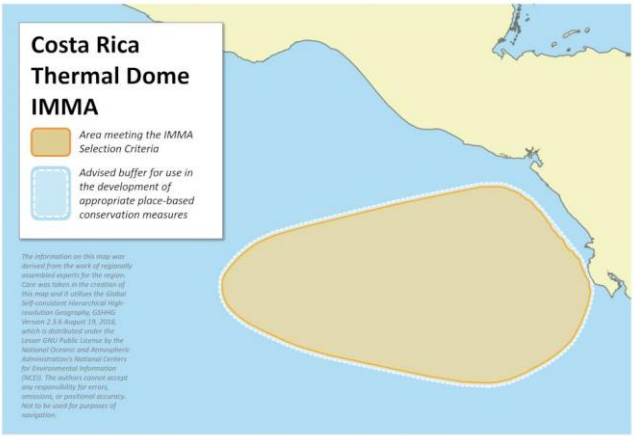

Area Size

518 078 km²

Qualifying Species and Criteria

Blue whale – *Balaenoptera musculus*

Criterion A; B (2); C (1, 2)

Striped dolphin – *Stenella coeruleoalba*

Criterion B (2)

Common dolphin – *Delphinus delphis*

Criterion B (2)

Pygmy beaked whale – *Mesoplodon peruvianus*

Criterion B (2)

Marine Mammal Diversity

Criterion D (2)

Stenella longirostris orientalis, Stenella attenuata graffmani, Stenella attenuata, Tursiops truncatus, Steno bredanensis, Feresa attenuata, Globicephala macrorhynchus, Kogia sima, Megaptera novaeangliae, Grampus griseus, Balaenoptera edeni, Peponocephala electra, Mesoplodon densirostris, Pseudorca crassidens, Orcinus orca, Physeter macrocephalus, Ziphius cavirostris

Summary

The Thermal Dome region in the Central American Pacific Ocean, also referred to as the Costa Rica Thermal Dome, is characterized by pronounced and regular upwelling that leads to high levels of productivity. This provides a unique habitat for cetaceans in the Eastern Tropical Pacific. Blue whales (*Balaenoptera musculus*) from the North Eastern Pacific and, presumably, South Eastern Pacific blue whales to migrate, feed, and reproduce in the area. Other cetacean species using this IMMA include striped dolphins (*Stenella coeruleoalba*) and common dolphins (*Delphinus delphis*), utilising the Thermal Dome as a feeding ground. The Dome serves as both a feeding and a nursery ground for many other marine mammal species. Among the 21 cetacean species and subspecies present in the Thermal Dome region, 14 have distributions that regularly extend into the Dome, likely attracted by the high productivity and abundance of prey. Seven other species extend their range into the Dome but do not show a specific preference for this area.

Costa Rica Thermal Dome IMMA

Summary, continued.

Description:

The Costa Rica Thermal Dome (CRTD) is an oceanic upwelling area associated with the cyclonic flow of the North Equatorial Countercurrent, the Costa Rica Coastal Current and the North Equatorial Current. It is a permanent oceanic feature that is, however, influenced seasonally from February to April by the coastal Papagayo wind jet. Its central region extends from the high seas into the EEZs of Costa Rica, Nicaragua and El Salvador (Wyrtki, 1964; Fiedler, 2002; Fiedler, 2022 pers. Comm.). Upwelling of deep cold, nutrient-rich waters in the area leads to enhanced productivity that triggers a complex and diverse food web. Chlorophyll concentrations range from high to very high (0.3-1.2 mg/m3) (Fiedler et al.,

