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Correspondence

Costs and Difficulties of Blocking the Strait of Hormuz

William D. O'Neil

Caitlin Talmadge

To the Editors (William D. O'Neil writes):

Caitlin Talmadge's analysis of the threat of Iranian action to close the Strait of Hormuz is not only timely but provides many valuable insights.¹ Several aspects of this complex issue call out for further clarification, however.

COSTS OF CLOSURE

To begin, Talmadge should have put greater emphasis on the costs that Iran would almost surely bear in the wake of any closure attempt. Unless the Iranians were able to convince the world that it was an act essential for self-defense, closure would inflame opinion widely against them. Closing the strait would be seen not only as a serious violation of international norms but, worse yet, one that directly and significantly touched the interests of most states, virtually making it a campaign of piracy. Even states ready to accept Iran's right to retaliate against some offense would find it hard to forgive a response so indiscriminately damaging.

Under these circumstances, the United States could have wide latitude for action. U.S. leaders might well take the opportunity to leave Iran not only greatly impoverished through a loss of oil revenues and massive destruction of critical infrastructure but stripped of its naval and air defenses. U.S. forces would probably need to seize the Iranian-held islands lying near the shipping lanes east of the strait, and they would not likely be returned. Given the geographic isolation of the region near the strait from the rest of Iran, it is even conceivable that this area might be held under occupation. And the residue of suspicion and resentment against Iran would surely linger among those who suffered losses from the closure, prompting support for a tight sanctions regime.

In short, Iran would find itself essentially in the same position as Iraq after the 1991 Gulf War, if not worse. Such a prospect might sober even the most adventurous or desperate of Iranian leaders.

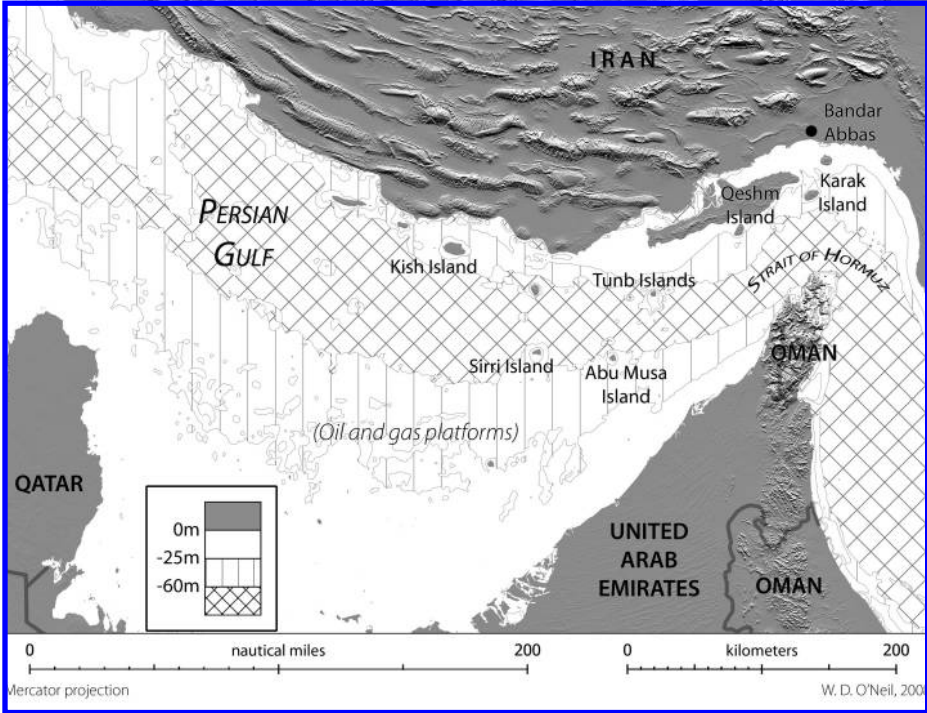
William D. O'Neil is an author and consultant who formerly served as an official in the Office of the Secretary of Defense and as a naval officer, as well as a defense industry engineering and analysis executive. He thanks H.H. Gaffney and G.H. Porter for helpful comments.

