Animal Legal Defense Fund • Animal Welfare Institute • Center for Biological Diversity • Earthjustice • Environmental Protection Information Center • Friends of the Earth • Friends of the San Juans • The Humane Society of the United States • InterTribal Sinkyone Wilderness Council • Klamath Forest Alliance • Natural Resources Defense Council • New York Whale and Dolphin Action League • Northcoast Environmental Center • Ocean Mammal Institute • Orca Network • Surfrider Foundation, Mendocino Coast Chapter • Carol Van Strum • Whale and Dolphin Conservation

By Electronic Submission via *regulations.gov*

July 17, 2015

Jolie Harrison, Chief
Permits and Conservation Division
Office of Protected Resources
National Marine Fisheries Service
1315 East-West Highway
Silver Spring, MD 20910-3225

Re: Comments Regarding Proposed Rule and Navy's Proposed NWTT Activities, 2015-2020 (0648-BD89)

Dear Ms. Harrison:

On behalf of the Animal Legal Defense Fund, Animal Welfare Institute, Center for Biological Diversity, Earthjustice, Environmental Protection Information Center, Friends of the Earth, Friends of the San Juans, The Humane Society of the United States, InterTribal Sinkyone Wilderness Council, Klamath Forest Alliance, Natural Resources Defense Council, New York Whale and Dolphin Action League, Northcoast Environmental Center, Ocean Mammal Institute, Orca Network, Surfrider Foundation -Mendocino Coast Chapter, Carol Van Strum, Whale and Dolphin Conservation, and our millions of members and activists, thousands of whom reside in Washington, Oregon, California, and Alaska, we are writing to submit comments on the Proposed Rule for the U.S. Navy's Northwest Training and Testing Activities ("NWTT"). *See* 80 Fed. Reg. 31738 (June 3, 2015).

Introduction

We urge the National Marine Fisheries Service ("NMFS") to withdraw its Proposed Rule, published at 80 Fed. Reg. 31738 *et seq*. (June 3, 2015) (hereafter "Proposed Rule"), and revise its analysis and mitigation consistent with its obligations under the Marine Mammal Protection Act ("MMPA"). The Proposed Rule permits a greater than negligible level of take of marine mammals in direct violation of the MMPA. The Proposed Rule further fails to include meaningful mitigation and monitoring that would ensure the "least practicable impact" as obligated by the MMPA. In short, the Proposed Rule violates the MMPA and fails to protect and promote the growth of marine mammal populations to the greatest extent feasible and commensurate with sound policies of resource management. *See* 16 U.S.C. § 1361(6).

In passing the Marine Mammal Protection Act ("MMPA"), Congress sought to ensure that NMFS would act conservatively in the face of unknowns in order to protect marine mammals against adverse and irreversible harm. Report of the House Committee on Merchant Marines and Fisheries, reprinted in 1972 U.S. Code Cong. & Admin. News 4148. The Navy's NWTT permit application and NMFS's related Proposed Rule act in direct disregard of Congress' stated policy goal and the MMPA's mandate. NMFS's Proposed Rule green-lights unprecedented levels of harm, including population level harm, to marine mammals in the face of, on the one hand, increased scientific certainty related to the sensitivity of marine mammals to Navy sonar and, on the other hand, increased scientific concern regarding the population-level, long-term, and eco-system effects of Navy sonar on marine mammal species.

The sonar and munitions training contemplated in the Navy's NWTT Draft Environmental Impact Statement ("DEIS") is extensive and details extraordinary harm to the Pacific Northwest's marine resources. Generally, the Navy's training range would adversely impact whales, fish, turtles, sea birds, and other wildlife that depend on sound for breeding, feeding, navigating, and avoiding predators—in short, for their survival and reproduction. Many of the exercises proposed would employ the same sonar systems that have been implicated in mass injuries and mortalities of whales around the globe. The same technology is known to affect marine mammals in countless other ways, inducing panic responses, displacing animals, and disrupting crucial behavior such as foraging. Specifically, the harm contemplated by NMFS in the Proposed Rule includes thousands of instances of temporary hearing loss, a significant impact for species dependent on their hearing for survival and reproduction; and more than a million additional cases of disruption of vital behaviors, such as calving and foraging.

Even using the Navy and NMFS's analysis, which substantially understates the potential effects, the activities would cause nearly 250,000 biologically significant impacts on marine mammals along the Washington, Oregon, Northern California, and Southern Alaska coasts each year – more than 1.2 million takes during the 5-year life of a Marine Mammal Protection Act incidental take permit.

Unfortunately, the twofold increase in impacts from the prior 5-year authorization did not trigger a corresponding effort on either the Navy's or NMFS's part to identify better means of mitigation as required in order to achieve the least practicable impact and sound resource management. This failure is despite recent advances (1) in our scientific understanding of marine mammals' sensitivity to sonar and the harm that Navy sonar causes to those mammals and (2) scientific data and experts' ability to map biologically important areas.

In sum, under these circumstances of non-negligible take and population-level impacts, the Navy's exercises must be conducted with substantial mitigation and monitoring. Yet NMFS's Proposed Rule: (1) underrepresents the total take, (2) fails to conduct a population level analysis, (3) relies on minimal and insufficient mitigation despite widely known and acknowledged available alternatives, (4) fails to identify or require the avoidance of biologically important areas for species, (5) fails to consider an alternative in the DEIS that would reduce Navy activity in such biologically important areas, (6) fails to adequately account for the best available science, and (7) relies on a faulty, flawed, and incomplete DEIS.[1]

I. ACTIVITY

The Navy's training and testing activities in the NWTT Study Area are entering a new phase. For the first time, the Navy has provided a more comprehensive picture of the training and testing activities it is conducting and plans to conduct from November 2015 to November 2020 in the sea and air space along the Washington, Oregon, Northern California, and Southern Alaska coasts and the impacts to the environment from those activities. It is a picture of harm that exceeds anything the Navy has proposed for the area in the past and NMFS is planning on authorizing that activity and its resulting take without requiring any measures that would significantly reduce the anticipated harm. Indeed, NMFS has proposed authorizing all of the take requested by the Navy without putting in place any additional or independent measure that would reduce it by even one instance of significant behavioral impact.

If the Proposed Rule is adopted, the Navy will be allowed to harm whales, dolphins, and other marine mammals more than 1.2 million times over five years, which equates to more than 650 instances of take every day, more than 27 takes every hour, more than 2 takes every five minutes for five years. NMFS's proposal includes authorizing the Navy to subject 5 species to almost 1,000 instances of permanent hearing loss and subject almost 30 marine mammal species to more than 269,675 instances of temporary hearing loss and more than 707,635 instances of significant behavioral harassment over the life of the rule. Authorization of this amount of take for this area would be unprecedented.[2]

Of particular concern are vulnerable species such as endangered southern resident killer whales, blue whales, and fin whales; harbor porpoises, which will bear the brunt of harm meted out by the Navy's activities; and the beaked whales. The most vulnerable marine mammals are harbor porpoises and beaked whales, species that are considered acutely sensitive to naval active sonar, with documented injury and mortality for beaked whales. A study published in 2013 indicates that California Current beaked whale populations have declined substantially over the past 20

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[1] The flaws in the DEIS and the Supplement to the DEIS are detailed in comments submitted to NMFS and the Navy by many of the undersigned organizations on April 15, 2014 and February 2, 2015. We hereby incorporate those comments and refer NMFS to those letters for additional details about the problems with its DEIS and Supplemental DEIS.

[2] Authorizing the Navy's activities would also likely result in greater take than predicted. The Navy's application to NMFS includes the use of a "post-model analysis." Unfortunately, as discussed in more detail below, the Navy's pot-model analysis is fraught with problems ranging from unjustified assumptions regarding the "sightability" of different species using observation rates of marine mammals specialists from differently situated platforms in ideal conditions (*e.g.*, not at night) to questionable and unsupported assumptions regarding marine mammal avoidance behavior.

years and identifies anthropogenic sound, particularly Navy sonar, as one of only two plausible causes.[3]

II. MARINE MAMMAL PROTECTION ACT

The MMPA was adopted more than thirty years ago to ameliorate the consequences of human impacts on marine mammals. Its goal is to protect and promote the growth of marine mammal populations "to the greatest extent feasible commensurate with sound policies of resource management" and to "maintain the health and stability of the marine ecosystem." 16 U.S.C. § 1361(6). A careful approach to management was necessary given the vulnerable status of many of these populations (a substantial percentage of which remain endangered or depleted) as well as the difficulty of measuring the impacts of human activities on marine mammals in the wild. 16 U.S.C. § 1361(l), (3). "[I]t seems elementary common sense," the House Committee on Merchant Marine and Fisheries observed in sending the bill to the floor, "that legislation should be adopted to require that we act conservatively—that no steps should be taken regarding these animals that might prove to be adverse or even irreversible in their effects until more is known. As far as could be done, we have endeavored to build such a conservative bias into the [MMPA]." Report of the House Committee on Merchant Marines and Fisheries, reprinted in 1972 U.S. Code Cong. & Admin. News 4148.