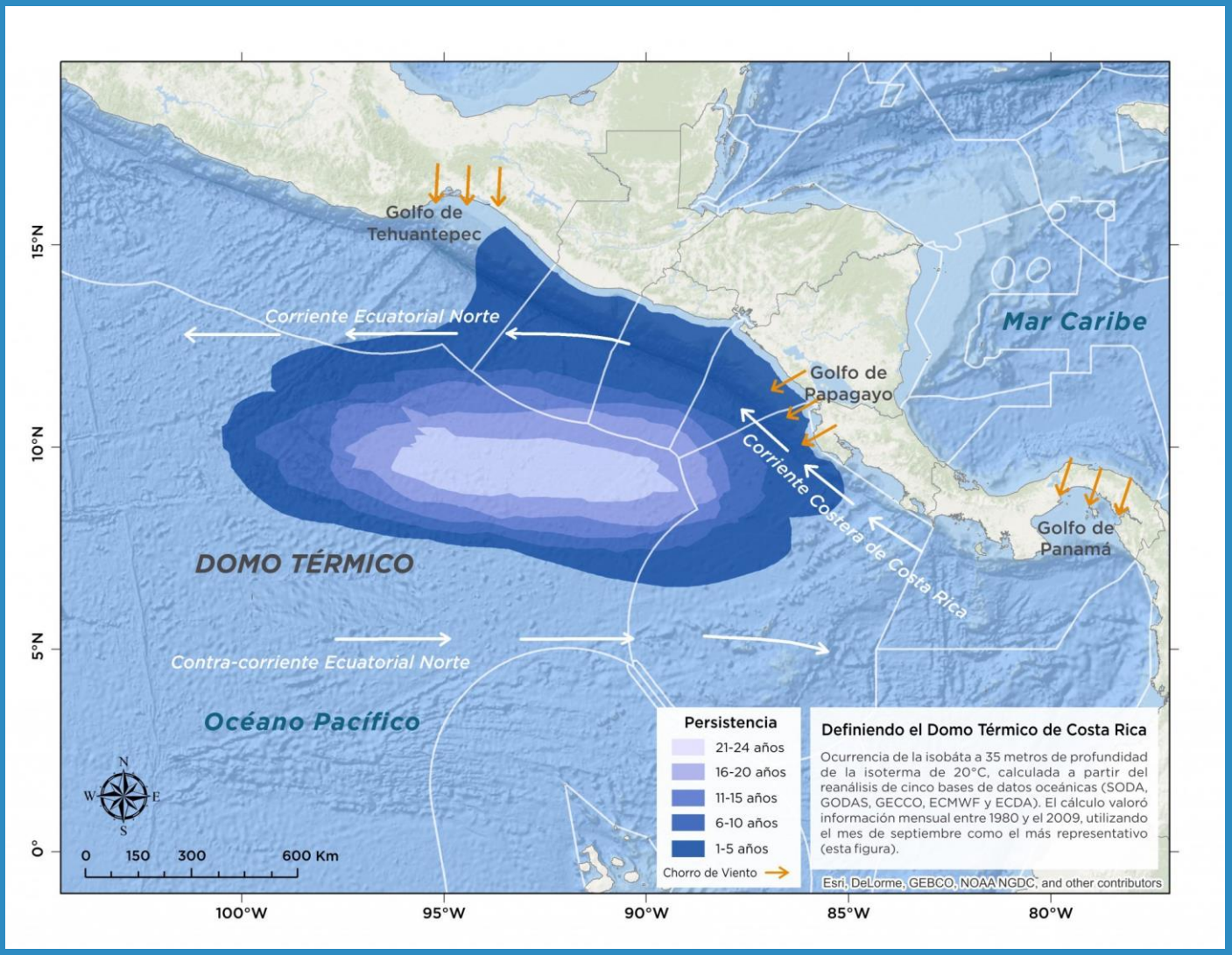

Figure 1: Defining Costa Rica Thermal Dome. Photo: SARGADOM PROJECT.

1991; Ahlgren et al., 2014). High primary productivity is characteristic in the dome region (>700 mg C m2/d) and higher values tend to concentrate on the west side of the Dome, away from its core and associated with the ridge of the NECC (Fiedler et al., 1991). Zooplankton biomass (250-300 ml/1000 m3) is as high or higher than that reported in other upwelling regions within the ETP (Sameoto, 1986; Segura et al., 1992; Fernández-Álamo & Faber-Lorda, 2006). Not surprisingly, the abundance of food makes the Dome and surrounding waters an important region for an assemblage of cetaceans.

According to Ross et al. (2019) because a large part of the CRTD falls into Areas Beyond National Jurisdiction (ABNJ), most of the Dome does not fall under a regulatory framework. The temporary effects of the CRTD can extend into the EEZs of different nations, each with different specific regulations and different regulatory and enforcement authorities. The ABNJ portions of the CRTD are not under the jurisdiction of any State. The absence of a mechanism that protects marine biodiversity in the High Seas, has raised questions about whether the current governance structure will ensure the conservation of the biological resources associated with this vast space, in light of the growing maritime traffic, fishing exploitation and the effects of climate change.

Figure 2: Aerial view of a blue whale (*Balaenoptera musculus*) in Costa Rica Thermal Dome. Photo: @powell'sPoint/Shutterstock.