Caitlin Talmadge is a Ph.D. candidate in political science at the Massachusetts Institute of Technology, where she is a member of the Security Studies Program. She is also a Research Fellow at the Brookings Institution.

1. Caitlin Talmadge, "Closing Time: Assessing the Iranian Threat to the Strait of Hormuz," *International Security*, Vol. 33, No. 1 (Summer 2008), pp. 82–117.

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Figure 1. Strait of Hormuz and Adjacent Areas



SOURCES: Compiled and drawn by William D. O'Neil, based on bathymetry from "SRTM30 PLUS," measured and estimated seafloor topography, Scripps Institution of Oceanography, University of California, San Diego, ver. 5.0, last updated September 16, 2008; and land topography from "SRTM 90m Digital Elevation Data," CGIAR Consortium for Spatial Information, ver. 4, last updated August 19, 2008; supplemented with information from Nautical Chart 62510, published by the U.S. National Geospatial-Intelligence Agency.

THE GEOGRAPHIC SITUATION AND MINING

In figure 1, the 25-meter depth contours (the line between the clear and vertically hatched regions) mark the approximate limits of feasible navigation for large tankers.² They are separated by nearly 30 nautical miles in the throat of the strait and fan out slowly for a considerable distance to the west into the Persian Gulf. To the southeast, the Gulf of Oman broadens out rapidly, and water too deep for effective mining is reached quickly. Thus the region from the strait proper westward into the Persian Gulf presents problems distinctly different from those in the Gulf of Oman. Specific shipping

2. Tankers with drafts that exceed 21 meters are not usually employed in Persian Gulf trade. See Martin Stopford, *Maritime Economics*, 2d ed. (London: Routledge, 1997), p. 407.

lanes are laid out in parts of this region, but there are other waters deep enough to permit passage of large ships if necessary.

Talmadge posits a closure scenario involving minefields to deny transit, with antiship missiles in overwatch. She gives Iran considerable capacity to lay the necessary fields and to sustain a missile threat. In both respects, she exaggerates the seriousness of the threat Iran can pose.

The analogies Talmadge employs to analyze the mining issues have little relevance to this case. The Dardanelles, Wonsan, and Iranian cases she cites were all defensive fields, in waters under the control of the state that laid the fields and not subject to observation by would-be intruders. The Dardanelles case, nearly a century ago, and the Wonsan case, more than fifty years ago, involved dense fields in narrow waters. The Iranians would be attempting to lay offensive fields in broad waters not under their control, and moreover presumably under constant active surveillance by U.S. forces.

Talmadge has the Iranians attempting to close a strait more than 25 nautical miles wide with fewer than 1,000 mines laid by submarines and surface craft. She does not provide a precise timeline, but given that at least eight separate sorties would be required of just two submarines, it could not take less than a week.

Iran's Kilo-class submarines stand about 25 meters high from the keel to the top of the sail. To operate submerged in these waters, they must pass under the keels of numerous tankers but stay clear of the bottom. Even given extremely skillful depth-keeping by highly trained and well-practiced crews, this is only possible in waters at least 60 meters deep (as the cross-hatching in figure 1 shows). Surface craft would have to lay all of the other mines. Most critically, the vertically hatched region lying south of the deeper water and closer to Arab than to Iranian shores would have to be sown from the surface.

How long would nearby U.S. forces remain unaware of the significance of this activity? In Talmadge's scenario the mine laying occurs at night, but darkness would provide little shielding against modern surveillance systems. The surface craft may be observed by radar or infrared systems day or night. Even if the submarines managed to lay their mines covertly, their frequent trips back to their base at Bandar Abbas to reload would very likely be noticed. In effect, Talmadge's scenario assumes that either the U.S. forces are especially negligent or the Iranians are phenomenally lucky. Otherwise the conflict could start before Iranian preparations had been completed, with important areas yet unmined.