At the heart of the MMPA is its so-called "take" provision, which establishes a moratorium on the harassing, hunting, or killing of marine mammals, and generally prohibits any person or vessel subject to the jurisdiction of the United States from taking a marine mammal on the high seas or in waters or on land under the jurisdiction of the United States. 16 U.S.C. §§ 1362(13), 1371(a). Under the law, NMFS may grant exceptions to the take prohibition, provided it determines, using the best available scientific evidence, that such take would have only a negligible impact on marine mammal populations or stocks. NMFS must prescribe "methods" and "means of effecting the least practicable impact" on protected species as well as "requirements pertaining to the monitoring and reporting of such taking." 16 U.S.C. §§ 1371(a)(5)(A)(ii), (D)(vi).

III. IMPACTS ANALYSIS

Under the MMPA's general permit provision, NMFS can authorize exceptions to the take moratorium only upon making an affirmative finding that an activity will have no more than a "negligible impact" on a species or stock. 16 U.S.C. §§ 1371(a)(5)(A)(i), (D)(i)(I). "Negligible impact" has been defined by the agency as one "that cannot be reasonably expected to, and is not reasonably likely to, adversely affect the species or stock through effects on annual rates of recruitment or survival" (50 C.F.R. § 216.103); or, as the agency translates, one that is "not likely to reduce annual rates of adult survival or recruitment" (71 Fed. Reg. 21003). The extraordinary number of takes expected from the next five years of Navy activity should give caution that the effects of deployment could exceed the bounds that Congress intended.

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[3] Moore J.E. and Barlow, J.P., Declining Abundance in beaked whales (Family *Ziphiidae*) in the California Current Large Marine Ecosystem. *PLoS ONE* 8(1):e52770 (2013).

Unfortunately—and absent significant additional mitigation measures—the analysis presented in NMFS's Proposed Rule and the Navy's DEIS fails to support a finding of negligible impact.

A. Failure to Properly Analyze the Potential for Serious Injury and Mortality

NMFS assumes that few if any serious injuries and no mortalities would result from the Navy's thousands of hours of annual use of mid-frequency active sources. In doing so, the agency has misrepresented the science.

In March 2000, sixteen whales from at least three species stranded over 150 miles of shoreline along the northern channels of the Bahamas. The beachings occurred within 24 hours of Navy ships using mid-frequency sonar in those same channels.[4] Post-mortem examinations found, in all whales examined, hemorrhaging in and around the ears and other tissues related to sound conduction or production, such as the larynx and auditory fats, some of which was debilitative and potentially severe.[5] It is now accepted that these mortalities were caused, through an unknown mechanism, by the Navy's use of mid-frequency sonar. The Bahamas event is merely one of numerous mortality events coincident with military activities and active sonar that have now been documented, including[6] the Canary Islands (1985, 1988, 1989, 1991, 2002, 2004),[7] Greece (1996, 1997, 2011),[8] Hawaii (2004),[9] Madeira (2000),[10] Spain (2006),[11] Virgin Islands

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[4] Commerce and Navy, Joint interim report: Bahamas marine mammal stranding event of 15-16 March 2000 (2001).

[5] *Id.*

[6] The following is not a complete list, as other relevant events have been reported in Bonaire, Japan, Taiwan, and other locations. See, *e.g.*, R.L. Brownell, Jr., T. Yamada, J.G. Mead, and A.L. van Helden, Mass strandings of Cuvier's beaked whales in Japan: U.S. naval acoustic link? (2004) (IWC SC/56E37); J.Y. Wang and S.-C. Yang, Unusual cetacean stranding events of Taiwan in 2004 and 2005, *Journal of Cetacean Research and Management* 8: 283-292 (2006); P.J.H. van Bree and I. Kristensen, On the intriguing stranding of four Cuvier's beaked whales, *Ziphius cavirostris*, G. Cuvier, 1823, on the lesser Antillean island of Bonaire, *Bijdragen tot de Dierkunde* 44: 235-238 (1974).

[7] M. Simmonds and L.F. Lopez-Jurado, Whales and the military, *Nature* 337: 448 (1991); V. Martín, A. Servidio, and S. Garcia, Mass strandings of beaked whales in the Canary Islands, in P.G.H. Evans and L.A. Miller, *Proceedings of the Workshop on Active Sonar and Cetaceans* 33-36 (2004); A. Fernández, A., J.F. Edwards, F. Rodríguez, A. Espinosa de los Monteros, P. Herráez, P. Castro, J.R. Jaber, V. Martín, and M. Arbelo, M., 'Gas and fat embolic syndrome' involving a mass stranding of beaked whales (family *Ziphiidae*) exposed to anthropogenic sonar signals, *Veterinary Pathology* 42: 446-57 (2005).

[8] A. Frantzis, Does acoustic testing strand whales? *Nature* 392: 29 (1998); SACLANT Undersea Research Center, Summary Record, La Spezia, Italy, 15-17 June 1998, SACLANTCEN Bioacoustics Panel, SACLANTCEN M-133 (1998); A. Frantzis, The first mass stranding that was associated with the use of active sonar (Kyparissiakos Gulf, Greece, 1996), in P.G.H. Evans and L.A. Miller, *Proceedings of the Workshop on Active Sonar and Cetaceans* 14-20 (2004); A. Frantzis, "Growing numbers – Update on the mass stranding of Ziphius in the Ionian Sea, Greece" (posting of Greek biologist to the MARMAM academic listserv, with previous updates embedded) (Dec. 7, 2011).

[9] B.L. Southall, R. Braun, F.M.D. Gulland, A.D. Heard, R.W. Baird, S.M. Wilkin, and T.K. Rowles, Hawaiian melon-headed whale *(Peponacephala electra)* mass stranding event of July 3-4, 2004 (2006) (NOAA Tech. Memo. NMFS-OPR-31); *see also* R.L. Brownell, Jr., K Ralls, S. Baumann-Pickering and M.M. Poole, Behavior of melon-headed whales, *Pepnoncephalia electra*, near oceanic islands, *Marine Mammal Science* 25: 639-658 (2009).

[10] D.R. Ketten, Beaked whale necropsy findings 22 (2002) (paper submitted to NMFS); L. Freitas, The stranding of three Cuvier's beaked whales *Ziphius Cavirostris* in Madeira Archipelago—May 2000, in P.G.H. Evans and L.A. Miller, *Proceedings of the Workshop on Active Sonar and Cetaceans* 28-32 (2004).

(1999),[12] and Washington State (2003).[13] While most of these events have involved beaked whales, and that family of species has received most of the scientific attention, minke whales, and harbor porpoises have also been implicated.

NMFS dismisses the leading explanation about the mechanism of sonar-related injuries—that whales suffer from bubble growth in organs that is similar to decompression sickness, or "the bends" in human divers—as one of several controversial hypotheses. But this explanation has now been supported by numerous papers, including pathological investigations, laboratory study of organ tissue, and theoretical work on dive physiology, and by expert reviews, and is best available science.[14] Even if it were controversial, there is no serious debate that sonar can cause severe injuries to at least some species (*i.e.*, beaked whales) at sea, independent of any stranding event.[15] Contrary to NMFS's analysis, most beaked whale casualties are bound to go undocumented because of the species' preference for deep water and the small chance that a dead or injured animal would actually strand.[16] At the same time, NMFS fails to acknowledge

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[11] International Whaling Commission, Report of the Scientific Committee, Annex K at 28 (2006) (IWC/ 58/Rep1).

[12] Personal communication of Dr. David Nellis, U.S. Virgin Island Department of Fish and Game, to Eric Hawk, NMFS (Oct. 1999); personal communication from Ken Hollingshead, NMFS, to John Mayer, Marine Acoustics Inc. (March 19, 2002); Letter from William T. Hogarth, Regional Administrator, NMFS Southeast Regional Office, to RADM J. Kevin Moran, Navy Region Southeast (undated); personal communication from Ken Hollingshead, NMFS, to John Mayer, Marine Acoustics Inc. (March 19, 2002).

