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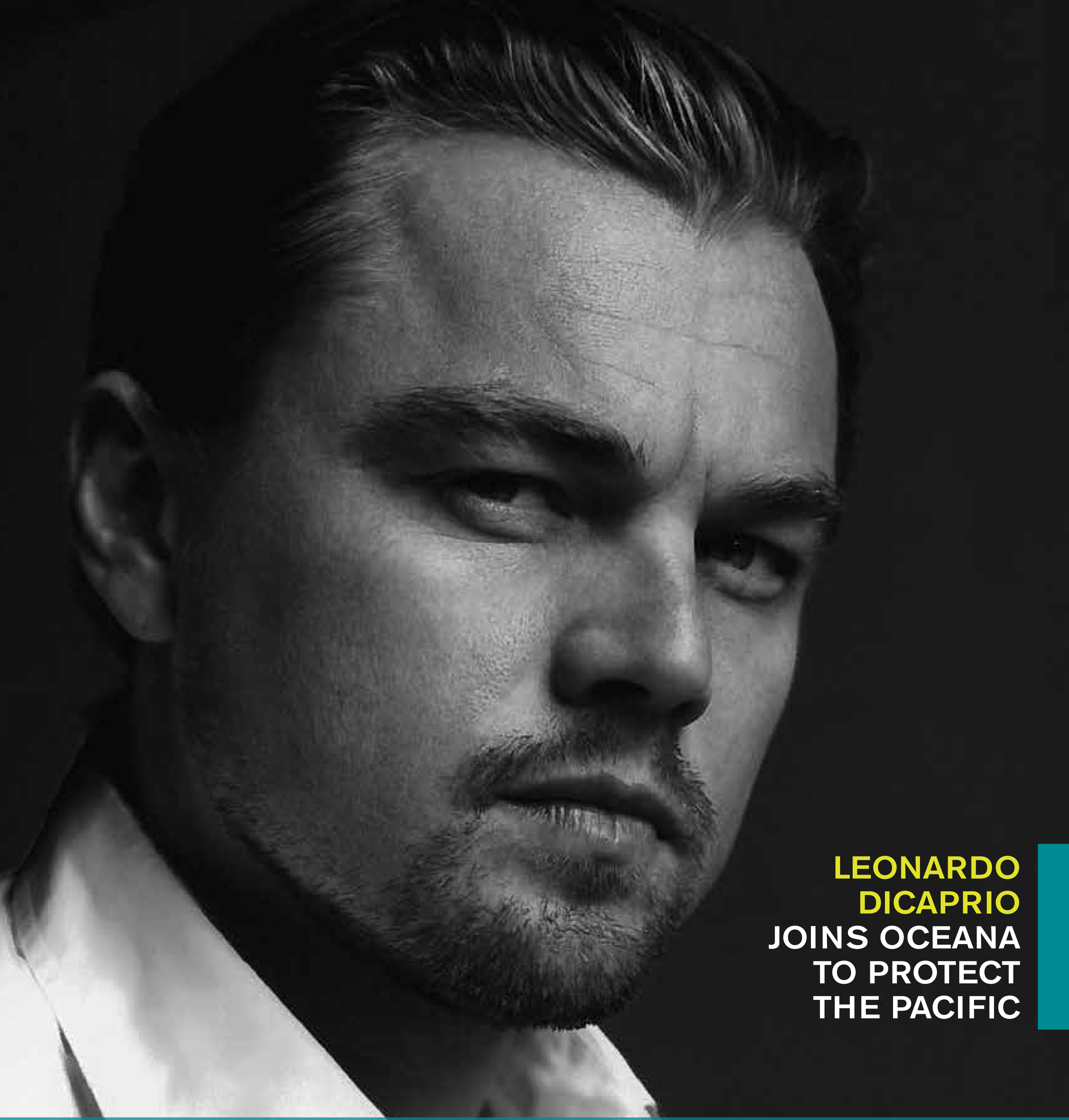

LEONARDO DICAPRIO JOINS OCEANA TO PROTECT THE PACIFIC

PLUS: OCEANA REPORTS ON U.S. BYCATCH | TOUGH QUESTIONS ON ARCTIC DRILLING | SEISMIC AIRGUNS THREATEN BLUEFIN TUNA

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ASK DR. PAULY

How do we know how many fish there are in the sea?

Fishing is meant to remove fish from the sea, and so it is no wonder that there are fewer fish in the sea, given all that we do to catch them. However, we do not want to leave so few fish in the sea that they can't maintain their population, and this begs the question in the title: How do we know how many fish there are in the sea?

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However, we do not want to leave so few fish in the sea that they can't maintain their population, and this begs the question in the title: How do we know how many fish there are in the sea?

Fisheries scientists answer this question by performing stock assessments to estimate the biomass, or weight, of fish in the sea. These assessments can involve a wide array of methods, as determined by the data that are available. One method is to divide the catch of a fishery (the weight of the fish that are caught in a given year) by the effort needed to generate the catch (the number of fishing hours or days deployed to catch the fish in that year). The result of this calculation, called the catch per unit effort (CPUE), is going to be higher when the stock is abundant and lower when the stock is depleted. Thus, if CPUE estimates are available for a number of years, their trend will be roughly parallel to the trend of the (still unknown) biomass of a fish population.

Another technique is called the swept-area method, used for fish living on or near the sea floor that can be caught by bottom trawlers. Research trawlers drag a net of known width for say one hour at a known speed to cover an area of the sea floor that can be easily calculated. Thus, their catch during that hour can be multiplied by the number of times that area fits in the entire fishing ground, and voila! In reality, analyzing the results of bottom-trawl surveys is more complicated than that, but the basic idea remains simple.

Another technique is to use sound, which we already use to locate schooling fish (like dolphins and whales also do) to estimate the size of a school of fish. Thus, if a sound wave of known energy level is sent from a fishing boat, the fraction of this wave that is reflected as an echo by a fish school will tend to be proportional to the size of that school – so a small school will reflect less sound than a big school. Echosounding – or hydroacoustic methods in general – can then be calibrated using schools that have been caught and weighed, and the biomass in the water thus estimated. This method works best with small schooling fishes, including herring, sardine, and anchovies.

Still other methods involve tagging, where a certain number of fish are given a tag or mark and then released into the population. (Tags can range from a clipped fin to electronic devices that provide information on movements and information of the environments that the fish encounter.) Subsequent catches will contain both tagged and un-tagged fish, and using some simple arithmetic one can then calculate the size of the population, along with the exploitation rate. Finally, one can move from simple arithmetic to more serious mathematics, and integrate into computer models of exploited fish population all fishery-dependent and other information that is available on catches, effort, biomass estimates from hydroacoustics, and tagging data into one single analysis. These analyses are usually accurate and precise, but occasionally they can be very wrong. A good example of this is provided by the collapse, in the early 1990s, of the cod fishery off Newfoundland and Labrador, Canada, which was then being assessed using the best integrated models of the day, as operated by one of the then most respected fishery management agency in the world. Their model was essentially flawed because it did not correctly interpret spatial information, but at the time that was not visible because of the model's inherent complexity. This is one reason why the marine conservation community now insists on transparency, where the data and assumptions that go into fish stock assessments are made explicit and justified publicly.

In conclusion, whether using simple CPUE-based analyses, as commonly done in developing countries, or integrated models, as often done in developed countries, the abundance of fish can be estimated for the purposes of fisheries management, allowing fisheries managers to determine how much can be taken for a fishery to be sustained. And we must insist that it be done for all fisheries.