Suppose, however, that the Iranians somehow were able to obstruct the strait with, say, 1,000 mines without interference. For comfortable clearance of inbound and outbound traffic, two shipping lanes, each approximately 2 nautical miles wide, would be required.³ (They should be separated by at least 2 nautical miles, but the buffer area need not be cleared or even navigable.) This represents less than 20 percent of the usable width between 25-meter contours, even in the most constricted areas. The Iranians would be unable to reseed the field after hostilities had commenced, so the total threat

3. The normal peacetime vessel traffic separation scheme in the Persian Gulf uses channels of this width, as shown in Chart 62510, edition 3, U.S. National Geopolitical-Intelligence Agency, February 1, 2003.

faced by shipping in whatever channels were selected would consist of fewer than 200 mines.

Talmadge assumes that almost all of the mines would have to be cleared before the normal flow of shipping could resume. This is a fallacy; all that is required is adequately clear channels. For several decades after World War II, for instance, numerous heavily trafficked shipping lanes off the coasts of Europe and Asia consisted of swept channels surrounded by areas with residual mine threats.

Two hundred mines are a menacing inconvenience, not a major threat. Dud rates can be expected to be high, and the more sophisticated the mines, the more duds there will be. As Talmadge correctly observes, there is never a shortage of mariners and owners willing to take their chances in return for receiving war rates, and large tankers are resilient. After an initial sweep and survey, tanker transits could continue in parallel with complete mine clearance operations.

How the clearance operations would be conducted would depend on the circumstances, and in particular, the degree of knowledge regarding the mine locations. If surveillance failed entirely, clearance would be impeded; however, even general information about mine locations would permit much faster clearance.

THE ANTISHIP MISSILE THREAT

Talmadge dwells on possible Iranian antiship missile threats, without dealing adequately with the end-to-end system issues on either side. To pose a meaningful missile threat, Iran must first maintain surveillance of the area. Targets must be located either by the surveillance system or by dedicated targeting sensors. The targeting information must be passed to a control facility where firing orders are computed and transmitted to the missile battery. The missile is launched and flies out to the target area, where it turns on its seeker at the programmed time. To guide the missile to its target, the seeker must acquire the correct target and resist natural and intended diversions. Delays of more than a few minutes or errors of more than a few hundred meters entail a high risk that the missile will miss its target.

The only surveillance scheme likely to produce effective results involves the use of radars able to cover the target area. The location requirements of the surveillance radar are strict. To see ships well, the radar must view them against the horizon or against a background separated from the ship by a distance that is large relative to the range discrimination of the radar. If the radar points down into the sea clutter, its probability of detection will fall off sharply; this largely bars the ridgeline locations that Talmadge speculates about. In addition, the site must avoid nearby reflecting surfaces and provide a good ground plane. Near-shoreline towers are usually the best solution.

The limited choice of good sites combines with the ease of detecting radar emissions to make the radars highly vulnerable. Talmadge seems to believe that destruction of all the missile launchers is necessary to cut off an antiship missile campaign. Once the radars are gone, however, the game is over—the missiles are no longer usable. Efforts might be made to hunt down and attack the mobile missile launchers, and this could well prove as exacting and frustrating as she envisions it to be, but success in this is not essential to protect shipping.

Talmadge also seems to believe that the antiship missiles in flight must be shot down to be rendered ineffective, or at least that interception is the primary defense against

them. Fortunately, there are much better responses. This is particularly true in the region surrounding the Strait of Hormuz, which is so unfavorable for the operation of antiship missile seekers that most missiles may be defeated by a combination of tactical and technical means to exploit and exacerbate natural difficulties—so-called soft-kill defenses. “Hard kill”—physical interception and destruction of the antiship missile—would play an important but secondary role in this case.

Broadly speaking, three distinct categories of seekers are available for use by antiship missiles, each of which faces special problems in the region of the Strait of Hormuz. In an infrared seeker, a bolometer or (in more modern and complex versions) an imaging camera sensitive to heat radiation detects the target based on its difference in effective temperature from the sea background. Although ships are not sources of intense heat, they generally are sufficiently hotter or cooler than the background to permit contrast detection, at least for most of the day. The Strait of Hormuz, however, is an unfavorable location for this because the exceptionally high water vapor and dust content of the atmosphere rapidly absorb and attenuate infrared heat radiation, severely limiting the range at which the ship may be detected.