[13] NMFS, Assessment of acoustic exposures on marine mammals, *supra*; NMFS, Preliminary Report: Multidisciplinary Investigation of Harbor Porpoises (Phocoena phocoena) Stranded in Washington State from 2 May – 2 June 2003 Coinciding with the Mid-Range Sonar Exercises of the USS Shoup 53-55 (2004) (conclusions unchanged in final report).

[14] *See*, *e.g.*, P.D. Jepson, M. Arbelo, R. Deaville, I.A.P. Patterson, P. Castro, J.R. Baker, E. Degollada, H.M. Ross, P. Herráez, A.M. Pocknell, F. Rodríguez, F.E. Howie, A. Espinosa, R.J. Reid, J.R. Jaber, V. Martín, A.A. Cunningham, A. Fernández, Gas-bubble lesions in stranded cetaceans, *Nature* 425: 575-576 (2003); Fernández *et al.*, 'Gas and fat embolic syndrome', 42 *Veterinary Pathology* at 415; S.K. Hooker, R.W. Baird, and A. Fahlman, Could beaked whales get the bends? Effect of diving behavior and physiology on modeled gas exchange for three species: *Ziphius cavirostris*, *Mesoplodon densirostris*, and *Hyperoodon ampullatus*, *Respiratory Physiology and Neurobiology* (2009); S.K. Hooker, A. Fahlman, M.J. Moore, N. Aguilar de Soto, Y. Bernaldo de Quiros, A.O. Brubakk, D.P. Costa, A.M. Costidis, S. Dennison, K.J. Falke, A. Fernandez, M. Ferrigno, J.R. Fitz-Clarke, M.M. Garner, D.S. Houser, P.D. Jepson, D.R. Ketten, P.H. Kvadsheim, P.T. Madsen, N.W. Pollock, D.S. Rotstein, T.K. Rowles, S.E. Simmons, W. van Bonn, P.K. Weathersby, M.J. Weise, T.M. Williams, and P.L. Tyack, Deadly diving? Physiological and behavioural management of decompression stress in diving mammals, *Proceedings of the Royal Society Part B: Biological Sciences* (2011); P.D. Jepson, R. Deaville, I.A.P. Patterson, A.M. Pocknell, H.M. Ross, J.R. Baker, F.E. Howie, R.J. Reid, A. Colloff, and A.A. Cunningham, Acute and chronic gas bubble lesions in cetaceans stranded in the United Kingdom, *Vet. Pathol.* 42: 291-305 (2005); E.C.M. Parsons, S.J. Dolman, A.J. Wright, N.A. Rose, and W.C.G. Burns, Navy sonar and cetaceans: just how much does the gun need to smoke before we act? *Marine Pollution Bulletin* 56: 1248 (2008).

[15] *E.g.*, Cox et al., Understanding the Impacts, at 177-187; Fernández et al., 'Gas and Fat Embolic Syndrome', at 446-457; International Whaling Commission, Report of the Scientific Committee Annex K at 27-28 (2006); P.A. Allison, C.R. Smith, H. Kukert, J.W. Denning, B.A. Bennett, Deep-water taphonomy of vertebrate carcasses: A whale skeleton in the bathyal Santa Catalina Basin, *Paleobiology* 17: 78-89 (1991); G. Wobeser, *Investigation and Management of Disease in Wild Animals* (2007).

[16] J.V. Carretta, K.A. Forney, M.M. Muto, J. Barlow, J. Baker, and M. Lowry, U.S. Pacific Marine Mammal Stock Assessments: 2006 (2007); G. Wobeser, *Investigation and Management of Disease in Wild Animals* 13-15 (1994); P.A. Alison, C.R. Smith, H. Kukert, J.W. Deming, B.A. Bennett, Deep-water taphonomy of vertebrate carcasses: a whale skeleton in the bathyal Santa Catalina Basin, 17 *Paleobiology* 78-89 (1991).

that sonar can seriously injure or kill marine mammals at distances well beyond those established for permanent hearing loss; assumes without evidence that such effects can realistically transpire only under the same set of circumstances that occurred during the 2000 Bahamas mortality event; and does not consider the potential for acoustic sources other than mid-frequency naval sonar—such as high-frequency sonar—to cause these effects even while it modifies its hearing loss thresholds to account for the greater sensitivity of some cetacean species to high-frequency sound. None of these assumptions is supported by the record, and all lead to an underestimation of impacts.[17]

Nor is NMFS's reliance on "post-model analysis" any more persuasive. Presumably, NMFS has accepted the Navy's justification for not including any projected mortalities or non-PTS injuries in its application by the potential for marine mammals to vacate the area upon exposure to harassing noise, and—perhaps most relevant—the ability of Navy lookouts to spot marine mammals in the water. Yet none of these factors, least of all the Navy's ineffective monitoring scheme, supports concluding that all modeled mortalities or non-PTS injuries will be avoided. Furthermore, since NMFS and the Navy do not indicate how much of a reduction each factor represents, let alone the results of the model prior to the Navy's "post-model" massaging, it is impossible for the public to fully comment on this important issue, rendering notice and comment deficient under the Administrative Procedure Act ("APA"). 5 U.S.C. § 553(b), (c); 5 U.S.C. § 706(2)(D).[18]

B. Failure to Set Proper Thresholds for Threshold Shift and Injury

NMFS has followed the Navy in revising its hearing loss thresholds to reflect certain new data, particularly studies showing that harbor porpoises experience threshold shift at substantially lower levels than the mid-frequency cetaceans previously tested by the Navy, and SPAWAR data indicating that mid-frequency cetaceans experience threshold shift at earlier onsets within their best hearing range than was previously assumed. While the agencies were correct in incorporating these new data, their thresholds for hearing loss remain problematic.

First, NMFS's direct extrapolation of data from bottlenose dolphins and belugas to low-frequency cetaceans is not justifiable. There is no reason for NMFS to assume that low-frequency cetaceans, which have never been studied for threshold shift, will mirror mid-frequency cetaceans rather than high-frequency cetaceans in their onset of hearing loss, and such

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[17] *See, e.g.*, Commerce and Navy, Joint Interim Report at 7-11; SACLANT Undersea Research Centre, Summary Record SACLANTCEN Bioacoustics Panel, La Spezia, Italy, 15-17 June 1998, at 2-6, 2-35 to 36 (1998); International Whaling Commission, Report of the Scientific Committee Annex K at 27-28 (2006); Cox et al., Understanding the Impacts, at 179; Fernández et al., 'Gas and Fat Embolic Syndrome', at 446-457; B. Taylor, J. Barlow, R. Pitman, L. Balance, T. Klinger, D. DeMaster, J. Hildebrand, J. Urban, D. Pacacios, and J. Mead, A Call for Research to Assess Risk of Acoustic Impact on Beaked Whale Populations (2004) (IWC SC/56/E36).

[18] We note that a document that allegedly could shed light on this issue is not yet available for public review although it was apparently relied upon by NMFS and the Navy when preparing their Draft Environmental Impact Statement. See U.S. Department of the Navy (2014) Post-Model Quantitative Analysis of Animal Avoidance Behavior and Mitigation Effectiveness for the Northwest Training and Testing. Technical report prepared by Navy Marine Mammal Program, SPAWAR, cited at DEIS 3.14 p. 120.

an approach is not conservative.[19] *Second*, NMFS makes no attempt to account for the potential bias in SPAWAR's bottlenose dolphin data, particularly the age of the subjects used in these influential studies and their situation for years within a noisy bay.[20] *Third*, NMFS's weighting curve for high-frequency cetaceans is not sufficiently conservative in light of ongoing studies, as by Ron Kastelein, showing threshold shift in harbor porpoises at lower levels than the agency supposes, even into the low frequencies.[21] *Fourth*, NMFS's analysis fails to incorporate empirical data on both humans and marine mammals indicating that permanent threshold shift can occur at levels previously thought to cause temporary threshold shift only.[22]

Hearing loss remains a very significant risk where, as here, the agency has not required aerial or passive acoustic monitoring as mandatory mitigation, appears unwilling to restrict operations in low-visibility conditions, has set safety-zone bounds that are inadequate to protect high-frequency cetaceans even from permanent threshold shift, and has not established seasonal exclusion areas for biologically important habitat. NMFS should take a conservative approach and apply the more precautionary standard.