Criterion A: Species or Population Vulnerability

The Blue Whale (*Balaenoptera musculus*) is listed as an Endangered (EN) on the IUCN Red List of Threatened Species due to strong reductions in its populations from commercial whaling (Cooke, 2018). Blue whales off the coast of California migrate during the boreal winter-spring season to the Thermal Dome, which constitutes their primary feeding and breeding ground during that season (Ballance et al., 2006; Mate et al., 2008; Fiedler et al., 2017; Leduc et al., 2017; Busquets-Vass et al., 2020). The population also breeds in the Dome region; making the site critical to the life-cycle of this vulnerable species (Bailey et al., 2009; Reilly & Thayer. 2006) and a critical element in its migratory route (Bailey et al., 2009). Limited information suggests that there may be also migrants from the Southern Ocean, or even residents at the Dome year-round (Sears & Perrin, 2009).

Criterion B: Distribution and Abundance Sub-criterion B2: Aggregations

Out of 211 blue whale sightings documented in the eastern tropical Pacific, 90% were concentrated along two areas: Baja California, and the vicinity of the Thermal Dome (Reilly & Thayer, 2006). Distribution maps demonstrate that the distribution of blue whales in the eastern tropical Pacific is closely related to the presence and fluctuations in the Dome's occurrence (Fiedler, 2017). The distribution patterns of striped dolphins (*Stenella coeruleoalba*), common dolphins (*Delphinus delphis*) and pygmy beaked whales (*Mesoplodon peruvianus*) are closely-related to the Thermal Dome (Fiedler et al., 2017; Hamilton et al., 2008). All these species aggregate here probably due to the high productivity and availability of preferred prey species (Mate et al., 1999; Reilly & Thayer, 2006; Bailey et al., 2009).

Criterion C: Key Life Cycle Activities
Sub-criterion C1: Reproductive Areas

Blue whales from the northeast Pacific use the Gulf of California and the Thermal Dome in the eastern Tropical Pacific as their primary winter-spring breeding grounds (Leduc et al., 2017; Mate et al., 1999; Reilly & Thayer, 1990; Hoyt, 2009). Young calves have been observed in the Dome region during the boreal winter, attracting orcas (*Orcinus orca*) to the region to prey on the calf population (Pitman et al., 2007; Brower, 2009).

Sub-criterion C2: Feeding Areas

Blue whales occupy the Thermal Dome year-round (Reilly & Thayer, 2006) and are mainly concentrated on the western side of the Dome (Bailey et al., 2009). It is known that biomass aggregates not at the core of the upwelling but "downstream" where sharp transitions in water density retain many nutrients, allowing phytoplankton and primary consumers to grow and aggregate (Pardo et al., 2015; White et al., 1995). The abundance of blue whales at the western side of the Dome coincides with the presence of extensive patches of krill (euphausiids), which are most abundant at depths ranging of 50-200m. Diving profiles of blue whales tagged in this region indicate regular dives of 50-300 m coinciding with krill vertical migration patterns (Stafford et al., 2005; Mate et al., 2008). The high aggregations of blue whales in winter are significantly associated with high chlorophyll concentrations and low subsurface temperatures, indicating that feeding is linked to plankton aggregations (Matteson et al., 2010).

Criterion D: Special Attributes
Sub-criterion D2: Diversity

The Thermal Dome region, due to its consistently high levels of productivity and prey availability, is a site with a high richness of marine mammal species. The distribution of three species: blue whales, common dolphins, and striped dolphins, are closely associated with the Dome region (Fiedler et al., 2017). A further 12 species have documented distributions partially overlapping with the Dome region (Fiedler et al., 2017). Of these 12, the offshore pantropical spotted dolphins (*Stenella attenuata*), eastern spinner dolphins (*Stenella longirostris orientalis*), rough-toothed dolphins (*Steno bredanensis*) and short-finned pilot whales (*Globicephala macrorhynchus*) show association with warm water regions north or south of the Dome, and are partially distributed within the Dome region itself (Fiedler et al., 2017). Common bottlenose dolphins (*Tursiops truncatus*), Risso's dolphins (*Grampus griseus*), coastal pantropical spotted dolphins (*Stenella attenuata graffmani*), dwarf sperm whales (*Kogia sima*), pygmy killer whales (*Feresa attenuata*), pygmy beaked whales (*Mesoplodon peruvianus*), and humpback whales (*Megaptera novaeangliae*), though mainly coastal in their distribution, extend their range into the Dome (Hamilton et al., 2008). Six other species: false killer whales (*Pseudorca crassidens*), killer whales (*Orcinus orca*), sperm whales (*Physeter macrocephalus*), Cuvier's beaked whales (*Ziphius cavirostris*), melon-headed whales (*Peponocephala electra*) and Blainville's beaked whales (*Mesoplodon densirostris*), have been recorded in the Dome region but in lower densities and without a clear preference for this area (Hamilton et al., 2008; Fiedler et al., 2017).