Another approach is a passive electronic seeker, essentially a radio receiver with a directional antenna programmed to receive and recognize the signal of a radar or other electronic emitter associated with the target. These seekers can be useful against ships with a distinctive emitter, such as the radar of an Aegis cruiser, but not against merchant ships or mine countermeasures ships, whose radars and other emitters are too similar to those of other vessels in the vicinity to be distinguished by the seeker.

The most common seeker is radar—a compact set in the missile’s nose programmed to detect and home on surface ships. (This may be combined with an infrared or passive electronic system to confirm target identification and refine homing accuracy.) Radar is generally preferred because it provides reliable detection at ranges great enough to permit acquisition of targets whose location is only approximately known. But in the region of the Strait of Hormuz, this can not be relied upon. First of all, it is dense with islands and man-made structures (chiefly oil platforms) that have very large radar cross sections and can return enough energy to confuse and overwhelm radar seekers. This region is also especially subject to strong surface evaporation ducts, which greatly complicate radar propagation and may confuse the seeker or make the target invisible to it.⁴

In such a region, the first line of defense against antiship missiles is to operate ships to take best advantage of the natural vulnerabilities of the missile seekers. In particular, tankers can be routed close to land and oil platforms whose radar returns will blank those of the ships. Talmadge suggests that traffic could be routed through the more southerly portions of the region to the west of the strait, and this would serve the purpose admirably, as well as putting it farther from the Iranian coast. Mariners would grumble about the navigational difficulties involved in threading their way through the

4. Talmadge mentions ducts, but she is not clear about their nature or effects. For a succinct treatment of surface evaporation ducting in a radar context, see Merrill L. Skolnik, *Introduction to Radar Systems*, 3d ed. (New York: McGraw-Hill, 2002), pp. 502–507. Skolnik also provides accurate technical descriptions of the other radar-related topics discussed here.

obstacles, but the universal use of high-accuracy GPS navigational plotters makes this far more feasible than it would have been not long ago, even when visibility is limited.⁵

These steps in themselves would afford considerable protection against missile seekers. Employing passive or active electronic and infrared countermeasures would further confuse or blind the seekers and augment protection. U.S. Navy ships are reported to carry an array of such countermeasures, and further countermeasures could be deployed using dedicated platforms or shore sites.

Finally, the surveillance and targeting radars that are so essential to the entire antiship enterprise would also be greatly affected by the natural difficulties of the region and would be vulnerable to countermeasures—particularly to powerful jammers. These jammers could be deployed either by specialized aircraft or in fixed sites on the heights overlooking the strait from the Arabian Peninsula side. Thus, even before surveillance radars were destroyed, they could be rendered largely ineffective.

CONCLUSION

Notwithstanding these reservations regarding important details, the essential point of Talmadge's argument remains valid. While any attempt by Iran to close the Strait of Hormuz would be self-destructive folly, it is a possibility that cannot be ruled out. Although an attempt would be defeated more swiftly than Talmadge suggests, there would nevertheless be a cost both in ships and in lives, as well as widespread economic disruption. Because the costs would be great, it is important to take precautions even though the contingency is unlikely. But the precautions should be tailored to the true nature and extent of the threat.

—William D. O'Neil
Falls Church, Virginia

Caitlin Talmadge Replies:

I thank William O'Neil for his close reading of my article and for taking the time to share his observations and knowledge with the readers of *International Security*.¹ His letter represents exactly the sort of exchange about the Strait of Hormuz that I hoped my article would spark—one in which analysts debate the relevance or plausibility of certain assumptions about U.S. and Iranian action, examine how different data affect the estimates generated from those assumptions, and then discuss the policy implications of various estimates. I am especially pleased to have the chance to participate in this kind of conversation with O'Neil, an analyst who brings both operational experience and scholarly expertise to the study of naval issues in the Persian Gulf.

O'Neil and I seem to agree on four important points. First, we concur that, other things being equal, Iran is unlikely to close the strait, because doing so would be, as he

5. If the Iranians were to attempt to jam GPS signals, the jammers should be rapidly smothered with antiradiation weapons.