C. Failure to Set Proper Thresholds for Behavioral Impacts

The risk curves used in NMFS's Proposed Rule are substantially similar to those applied during the previous five-year rulemaking, with the exception of a special threshold established for beaked whales, now acknowledged to constitute particularly sensitive species. These risk functions are flawed and continue to underestimate take.

First, NMFS and the Navy again rely on inapposite studies of temporary threshold shift in captive animals for one of their primary sources of data. Marine mammal scientists have long recognized the deficiencies of using captive subjects in behavioral experiments, and to blindly rely on this material, to the exclusion of copious data on animals in the wild, is not supportable by any standard of scientific inquiry. *Cf.* 42 C.F.R. § 1502.22. The problem is exacerbated further by the fact that the subjects in question, roughly two belugas and five bottlenose dolphins, are highly trained animals that have been working in the Navy's research program in the SPAWAR complex for years.[23] Indeed, the disruptions observed by Navy scientists, which included pronounced, aggressive behavior ("attacking" the source) and avoidance of feeding areas associated with the exposure, occurred during a research protocol that the animals had been

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[19] *See* discussion in California State Lands Commission, Draft Environmental Impact Report at H-46, *supra*.

[20] M.L.H. Cook, Behavioral and Auditory Evoked Potential (AEP) Hearing Measurements in Odontocete Cetaceans (2006) (Ph.D. thesis).

[21] *See e.g.*, Tougaard, J., et al. Cetacean noise criteria revisited in the light of proposed exposure limits for harbour porpoises. Mar.Pollut. Bull. (2014), http://dx.doi.org/10.1016/j.marpolbul.2014.10.051

[22] *E.g.*, Kastak, D., Mulsow, J., Ghoul, A., Reichmuth, C., Noise-induced permanent threshold shift in a harbor seal [abstract], *Journal of the Acoustical Society of America* 123: 2986 (2008); Kujawa, S.G., and Liberman, M.C., Adding insult to injury: cochlear nerve degeneration after "temporary" noise-induced hearing loss, *Journal of Neuroscience* 29:14077-14085 (2009).

[23] *See, e.g.*, S.H. Ridgway, D.A. Carder, R.R. Smith, T. Kamolnick, C.E. Schlundt, and W.R. Elsberry, Behavioral responses and temporary shift in masked hearing threshold of bottlenose dolphins, *Tursiops truncates*, to 1-second tones of 141 to 201 dB re 1 μPa (1997) (SPAWAR Tech. Rep. 1751, Rev. 1).

rigorously trained to complete.[24] The SPAWAR studies have several other major deficiencies that NMFS, among others, has repeatedly pointed out; and in relying so heavily on them, NMFS has ignored the comments of numerous marine mammal behaviorists on the Navy's USWTR DEIS, which sharply criticize the Navy for putting any serious stock in them.[25]

Second, NMFS appears to have misused data garnered from the Haro Strait incident—one of only three data sets it considers—by including only those levels of sound received by the "J" pod of killer whales when the USS *Shoup* was at its closest approach. These numbers represent the maximum level at which the pod was harassed; in fact, the whales were reported to have broken off their foraging and to have engaged in significant avoidance behavior at far greater distances from the ship, where received levels would have been orders of magnitude lower.[26] Not surprisingly, then, the agencies' results are inconsistent with other studies of the effects of various noise sources, including mid-frequency sonar, on killer whales. We must insist that NMFS provide the public with the Navy's propagation analysis for the Haro Strait event, which it used in preparing its 2005 Assessment of the incident.

Third, NMFS excludes a substantial body of controlled exposure research and opportunistic study on wild animals (and some research on other experimental animals as well, within a behavioral experimental protocol). For example, NMFS fails to include data from the July 2004 Hanalei Bay event, in which 150-200 melon-headed whales were embayed for more than 24 hours during the Navy's Rim of the Pacific exercise. According to the Navy's analysis, predicted mean received levels (from mid-frequency sonar) inside and at the mouth of Hanalei Bay ranged from 137.9 dB to 149.2 dB.[27] NMFS's failure to incorporate these numbers into its methodology as another data set, and its failure to include the results of other plainly relevant studies,[28] is not justifiable.

Fourth, while the Navy and NMFS acknowledge the strong sensitivity of certain species, particularly harbor porpoises and beaked whales, by assigning them species-specific take

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[24] C.E. Schlundt, J.J. Finneran, D.A. Carder, and S.H. Ridgway, Temporary shift in masked hearing thresholds of bottlenose dolphins, *Tursiops truncates*, and white whales, *Delphinapterus leucas*, after exposure to intense tones, *Journal of the Acoustical Society of America* 107: 3496, 3504 (2000).

[25] *See* comments from M. Johnson, D. Mann, D. Nowacek, N. Soto, P. Tyack, P. Madsen, M. Wahlberg, and B. Møhl, received by the Navy on the Undersea Warfare Training Range DEIS. *See also* Letter from Rodney F. Weiher, NOAA, to Keith Jenkins, Naval Facilities Engineering Command Atlantic (Jan. 30, 2006).

[26] *See,. e.g.*, NMFS, Assessment of Acoustic Exposures on Marine Mammals in Conjunction with USS Shoup Active Sonar Transmissions in the Eastern Strait of Juan de Fuca and Haro Strait, Washington—5 May 2003, at 4-6 (2005); Declaration of David E. Bain, NRDC v. Winter, CV 07-0335 FMC (FMOx) (C.D. Cal. 2007).

[27] Navy, 2006 Supplement to the 2002 Rim of the Pacific (RIMPAC) Programmatic Environmental Assessment D-1 to D-2 (May 2006). *See also* B.L. Southall, R. Braun, F.M.D. Gulland, A.D. Heard, R.W. Baird, S.M. Wilkin, and T.K. Rowles, Hawaiian Melon-Headed Whale (Peponacephala electra) Mass Stranding Event of July 3-4, 2004 (2006) (NOAA Tech. Memo. NMFS-OPR-31).

[28] *E.g.*, M.L. Melcon, A.J. Cummins, S.M. Kerosky, L.K. Roche, S.M. Wiggins, Blue whales respond to anthropogenic noise, *PLoS ONE* 7(2): e32681 (2012); P. Miller *et al.*, 3S Behavioral Response Study on cetaceans (presentation given at the Society of Marine Mammalogy Biennial, Tampa Florida, summarizing results of 3S research program).

thresholds, the agencies fail to include any of the underlying studies on harbor porpoises and beaked whales in their general data set. The result is clear bias, for even if one assumes (for argument's sake) that the SPAWAR data on bottlenose dolphin behavior has value, NMFS has included a relatively insensitive species in setting its general standard for marine mammals while excluding relatively sensitive ones. By placing great weight on the SPAWAR data, excluding other relevant data, and misusing the Haro Strait data, the agencies have produced a risk function that is belied by the existing record: one that clearly demonstrates high risk of significant behavioral impacts from mid-frequency sources, including mid-frequency sonar, on a diverse range of wild species at levels below the function curve.[29] Given the high sensitivity in the Navy's model, standards that more accurately reflect existing data would produce take numbers far in excess of those calculated here.

Fifth, any risk function must take account of the social ecology of some marine mammal species. For species that travel in tight-knit groups, an effect on certain individuals can adversely influence the behavior of the whole. (Pilot whales, for example, are prone to mass strand for precisely this reason, and recent studies have shown that they respond to sonar as a group, in what seems like a socialized anti-predator response; the plight of the 200 melon-headed whales in Hanalei Bay, and of the "J" pod of killer whales in Haro Strait, may be other pertinent examples.) Should those individuals fall on the more sensitive end of the spectrum, the entire group or pod can suffer significant harm at levels below what the Navy would take as the mean. In developing its risk function, NMFS must take account of such potential indirect effects.

Sixth, NMFS's threshold is applied in such a way as to preclude any assessment of long-term behavioral impacts on marine mammals. It does not account, to any degree, for the problem of repetition: the way that apparently insignificant impacts, such as subtle changes in dive times or vocalization patterns, can become significant if experienced repeatedly or over time.[30] This is especially problematic in areas where species may be exposed frequently to noise levels that interrupt their behavior briefly, to a degree that NMFS believes does not constitute take, but which cumulatively would amount to take if the disruption were aggregated.