Figure 3: Pantropical spotted dolphins (*Stenella attenuata*). Photo: David Herra.

Figure 4: Fox shark (*Alopias vulpinus*) surfacing near Thermal Dome. Photo: FtLaud / Shutterstock.

Supporting Information

Ahlgren, H.A., Noble, A., Patton, A.P., Roache-Johnson, K., Jackson, L., Robinson, D., McKay, C., Moore, L.R., Saito, M. and Rocap, G. 2014. The unique trace metal and mixed layer conditions of the Costa Rica upwelling dome support a distinct and dense community of *Synechococcus*. Limnology and Oceanography, 59(6): 2166–2184.

Bailey, H., Mate, B.R., Palacios, D.M., Irvine, L., Bograd, S.J. and Costa, D.P. 2009. Behavioural estimation of blue whale movements in the Northeast Pacific from state-space model analysis of satellite tracks. Endangered Species Research 10: 93–106. doi:10.3354/esr00239.

Balance, L.T., Pitman, R.L. and Fiedler, P.C. 2006. Oceanographic influences on seabirds and cetaceans of the Eastern Tropical Pacific: A review. Progress in Oceanography 69: 360–390.

Brower, K. 2009. Still Blue. National Geographic Magazine. http://ngm.nationalgeographic.com/print/2009/03/blue-whales/brower-text

Busquets-Vass, G., Newsome, S.D., Pardo, M.A., Calambokidis, J., Aguíñiga-García, S., Páez-Rosas, D., Gómez-Gutiérrez, J., Enríquez-Paredes, L.M. and Gendron, D. 2021. Isotope-based inferences of the seasonal foraging and migratory strategies of blue whales in the eastern Pacific Ocean. Marine Environmental Research. Vol. 163. doi.org/10.1016/j.marenvres.2020.105201.

Cooke, J.G. 2018. *Balaenoptera musculus* (errata version published in 2019). The IUCN Red List of Threatened Species 2018: e.T2477A156923585. doi.org/10.2305/IUCN.UK.2018-2.RLTS.T2477A156923585.en. Accessed on 10 June 2022.

Culik, B. 2004. Review of Small Cetaceans: Distribution, Behaviour, Migration and Threats. Marine Mammal Action Plan /Regional Seas Reports and Studies no. 177. UNEP / CMS Secretariat, Bonn, Germany. 343 pp.

Fernández-Álamo, M.A. and Färber-Lorda, J. 2006. Zooplankton and the oceanography of the Eastern Tropical Pacific: A review. Progress in Oceanography 69: 318-359.

Fiedler, P.C., Redfern, J.V., Forney, K.A., Palacios, D.M., Sheredy, C., Rasmussen, K., García-Godos, I., Santillán, L., Tetley, M.J., Félix, F. and Balance, L.T. 2018. Prediction of Large Whale Distributions: A Comparison of Presence–Absence and Presence-Only Modeling Techniques. Front. Mar. Sci. https://doi.org/10.3389/fmars.2018.00419.

Fiedler, P.C., Philbrick, V. and Chavez, F.P. 1991. Oceanic upwelling and productivity in the eastern tropical Pacific. Limnology and Oceanography 36(8): 1834-1850.

Fiedler, P.C. and Lavin, M.F. 2006. Introduction: A review of eastern tropical Pacific oceanography. Progress in Oceanography 69: 94–100.

Fiedler, P.C. and Talley, L.D. 2006. Hydrography of the Eastern tropical Pacific: a review. Progress in Oceanography 69: 143–180.

Fiedler,, P.C., Redfern, J.V. and Balance, L.T. 2017. Oceanography and Cetaceans of the Costa Rica Dome region. NOAA Technical Memorandum NMFS. NOAA-TM-NMFS-SWFSC-590. 37 pp.

Hamilton T.A., Redfern J.V., Ballance L.T., Gerrodette T., Holt R.S., Forney K.A. and Taylor B.L. 2008. Atlas of cetaceans sightings from southwest fisheries Science Center Cetacean and Ecosystem Surveys: 1986-2005.

Hoyt, E.. 2009. The blue whale *Balaenoptera musculus*: An endangered species thriving on the Costa Rica Dome. An illustration submitted to the convention on biological diversity. available online at www.cbd.int/cms/ui/forums/attachment.aspx?id=73

Johnson, C., Reisinger, R., Palacios, D., Friedlaender, A., Zerbini, A., Willson, A., Lancaster, M., Battle, J., Graham, A., Cosandey-Godin, A., Jacob T., Felix, F., Grilly, E., Shahid, U., Houtman, N., Alberini, A., Montecinos, Y., Najera, E. and Kelez, S. 2022. Protecting Blue Corridors, Challenges and Solutions for Migratory Whales Navigating International and National Seas. WWF, Oregon State University, University of California, Santa Cruz, Publisher: WWF International, Switzerland. 69 pp.