1. Caitlin Talmadge, "Closing Time: Assessing the Iranian Threat to the Strait of Hormuz," *International Security*, Vol. 33, No. 1 (Summer 2008), pp. 87–88. All subsequent references to this article appear parenthetically in the text.

notes, “self-destructive folly.” Second, we both have no doubt that the United States would prevail militarily in any campaign to defend the Persian Gulf in the face of an Iranian attempt at closure. Third, despite the inevitability of ultimate U.S. victory, we both believe that Iran could impose considerable military and economic costs on the United States in the event of conflict. This is because the real issue is not whether Iran can “close” the strait, but whether it can threaten traffic enough to prompt U.S. intervention and further military escalation. Finally, because we agree that such escalation would be dangerous, we both emphasize that the United States should act to prevent it, particularly by maintaining close surveillance of Iranian activities in the gulf and pushing tankers toward more southern routes.

That said, O’Neil raises some objections to my treatment of points one and three—the circumstances that might surround Iranian closure of the strait, and the question of exactly how much Iran could interfere with traffic there. I address his points about my scenario, Iran’s potential use of mines, and its potential use of missiles in turn.

THE SCENARIO

O’Neil argues that I “should have put greater emphasis on the costs that Iran would almost surely bear in the wake of any closure attempt” and that “a closure threat would inflame world opinion widely against” Iran, giving the United States “wide latitude for action.” He implies that these factors make Iran extremely unlikely to close the strait—a prediction that I share (pp. 87–88).

Nevertheless, I and many other analysts remain concerned that, if pushed to a point of desperation, Iran might indeed lash out in the strait (pp. 83–84). If that happened, “world opinion” likely would hinge on what had prompted Iran to attempt to close the strait in the first place. If Iran had acted without provocation, then yes, it would have few friends. But if Iran were responding to a U.S. attack on its nuclear facilities, or an Israeli attack carried out with U.S. acquiescence, the situation might be different. Either way, the pertinent question is what Iran could actually do.

In general, O’Neil seems to interpret my discussion of possible Iranian operations as an unquestioning acceptance that Iran would definitely attempt or succeed at these operations, whereas my article mostly expresses a skepticism that mirrors his own. Yes, I choose to examine a wide range of possible Iranian actions, but at each stage of the analysis, I also try to state the potential constraints on those actions. O’Neil adds important information about these constraints that I consider in more detail below. Still, in general I prefer the approach of analyzing a full range of possible actions, rather than deciding in advance for the reader what will and will not happen—exactly the problem with so many “black box” analyses of potential conflict in the strait that provide conclusions without the rationale behind them (*ibid.*). A more transparent, “if-then” approach allows a consumer of the analysis to parse it more easily and to adjust projections in the future, if new information about capabilities becomes available.

IRANIAN MINE WARFARE

O’Neil adds usefully to our understanding of the challenges to Iranian mine laying in the Persian Gulf. In so doing, he also makes three main objections to my analysis of a potential Iranian campaign: my analogies to past mine warfare campaigns are inappro-

priate; Iran is likely to be caught laying mines; and I overestimate the degree to which the strait would need to be cleared to resume shipping.

First, O'Neil refers to my analogies as the Dardanelles, Wonsan, and Iranian, when in fact the cases on which I base my mine-clearance projections are Iraqi. More important, O'Neil suggests no alternatives that would make for better analogies. Mine warfare is a rare event, and I draw lessons as appropriate not only from these cases but also from the mining of Haiphong Harbor in 1972 and the mining of the North Sea in World War II. In none of these instances do I claim that potential Iranian action in the strait would be identical. Rather, I use these examples to highlight some features of the Iranian campaign and countercampaign that could be similar. For the Iraqi cases from which I actually derive my mine countermeasure projections, I go to considerable lengths to explain the U.S. capabilities used then and how the capabilities might differ today, and what this might mean (pp. 94–99). If there are better analogies to use, of course I am interested in learning about them to improve the analysis. But in the absence of such alternatives, cautious projections based on the data we have seem better than no projections at all.