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[29] *See, e.g.*, R.A. Kastelein, H.T. Rippe, N. Vaughan, N.M. Schooneman, W.C. Verboom, and D. de Haan, The effects of acoustic alarms on the behavior of harbor porpoises in a floating pen, *Marine Mammal Science* 16: 46 (2000); P.F. Olesiuk, L.M. Nichol, M.J. Sowden, and J.K.B. Ford, Effect of the sound generated by an acoustic harassment device on the relative abundance of harbor porpoises in Retreat Passage, British Columbia, *Marine Mammal Science* 18: 843 (2002); NMFS, Assessment of Acoustic Exposures, at 10 (2005); D.P. Nowacek, M.P. Johnson, and P.L. Tyack, North Atlantic right whales (*Eubalaena glacialis*) ignore ships but respond to alerting stimuli, *Proceedings of the Royal Society of London, Part B: Biological Sciences* 271: 227 (2004); Statements of D. Bain, K. Balcomb, and R. Osborne (May 28, 2003) (taken by NMFS enforcement on Haro Strait incident); Letter from D. Bain to California Coastal Commission (Jan. 9, 2007); E.C.M. Parsons, I. Birks, P.G.H. Evans, J.C.D. Gordon, J.H. Shrimpton, and S. Pooley, The possible impacts of military activity on cetaceans in West Scotland, *European Research on Cetaceans* 14: 185-190 (2000); P. Kvadsheim, F. Benders, P. Miller, L. Doksaeter, F. Knudsen, P. Tyack, N. Nordlund, F.-P. Lam, F. Samarra, L. Kleivane, and O.R. Godø, Herring (Sild), Killer Whales (Spekkhogger) and Sonar—the 3S-2006 Cruise Report with Preliminary Results (2007).

[30] *E.g.*, National Research Council, *Marine Mammal Populations and Ocean Noise: Determining When Noise Causes Biologically Significant Effects*, at 35-68 (2005).

Seventh, while NMFS and the Navy have assigned a specific threshold to beaked whales, in light of Tyack et al. (2011), it is clear that some beaked whales are taken on exposure to mid-frequency sonar at levels below 140 decibels (SPL). The beaked whale threshold should incorporate a function below 140 decibels to reflect these data.

Eighth, the agencies' methodology is flawed and non-conservative for the numerous reasons discussed in the technical comments prepared by Dr. David Bain. These comments, which were previously sent to your office for inclusion, as public comments, in other authorization processes, are attached to this letter and hereby incorporated by reference.

For all these reasons, NMFS's risk curves for behavioral impacts are fundamentally inconsistent with the scientific literature on acoustic impacts and, if used to support an incidental take authorization, would violate the MMPA.

D. Failure to Justify Reduction in the DEIS's Take Estimates

The take estimates NMFS presents in its Proposed Rule likely represent a significant reduction from those modeled by the Navy when preparing its DEIS, supplemental DEIS, and application for incidental take after applying the Navy's "post-model analysis." Unfortunately, the agency provides only summary explanations of this reduction process, pointing to a discount in some types of harm for animals fleeing the area and incorporation of mitigation into the analysis—without specifying how each factor influenced the total. NMFS's failure to provide any specific information has prevented the public from effectively commenting on this analysis, in contravention of the APA. 5 U.S.C. § 553(b), (c); 5 U.S.C. § 706(2)(D).

Moreover, insofar as the agencies have provided any information on these factors, it tends to suggest that the agencies have grossly overstated the effectiveness of the Navy's primary mitigation measure. The DEIS appears to use the species-specific g(0) factors used in professional marine mammal abundance surveys—primarily undertaken by NMFS biologists—as their basis of analysis for the Navy's safety zone mitigation. It should go without saying that the Navy's sighting effectiveness is likely to be much poorer than that of experienced biologists dedicated exclusively to marine mammal detection, operating under conditions aimed at maximizing sightings. Any reliance on survey data for this purpose would clearly be arbitrary and capricious.

E. Failure to Rationally Evaluate Effects of Take of Endangered Southern Resident Killer Whales

As NMFS has elsewhere repeatedly emphasized, any serious injury, mortality, or behavioral take that interferes with essential life functions of a Southern Resident killer whale is a non-negligible impact. There are only 81endangered Southern Resident killer whales remaining. When evaluating the potential for the Navy's actions to cause take of a member of this species, NMFS should consider in detail the recent death of a L112, a Southern Resident killer whale found dead on the Washington coast in 2012. The cause of death was determined to be blunt force trauma. While NMFS has not conclusively determined the precise cause of trauma, it occurred in proximity to blasting and sonar activities, and there were confirmed Canadian naval sonar and underwater blast activities in the area in the days preceding the stranding.[31] The unusual uniform loss of brain tissue is considered consistent with blast trauma.[32]

In addition to the population level impacts from serious or fatal injury to even a single individual Southern Resident Killer Whale, behavioral impacts can and do amount to population level impacts. Notably, acoustic disturbance can interfere with essential feeding activities. Southern Resident Killer Whales are threatened by a lack of available prey, and they use echolocation to find prey. This means that acoustic disturbance exacerbates the key threat to the killer whales. For example, recent research demonstrates that persistent anthropogenic noise drowns out ninety-seven percent of killer whale calls in busy waterways.[33] Other studies show that killer whales exposed to vessel noise undergo a shift in behavioral state that appears to significantly depress their nutritional intake.[34]

Rather than conduct a full analysis of the proposed training and testing on this endangered population, NMFS in the Proposed Rule has underestimated the impacts to Southern Residents based on its incorrect belief that "the majority of the Navy's proposed training and testing activities would …not occur in the southern resident killer whale's designated critical habitat," but would instead "occur in the offshore portions of the Study Area where they are only present briefly during their annual migration period." 80 Fed. Reg. at 31808. *See also id.* (stating that training in the offshore area "is not expected to occur in an area/time of specific importance for reproductive, feeding, or other known critical behaviors for killer whales"). As NMFS has elsewhere documented, the Southern Residents rely extensively on the Washington, Oregon, and Northern California coast during the critical winter and spring months and at many other times of the year.[35] Indeed, the agency recently relied on the strength of this and other extensive data to conclude that a revision of the current critical habitat to include these coastal waters is warranted.[36] NMFS must withdraw the Proposed Rule to correct its erroneous assumption– which infects both its take estimates and its proposed inadequate mitigation measures – that the Southern Residents will not be present in coastal waters during the Navy's training activities and

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[31] Duffield, D. et al. Wild Animal Mortality Investigation: Southern Resident Killer Whale L112 Final Report (2014).

[32] Balcomb, K. Comments on Wild Animal Mortality Investigation: Southern Resident Killer Whale L112 Final Report (http://media.wix.com/ugd/760f65_0af67de7dc7242d29ef5d6e235a2fd81.pdf)

[33] R. Williams et al., *Acoustic Quality of Critical Habitats for Three Threatened Whale Populations,* Animal Conservation 1, 2 (2014).

[34] Rob Williams et al., *Estimating Relative Energetic Costs of Human Disturbance to Killer Whales (*Orcinus orca*),* 133 BIOLOGICAL CONSERVATION 301-311 (2006).

[35] *See* NMFS's summaries of satellite tagging studies for 2013 and 2015, available at http://www.nwfsc.noaa.gov/research/divisions/cb/ecosystem/marinemammal/satellite_tagging/blog.cfm and http://www.nwfsc.noaa.gov/research/divisions/cb/ecosystem/marinemammal/satellite_tagging/blog2015.cfm (both visited July 14, 2015).

[36] NMFS, 12-Month Finding on a Petition To Revise the Critical Habitat Designation for the Southern Resident Killer Whale Distinct Population Segment**,** 80 Fed. Reg. 9682 (Feb. 24, 2015). NMFS's finding that Navy activities would have no effect on existing designated critical habitat in the Salish Sea is also arbitrary because prey and ability to find prey is impaired by the ensonification of critical habitat. These areas are essential to the conservation and recovery of the Southern Resident Killer Whales and the adverse impact of the proposed activities in these areas is therefore heightened.

perform a realistic and careful analysis of the potential impacts of any level of authorized take on this fragile population.

F. Failure to Assess Other Impacts on Marine Mammals

The Navy's activities have impacts that are not limited to the direct effects of ocean noise. Unfortunately, NMFS's analysis of these other impacts is cursory and inadequate.

