitted in Spanish shipyards between 1999 and 2003 (Carral et al., 2015a). This was the last time the fleet had been renewed in this country. In this study, the concept of total traction value for their winches was formulated to propose a relationship between the fishing winch and auxiliary winches. Thus a proposal could be made to determine the traction necessary for carrying out biological sampling experiment in fisheries science.

2. Oceanographic winches for fisheries science biological sampling: design and specific operational features. Trends

In whichever setting or scenario they are working, ORVs have winches with drums capable of handling the total amount of line needed to carry out experiments. Drums are driven by an electric or hydraulic engine, whose revolutions and torque are adapted to the required hauling speed and traction, through the use of a multistage reducer (Fig. 2). The equipment has a band brake, necessary for immobilising the drum whilst the vessel hauls the scientific apparatus.

2.1. Specific features of their design

For this reason, winch design is adapted to the type of line (rope or cable) that is being handled and the scientific device that is pulled at its end (Carral, 2005). On specific occasions, special coaxial conductor cables are handled. Whilst they are involved in hauling, these cables transmit sensor information to the vessel (Carral et al., 2017). Therefore, care must be taken in how they are operated and stowed (NSF, 2001).

Amongst the unique design features of scientific winches outlined by Carral et al. (2015b), the ones that are most relevant to fisheries science research will be the focus of this study. Among these are the characteristics that help them work with extensive lengths of metal cable and the fact that, at all times, the traction produced by the equipment is known. Other characteristics are of a more general nature: the noiseless way they work and the inalterability of the materials used in their manufacture.

Winches are classified according to their function and the type of experiments that they are involved with (Table 2). In this table, traction value ranges, capacity and speeds are determined. It is important to mention that, in the more elevated ranges of traction value, the two main ways in which line traction is produced are through direct traction and friction drive. (Chapter 11- NSF, 2001). Direct traction means that the drum stores and pulls the line; it is commonly used when the traction is not extreme. Friction drive relies on additional pulleys, which pull the coiled cable whilst the main drum serves as storage. When the latter system is used, the line has an extended service life (Carral et al., 2015b).

2.2. Trends

Table 2 shows the relationship between the experiments that are to be carried out and the oceanographic winches involved. However, the research protocols for doing those experiments have changed over time, and winches have been affected by this change (Pepin and Shears, 1997; Weinberg et al., 2002; Baumgartner, 2003; Nishimura and Studervant, 2011). Nishimura and Studervant (2011) mention different areas of innovation, such as advances in sample net design (Siler, 1983; Choat et al., 1993), oceanographic sample instruments (Rudnick and Klinke,