Second, I agree that at some point Iran would be caught laying mines. In fact, I frame the entire mine warfare section as a question of “how many it can lay before being detected” (p. 89). The crucial issue, though, is not whether Iran will have a chance to “close” the strait, but whether it could lay enough mines to provoke U.S. intervention in the Persian Gulf, opening the possibility of further military escalation (p. 60). Given the United States’ hair-trigger posture in the region, it seems possible that Iran could cross this threshold even with a relatively small campaign. This is why my conclusion, like O'Neil’s letter, heavily emphasizes “the critical importance of early detection of any Iranian mine laying in the gulf,” and notes that “such surveillance depends not only on U.S. activities in the region but also those of Iran’s gulf neighbors” (p. 117).

Third, the contention that I assume “that almost all of the mines would have to be cleared before the normal flow of shipping could resume” is not quite right. I project how long it would take to clear 10 percent and 80 percent of the mines, and note that as long as U.S. mine clearance ships are in the strait, which O'Neil acknowledges would be the case as long as mines were in the water, oil markets would likely remain spooked because of these highly vulnerable U.S. targets being within range of Iranian missiles. The issue is not whether a true supply disruption would occur, but whether the markets would remain concerned about the prospect of one. This is not simply an assertion, but based on the effect of Iraq’s 1990 invasion of Kuwait on oil prices (pp. 82–83).

IRANIAN ANTISHIP MISSILES

Here again, O'Neil’s letter contributes greatly to our understanding of the challenges Iran would face in targeting antiship missiles. His discussion of the specific problems each type of missile seeker would encounter and how these interact with the environmental and terrain features of the Persian Gulf is both fascinating and informative. Particularly illuminating is his point that oil platforms and structures on the gulf’s southern coast would interfere with radar returns, an issue I had not considered.

That said, I feel the need to respond to some of his claims about my analysis. O'Neil writes, “Talmadge seems to believe that destruction of all the missile launchers is neces-

sary to cut off an antiship missile campaign. Once the radars are gone, however, the game is over." He further notes that jamming aircraft could be used to disable these radars quickly. He adds, "Talmadge also seems to believe that the antiship missiles in flight must be shot down to be rendered ineffective."

To be clear, I could not agree more with O'Neil's take on the challenges of Iranian radar-based targeting or on how the United States would counter it. I write that "as a first priority, the United States would want to destroy the Iranian radars needed to find targets for the missiles, without which the problem of missile targeting becomes much harder for the Iranians" (pp. 106–107). I further note that "radars are by their nature cooperative targets: whenever they are used to search for targets, they emit signals that give away their locations" (p. 107). I then discuss how U.S. jamming aircraft could gather this intelligence and use it to destroy the radars (*ibid.*). I also discuss Israeli success in defeating radar-guided missiles during the 2006 Lebanon war, presumably using these same sorts of techniques (p. 103). And I review several "soft kill" approaches to defeating Iran's missile threat, although not in the detail that O'Neil does (p. 111).

Nevertheless, I then go on to discuss possible techniques for destroying the mobile missile launchers—because it is at least possible that Iran could target missiles without radar-based surveillance, using sea- or air-based spotters (p. 103). Still, substantively, I do not think O'Neil's and my conclusions are very far apart: it would be harder than often realized for Iran to target its missiles accurately in the Persian Gulf.

All this said, O'Neil is perhaps more sanguine than I am about the Iranians' tactical proficiency. Is it safe to assume that Iran will leave its radars on long enough and frequently enough for the United States to destroy its targeting abilities almost immediately? If Iran operates its radars less like the hapless Iraqis in 1991 and more like the clever Serbs in 1999, then this assumption may prove invalid. Can the United States be sure that Iran will not develop alternative targeting methods? It is hard to say. Hence my effort to develop a complete concept of operations for detecting and defending against antiship missile launches, as well as for finding the mobile launchers—just in case the Iranians stay in the game longer than planned.

Regardless, O'Neil has clearly refined our understanding of important aspects of a potential conflict in the strait, and for that I thank him. His letter exemplifies the sort of rigorous and research-based approach that leads to real progress in the analysis of complex security problems.

—Caitlin Talmadge
Washington, D.C.