First, the Navy fails to adequately assess the impact of stress on marine mammals, a serious problem for animals exposed even to moderate levels of sound for extended periods.[37] DEIS at 3.4-75 to 77. As the Navy has previously observed, stress from ocean noise—alone or in combination with other stressors, such as biotoxins—may weaken a cetacean's immune system, making it "more vulnerable to parasites and diseases that normally would not be fatal."[38] Moreover, according to studies on terrestrial mammals, chronic noise can interfere with brain development, increase the risk of myocardial infarctions, depress reproductive rates, and cause malformations and other defects in young—all at moderate levels of exposure.[39] Because physiological stress responses are highly conservative across species, it is reasonable to assume that marine mammals would be subject to the same effects and recent research is bearing this out. Indeed, a recent retrospective study of North Atlantic right whales indicated that exposures to low-frequency ship noise may well be associated with chronic stress in whales.[40] For the Navy, such studies should be particularly relevant when assessing impacts on those marine mammal populations that are subjected to stress-inducing impacts from training and testing activities on a regular basis. Nonetheless, despite the potential for stress in marine mammals and the significant consequences that can flow from it, NMFS and the Navy unjustifiably assume that such effects would be minimal.

Second, in the course of its training activities, the Navy would release a host of toxic chemicals, hazardous materials and waste into the marine environment that could pose a threat to marine

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[37] *See* National Research Council, *Ocean Noise and Marine Mammals*.

[38] Navy, Hawaii Range Complex Draft Environmental Impact Statement/ Overseas Environmental Impact Statement at 5-19 to 5-20 (2007). Additional evidence relevant to the problem of stress in marine mammals is summarized in A.J. Wright, N. Aguilar Soto, A.L. Baldwin, M. Bateson, C.M. Beale, C.Clark, T. Deak, E.F. Edwards, A. Fernández, A. Godinho, L. Hatch, A. Kakuschke, D. Lusseau, D. Martineau, L.M. Romero, L. Weilgart, B. Wintle, G. Notarbartolo di Sciara, and V. Martin, Do marine mammals experience stress related to anthropogenic noise?, 20 *International Journal of Comparative Psychology*, 274-316 (2007); see also T.A. Romano, M.J. Keogh, C. Kelly, P. Feng, L. Berk, C.E. Schlundt, D.A. Carder, and J.J. Finneran, Anthropogenic sound and marine mammal health: measures of the nervous and immune systems before and after intense sound exposure, *Canadian Journal of Fisheries and Aquatic Sciences* 61: 1124, 1130-31 (2004).

[39] *See, e.g.*, E.F. Chang and M.M. Merzenich, Environmental noise retards auditory cortical development, *Science* 300: 498 (2003); S.N. Willich, K. Wegscheider, M. Stallmann, and T. Keil, Noise burden and the risk of myocardial infarction, *European Heart Journal* (Nov. 24, 2005); F.H. Harrington and A.M. Veitch, Calving success of woodland caribou exposed to low-level jet fighter overflights, *Arctic* 45: 213 (1992).

[40] R. M. Rolland, S. E. Parks, K. E. Hunt, M. Castellote, P. J. Corkeron, D. P. Nowacek, S. K. Wasser, and S. D. Krauss. 2012. "Evidence That Ship Noise Increases Stress in Right Whales." *Proceedings of the Royal Society of Biology*. 10. 1098/rspb.2011.2429.

mammals over the life of the range. For example, according to the DEIS, under its preferred alternative, the Navy plans to abandon potentially toxic metals in Study Area waters. Nonetheless, NMFS fails to adequately consider the cumulative impacts of these toxins on marine mammals from past, current, and proposed training exercises. Careful study is needed into the way toxins might disperse and circulate within the area and how they may affect marine wildlife. The Navy's assumption that expended materials and toxics would dissipate or become buried in sediment leads to a blithe conclusion that releases of hazardous material would have no adverse effects. Given the amount of both hazardous and nonhazardous materials, this discussion is inadequate. In addition, the Navy also plans to abandon cables, wires, and other items that could entangle marine wildlife, including parachutes. Acknowledging that entanglement is a serious issue for marine mammals, the DEIS nonetheless dismisses the threat by claiming without support that a marine mammal that did become entangled could easily become free. Again, this discussion and analysis is inadequate under the MMPA.

Third, the Navy fails to evaluate and authorize ship collisions with large cetaceans. Not only are whales at risk of a shipstrike by the Navy activities, but also the use of active acoustics exacerbates the potential for a collision.

NMFS incorrectly assumes that it need not evaluate or authorize shipstrike takes due to the lack of past records of Navy vessel strikes during training and testing activities in the NWTT.[41] NMFS should require the Navy to model potential ship strikes in the same way it models acoustic harassment and injuries. The model should take into account the spatial and temporal activities and presence of whales in the action area. Increases in the intensity of the proposed activities will increase the probability of a shipstrike over past activities.

Since commercial hunting of whales was prohibited in 1986, mortality from vessel collisions is a primary threat to the survival of threatened and endangered whales. Between 2010 and 2014, more than 26 large whales have been struck by ships along the West Coast.[42] In 2015, several dead whales have stranded along the West Coast, and some had signs of injuries from ships. While the cause of death for most has not yet been determined, scientists have confirmed that a gray whale was killed in the Puget Sound in January 2015 by a ship's propeller that left several large gashes in the otherwise healthy whale.[43] Since most shipstrikes are undocumented, the number of collisions is much higher. Marine mammals may also experience energetic costs or altered behavior from vessel harassment. For example, NMFS should consider new studies that

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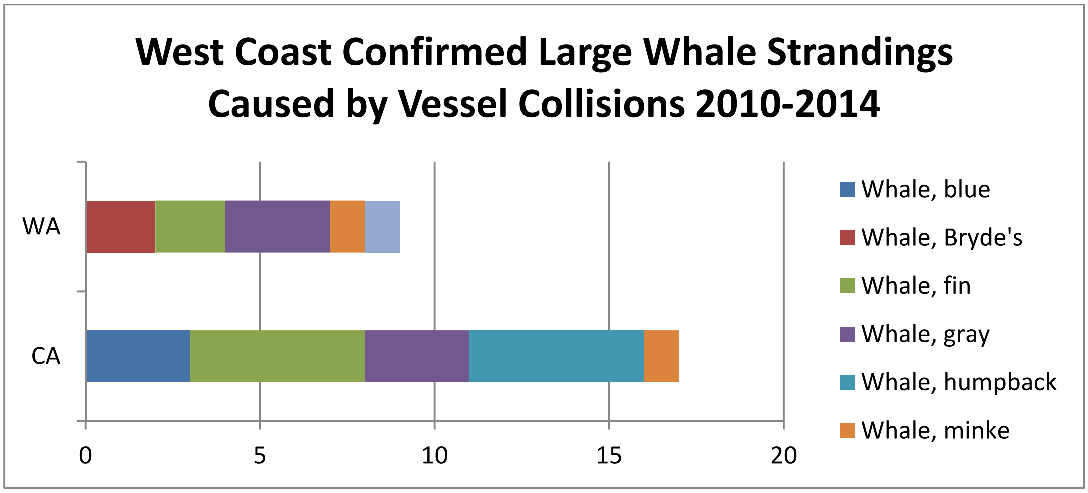
[41] This assumption is itself flawed. As NMFS notes, in 2012, a Navy Destroyer hit a whale (presumed to be a minke) off the coast of Oregon while transiting to San Diego from Seattle. It is arbitrary and inconsistent for the agency to justify its refusal to examine shipstrikes based on the lack of recorded vessel strikes during *testing and training,* while ignoring a shipstrike from a transiting Navy vessel. While any distinction between shipstrikes from training and transiting is itself dubiuos, vessel transits are, of course, part of each training exercise that will occur under the Proposed Rule.

[42] National Marine Fisheries Service, Large Whale Stranding Database (2015).

[43] Cascadia Research, Examination of gray whale on 24 January 2015 reveals it was killed by ship's propeller (Jan 24, 2015).

demonstrate that harbor porpoises experience harassment including masking of communication and echolocation from vessel noise.[44]



NMFS should undertake an evaluation of the potential for a vessel strike. Fin whales are among the most common to be killed by vessels in the Pacific Northwest.[45] Scientists note that whales are especially vulnerable to ship strikes in the approaches to the Strait of Juan de Fuca and the Puget Sound where they historically forage.[46]

The Navy's activities and use of active sonar is likely to enhance the risk of a vessel strike. For example, right whales have been shown to engage in dramatic surfacing behavior, increasing their vulnerability to ship strikes, on exposure to mid-frequency alarms above 133 dB re 1 µPa (SPL)—a level of sound that can occur many tens of miles away from the sonar systems slated for the range.[47] It should be assumed that other large whales (which, as the DEIS repeatedly notes, are already highly susceptible to vessel collisions) are subject to the same hazard. Acoustic disturbance not only causes whales to surface where they are more vulnerable to being hit by a ship, but it can also drive them into busy shipping lanes where they are more likely to be hit by commercial shipping traffic.