Kessler, W.S. 2006. The circulation of the eastern tropical Pacific: A review. Progress in Oceanography 69: 181–217.

Leduc, R.G., Archer, F.I., Lang, A.R., Martien, K.K., Hancock-Hanser, B., Torres-Florez, J.P., Hucke-Gaete, R., Rosenbaum, H.C., Van Waerebeek, K., Brownell, R.L. and Taylor, B.L., 2017. Genetic variation in blue whales in the eastern pacific: implication for taxonomy and use of common wintering grounds. Mol. Ecol. 26, 740–751. doi.org/10.1111/mec.13940.

Lusseau, D., Bain, D.E., Williams, R. and Smith, J.C. 2009. Vessel traffic disrupts the foraging behavior of southern resident killer whales *Orcinus orca*. Endangered Species Research 6:211-221.

Mate, B., Lagerquist, B.A. and Calambokidis, J. 1999. Movements of north pacific blue whales during the feeding season off southern California and their southern fall migration. Marine mammal science 15(4): 1246-1257.

Mate, B., Schaefers, J., Mate, M.L., Hayslip, C., Irvine, L., Matteson, R., Schlecter, W., Fox, G., Calambokidis, J., Oleson, E., Nicklin, F., Brower, K., Kovacs, E. and Houghton, S. 2008. Preliminary cruise report for expedition to Costa Rica Dome: 3-29 January 2008. Oregon State University. 10 pp.

Matteson, R.S. 2009. The Costa Rica Dome: A study of physics, zooplankton and blue whales. M.Sc. Thesis. Oregon State University. 36 pp.

Matteson, R.S., Benoit-Bird, J.K., Mate, B.R. and Calambokidis, J. 2010. Aggregation characteristics of prey determine blue whale distribution at the Costa Rica Dome. 2010 Ocean Sciences Meeting. American Geophysical Union, Washington DC Portland, OR.

Pardo, M.A., Gerrodette, T., Beier, E., Gendron, D., Forney, K.A., Chivers, S.J., Barlow, J. and Palacios, D.M. 2015. Inferring Cetacean Population Densities from the Absolute Dynamic Topography of the Ocean in a Hierarchical Bayesian Framework. PLoS ONE 10(3): e0120727. doi:10.1371/journal.pone.0120727.

Pitman, R.L., Fearnbach, H., LeDuc, R., Gilpatrik Jr., J.W., Ford, J.K.B and Balance, L.T. 2007. Killer whales preying on a blue whale calf on the Costa Rica Dome: genetics, morphometrics, vocalisations and

composition of the group. Journal of Cetacean Research and Management 9(2):151–157.

Reilly, S. and Thayer, V. 2006. Blue Whale distribution in the eastern tropical pacific. Marine Mammal Science 6 (4): 265-277.

Ross Salazar, E., Jiménez Ramón, J.A., Castro Campos, M. and Blanco Bolaños, M. 2019. The Thermal Dome of Costa Rica / Atlas. MarViva Foundation, San José. 108 pp.

Sameoto, D. 1986. Influence of the biological and physical environment on the vertical distribution of the mesozooplankton and micronekton in the eastern tropical Pacific. Marine Biology 93: 263–279.

Sears, R. and Perrin, W.F. 2009. Blue whale (*Balaenoptera musculus*). In: Perrin, W. F., B. Würsig and J. G. M. Thewissen (eds.) Encyclopedia of marine mammals, 2nd ed. Academic Press, Burlington MA, pp. 158-163.

Segura, L.., Hernández, R.M. and Morones, L. 1992. Distribución y abundancia de los quetogantos (Chaetognatha) en la región del Domo de Costa Rica. Revista de Biología Tropical. 40(1): 35-42.

Stafford, K.M., Moore, S.E. and Fox, C.G. 2005. Diel variation in blue whale calls recorded in the eastern tropical Pacific. Animal Behaviour. 69: 951-958. doi:10.1016/j.anbehav.2004.06.025.

White, J.R., Zhang, X., Welling, L.A., Roman, M.R. and Dam, H.G. 1995. Latitudinal gradients in zooplankton biomass in the tropical Pacific at 140°W during the JGOFS EqPac study : Effects of El Niño. Deep Sea Res Part II Top.Stud.Oceanogr. 42: 715–733.

Wyrtki, K. 1964. Upwelling in the Costa Rica Dome. Fishery Bulletin: 63 (2): 355-372.

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