Data do not support new claims about bluefin tuna spawning or abundance

Carl Safina[a,1]

Richardson et al. (1) assert, but do not adequately demonstrate, that western-stock Atlantic bluefin tuna spawn off the northeastern United States, the northeastern area is their main spawning area, and they spawn younger and are less vulnerable to fishing than believed. Further, their assertions lead logically to a conclusion about vulnerability that is opposite the authors' conclusion.

First, Richardson et al. (1) found larval bluefin tuna in an area not previously sampled. Previous researchers found larvae north to the Carolinas (2). The Gulf Stream could have transported some of the newfound larvae from previously known areas off the Carolinas. The origin remains equivocal.

Second, Richardson et al. (1) say two-thirds of western-stock spawning occurs outside the Gulf of Mexico, "assuming recent fishing mortality and maturity at age 5." Absent genetics, it is possible that Gulf Stream larvae are spawned by eastern-stock fish, which are more abundant.

Larvae spawned months later than in the Gulf of Mexico and facing cooling water months earlier may all die. McGowan and Richards (3) believed Atlantic conditions "not… favorable for… survival of bluefin tuna larvae."

Third, Richardson et al. (1) say their "assertion of a younger age at maturity for western Atlantic bluefin tuna is supported by three lines of evidence." Gulf of Maine fish older than 5 y had "endocrine measurements" indicating maturation. However, they might have been eastern-stock fish. Additionally, large Gulf of Maine fish "had atretic follicles… indicative of recent and proximate spawning." Atretic follicles can also indicate egg resorption from malnutrition, causing a skipped spawning year (ref. 4, pp. 211–212). Finally, in 1957, Slope Sea fish aged 4–12 y had developing to ripe gonads (5). It is unsurprising that fish aged 4–12 y include individuals with gonads "developing" or mature. In addition, Mather et al. (5) warned, "Estimates of spawning areas and seasons from gonad condition are subject to … serious errors."

Richardson et al. (1) believe smaller, younger fish must be breeding somewhere. So they "classify" fish that spent more than 20 d in the Slope Sea as "breeders." Thus, "Over 75% of individuals 133- to 212-cm (age 5–11) were classified as potential Slope Sea spawners." Brief residence does not imply breeding. Small fish in an area with large fish and larvae is not evidence of small fish spawning. They conclude, "evidence indicates that the western stock matures around age 4–5" (1). Their data do not support it, and several studies refute it.

Richardson et al.'s suspected "reproductive mixing" (1) is inconsistent with genetic studies (6), stable isotopes (7), and behavior (8).

Fourth, Richardson et al. (1) acknowledge that "By the start of the 21st century, intense fishing pressure had driven this species to historically low population levels." If we simply accept their claims *i–iii* above, then depletion occurred despite a vastly larger and wider distributed breeding population than known, making vulnerability higher than thought; thus, rebuilding targets must be revised far upward of current targets. A depleted species cannot withstand more stress than it has withstood simply because larvae have been found adjacent to a region where larvae were previously found.

1 Richardson DE, et al. (2016) Discovery of a spawning ground reveals diverse migration strategies in Atlantic bluefin tuna (*Thunnus thynnus*). *Proc Natl Acad Sci USA* 113(12):3299–3304.
2 Lamkin JT, et al. (2014) Do western Atlantic bluefin tuna spawn outside of the Gulf of Mexico? Results from a larval survey in the Atlantic Ocean in 2013. *Collect Vol Sci Pap ICCAT* 71(4):1736–1745.
3 McGowan MF, Richards WJ (1989) Bluefin tuna, *Thunnus thynnus*, larvae in the Gulf stream off of the southeastern United States: satellite and shipboard observations of their environment. *Fishery Bulletin* 87:615–631.
4 McMillan DB (2007) *Fish Histology: Female Reproductive Systems* (Springer, Heidelberg).
5 Mather FJ, Mason JM, Jones AC (1995) *Historical Document: Life History and Fisheries of Atlantic Bluefin Tuna* (US Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Miami), NOAA Technical Memorandum NMFS-SEFSC 370.
6 Rooker JR, et al. (2007) Life history and stock structure of Atlantic bluefin tuna (Thunnus thynnus). *Rev Fish Sci* 15(4):265–310.
7 Rooker JR, et al. (2008) Natal homing and connectivity in Atlantic bluefin tuna populations. *Science* 322(5902):742–744.
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[a]School of Marine and Atmospheric Sciences, Stony Brook University, Stony Brook, NY 11794-5000

Author contributions: C.S. wrote the paper.
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[1]Email: csafina@safinacenter.org.