Fourth, the Navy does not adequately analyze the potential for and impact of oil spills. As evidenced by the 1989 *Exxon Valdez* oil spill and the 2007 *Cosco Busan* fuel spill there is a risk of an oil spill in areas where oil is transported, such as areas within the Study Area. This risk is

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[44] Dyndo, M. *et al*. Harbour porpoises react to low levels of high frequency vessel noise. *Sci. Rep.* **5**, 11083; doi: 10.1038/srep11083 (2015); Hermannsen, L. High frequency components of ship noise in shallow water with a discussion of implications for harbor porpoises (Phocoena phocoena) J. Acoust. Soc. Am. 136 (4) (2014).

[45] Douglas, A.B., J. Calambokidis, S. Raverty, S.J. Jeffries, D.M. Lambourn and S.A. Norman. Incidence of ship strikes of large whales in Washington State. Journal of the Marine Biological Association of the United Kingdom.(2008).

[46] Id.

[47] Nowacek et al., North Atlantic Right Whales, at 227.

exacerbated by increasing the tempo and intensity of Navy training, which will involve more vessels, more transits, and longer missions.[48]

Finally, the Navy's analysis cannot be limited only to direct effects, *i.e.*, effects that occur at the same time and place as the training exercises that would be authorized. It must also take into account the activity's indirect effects, which, though reasonably foreseeable may occur later in time or are further removed. *Cf.* 40 C.F.R. § 1508.8(b). This requirement is particularly critical in the present case given the potential for sonar exercises to cause significant long-term impacts not clearly observable in the short or immediate term (a serious problem, as the National Research Council has observed).[49] Thus, for example, the Navy must not only evaluate the potential for mother-calf separation but also the potential for indirect effects—on survivability—that might arise from that transient change.

G. Failure to Adequately Assess Cumulative Impacts

NMFS's analysis of cumulative impacts, which is essential to any negligible impact determination, consists of no more than a few qualitative statements. The agency assumes that all of the Navy's estimated impacts would not affect individuals or populations through repeated activity—even though the takes anticipated each year would affect the same populations and, indeed, would admittedly involve extensive use of some of the same areas, such as the Navy's testing ranges. And, while NMFS states that behavioral harassment (aside from those caused by masking effects) involves a stress response that may contribute to an animal's allostatic load, it assumes without further analysis that any such impacts would be insignificant. Both statements are factually insupportable given the lack of any population analysis or quantitative assessment of long-term effects in the Proposed Rule and the numerous deficiencies in the thresholds and modeling that NMFS has adopted from the Navy.

Nor does NMFS consider the potential for acute synergistic effects from multiple activities taking place at one time, or from Navy activities in combination with other actions. For example, the agency does not consider the greater susceptibility to vessel strike of animals that have been temporarily harassed or disoriented. The absence of analysis is particularly glaring in light of the 2004 Nowacek *et al.* study, which indicates that mid-frequency sources provoke surfacing and other behavior in North Atlantic right whales that increases the risk of vessel strike.[50] Nor does NMFS consider (for example) the synergistic effects of noise with other stressors in producing or magnifying a stress-response.[51]

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[48] NMFS should include in its analysis and disclose to the public a chart that shows how the Navy's operating areas overlap shipping lanes, recommended routes, and Areas to Be Avoided as an indication of the potential for conflict with other vessels.

[49] "Even transient behavioral changes have the potential to separate mother-offspring pairs and lead to death of the young, although it has been difficult to confirm the death of the young." National Research Council, *Ocean Noise and Marine Mammals* at 96.

[50] Nowacek et al., North Atlantic right whales, at 227-31.

[51] A.J. Wright, N. Aguilar Soto, A.L. Baldwin, M. Bateson, C.M. Beale, C.Clark, T. Deak, E.F. Edwards, A. Fernández, A. Godinho, L. Hatch, A. Kakuschke, D. Lusseau, D. Martineau, L.M. Romero, L. Weilgart, B. Wintle,

Further, the Proposed Rule makes no attempt to analyze the cumulative and synergistic effects of mortality, injury, masking, energetic costs, stress, hearing loss, or any mechanism of cumulative impact, whether for the Navy's proposed activities or for the Navy's activities combined with other activities affecting the same marine mammal species and populations. Such mechanisms include but are not limited to quantitative or detailed qualitative assessment, including the use of reasonable proxies for population-level impact;[52] models of masking effects;[53] energetic models, such as on foraging success;[54] chronic noise;[55] and stress.[56]

Finally, NMFS makes no attempt to incorporate the effects of other reasonably foreseeable activities impacting the same species and populations into its impact analysis. Perhaps most prominently, though it notes that naval activities will take increasing numbers of marine mammals in the region, it nowhere accounts for impacts from shipping funneled off the northwest coast of Washington as commercial ships approach and utilize the Strait of Juan de Fuca for access to Seattle and Vancouver. Nor does it assess whether or to what extent Navy training in other ranges that affects many of the same populations and individuals of these highly migratory species may accumulate or act synergistically with the take it proposes to authorize in this rule. This lack of analysis is not supportable under the MMPA. Without an accurate

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G. Notarbartolo di Sciara, and V. Martin, "Do marine mammals experience stress related to anthropogenic noise?" (in press and forthcoming 2008); see also other papers published in same volume.

[52] *E.g.*, National Research Council, Marine Mammal Populations and Ocean Noise: Determining When Noise Causes Biologically Significant Effects (2005); Wright, A.J. ed., Report on the workshop on assessing the cumulative impacts of underwater noise with other anthropogenic stressors on marine mammals: from ideas to action, proceedings of workshop held by Okeanos Foundation, Monterey, California, August 26-29, 2009 (2009); California State Lands Commission, Draft Environmental Impact Report for Central Coastal California Seismic Imaging Project (2012).

[53] *E.g.*, Clark, C.W., Ellison, W.T., Southall, B.L., Hatch, L., van Parijs, S., Frankel, A., and Ponirakis, D., Acoustic masking in marine ecosystems as a function of anthropogenic sound sources (2009) (IWC Sci. Comm. Doc. SC/61/E10); Clark, C.W., Ellison, W.T., Southall, B.L., Hatch, L., Van Parijs, S.M., Frankel, A., and Ponirakis, D., Acoustic masking in marine ecosystems: intuitions, analysis, and implication, *Marine Ecology Progress Series* 395: 201-222 (2009).

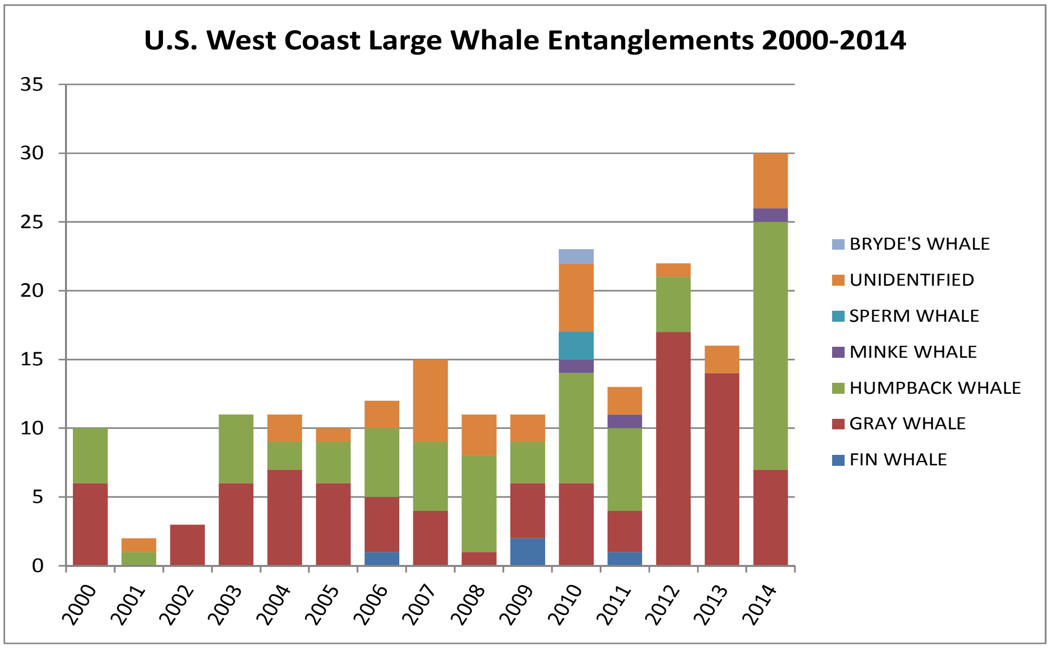
[54] Lusseau, D., Bain, D.E., Williams, R., and Smith, J.C., Vessel traffic disrupts the foraging behavior of southern resident killer whales *Orcinus orca*, *Endangered Species Research* 6: 211-221 (2009); Williams, R., Lusseau, D. and Hammond, P.S., Estimating relative energetic costs of human disturbance to killer whales (Orcinus orca), *Biological Conservation* 133: 301-311 (2006); Miller, P.J.O., Johnson, M.P., Madsen, P.T., Biassoni, N., Quero, M., and Tyack, P.L., Using at-sea experiments to study the effects of airguns on the foraging behavior of sperm whales in the Gulf of Mexico, *Deep-Sea Research I* 56: 1168-1181 (2009). *See also* Mayo, C.S., Page, M., Osterberg, D., and Pershing, A., On the path to starvation: the effects of anthropogenic noise on right whale foraging success, North Atlantic Right Whale Consortium: Abstracts of the Annual Meeting (2008) (finding that decrements in North Atlantic right whale sensory range due to shipping noise have a larger impact on food intake than patch-density distribution and are likely to compromise fitness).

[55] NOAA, Cetacean and Sound Mapping, *available at* www.st.nmfs.noaa.gov/cetsound (previewed at May NOAA symposium).

[56] A special issue of the *International Journal of Comparative Psychology* (20:2-3) is devoted to the problem of noise-related stress response in marine mammals. For an overview published as part of that volume, *see, e.g.,* A.J. Wright, N. Aguilar Soto, A.L. Baldwin, M. Bateson, C.M. Beale, C. Clark, T. Deak, E.F. Edwards, A. Fernández, A. Godinho, L. Hatch, A. Kakuschke, D. Lusseau, D. Martineau, L.M. Romero, L. Weilgart, B. Wintle, G. Notarbartolo di Sciara, and V. Martin, Do marine mammals experience stress related to anthropogenic noise? (2007).

assessment of existing and upcoming threats to marine mammals, NMFS cannot adequately determine whether the Navy's action will have no more than a negligible impact on marine mammal species and stocks. *See* 16 U.S.C. § 1371(a)9(5)(i) (requiring that NMFS find the proposed activity will have not more than a negligible impact in order to authorize incidental take).

NMFS must consider that the take authorization will add to marine mammal injuries and mortality that are intensifying from entanglement, harmful algal blooms and changing ocean conditions. There has been a significant increase in reported entanglements of large whales by fishing gear along the West Coast in 2014 and 2015. Most of these entanglements have involved humpback whales and gray whales. Between 2010 and 2014, NMFS documented 15 large whales stranded by fisheries interactions off the Washington and Oregon Coast.[57] In 2014, 20 different whales were confirmed to have been entangled in fishing gear off the California coast, including at least a dozen humpbacks and five gray whales. [58] In 2015, whale disentanglement experts and their volunteers have reported over 25 large whale entanglements off California.[59] Whale entanglements have also been reported in 2015 in Oregon and Washington.[60]



NMFS must account for the additive impact of its activities in light of changing ocean conditions. Warming waters may be shifting the ranges of marine mammals and their prey. In part the increase in whale entanglements may be caused by whales shifting foraging locations

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[57] NMFS, Large Whale Stranding Database (2015).

[58] Response to data request, received February 27, 2015 from Penny Ruvelas, Long Beach Office Branch Chief, NOAA Fisheries West Coast Region, Protected Resource Division.

[59] P. Folkens, Whale Entanglement Team, pers. comm, 4/21/2015

[60] *See e.g.*, Schmunck, Rhianna, Tangled Whales in B.C. Keeping Officials Busier Than Usual (July 2, 2015) (whale entangled in American fishing gear disentangled).

due to warm waters. NMFS should take into account how warming waters and shifting ranges will potentially place more whales in harm's way from the Navy testing and training activities. For example, North Pacific humpback whales concentrate in areas where there are the oceanographic conditions and climate variables that support krill.[61] Modeling of whale occurrences showed that the whales are associated with latitude and bathymetry as well as sea surface temperature and salinity.[62] This indicates that habitat and foraging areas are strongly influenced by climate change variables.

Additionally, harmful algal blooms are becoming more severe on the West Coast, and 2015 presented the most prolific toxic algal bloom recorded for this region. This year there have been numerous whales stranded along the West Coast, for example nine endangered fin whales have been found stranded in Alaska waters and harmful algal bloom is the suspected cause of death. Fisheries along the coast have been shut down due to the bloom. Exposure to domoic acid via food sources can affect the brain, causing seizures, provoke organ failure, and ultimately death in several marine mammal species, from small sea otters, seals, sea lions, to large whales. [63] In the past three decades, harmful algal blooms seem to have become more frequent, more intense, and more widespread.[64] Ocean acidification may already be intensifying the toxicity of algal blooms, and it has the potential to profoundly affect the growth and toxicity harmful algal blooms.[65] It is against this backdrop that the assessment of the Navy's take must be considered for the marine mammal populations.

H. Other Failures in Modeling Acoustic Impacts

The Navy bases its calculation of marine mammal impacts on a series of models that determine received levels of sound within a limited distance of a sonar array and then estimate the number of animals that would therefore suffer injury or disruption. It is difficult to fully gauge the

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[61] Dalla Rosa, L., J. K. B. Ford, and A. W. Trites. 2012. Distribution and relative abundance of humpback whales in relation to environmental variables in coastal British Columbia and adjacent waters. Continental Shelf Research 36:89–104.

[62] Id.

[63] *See e.g.*, McHuron, E. A., D. J. Greig, K. M. Colegrove, M. Fleetwood, T. R. Spraker, F. M. D. Gulland, J. T. Harvey, K. A. Lefebvre, and E. R. Frame. 2013. Domoic acid exposure and associated clinical signs and histopathology in Pacific harbor seals (Phoca vitulina richardii). Harmful Algae 23:28–33; Bargu, S., T. Goldstein, K. Roberts, C. Li, and F. Gulland. 2012. Pseudo-nitzschia blooms, domoic acid, and related California sea lion strandings in Monterey Bay, California. Marine Mammal Science 28:237–253.

[64] Lewitus, A. J., R. A. Horner, D. A. Caron, E. Garcia-Mendoza, B. M. Hickey, M. Hunter, D. D. Huppert, R. M. Kudela, G. W. Langlois, J. L. Largier, E. J. Lessard, R. RaLonde, J. E. Jack Rensel, P. G. Strutton, V. L. Trainer, and J. F. Tweddle. 2012. Harmful algal blooms along the North American west coast region: History, trends, causes, and impacts. Harmful Algae 19:133–159; Hallegraeff, G. M., editor. 2014. Impacts of climate change on harmful algal blooms and seafood safety. Assessment and management of seafood safety and quality: current practices and emerging issues.

[65] Tatters, A. O., F.-X. Fu, and D. A. Hutchins. 2012. High CO2 and Silicate Limitation Synergistically Increase the Toxicity of Pseudo-nitzschia fraudulenta. PLoS ONE 7:e32116; Fu, F., A. Tatters, and D. Hutchins. 2012. Global change and the future of harmful algal blooms in the ocean. Marine Ecology Progress Series 470:207–233.
Fu, F.-X., M. E. Warner, Y. Zhang, Y. Feng, and D. A. Hutchins. 2007. Effects of Increased Temperature and CO2 on Photosynthesis, Growth, and Elemental Ratios in Marine Synechococcus and Prochlorococcus (cyanobacteria). Journal of Phycology 43:485–496..

accuracy and rigor of these models with the limited information that the Proposed Rule and DEISs provide; but even from the description presented here, it is clear that they are deeply flawed. In addition to the non-conservative assumptions described above in this section (*e.g.*, the agencies' risk functions for behavioral effects), these flaws include: a lack of any indication that the Navy has accounted for reverberation effects in its modeling, or that its modeling sufficiently represents areas in which the risk of reverberation is greatest; and a failure to consider the possible synergistic effects on marine mammal physiology and behavior of using multiple acoustic sources in spatial and temporal proximity.

IV. MITIGATION AND MONITORING

NMFS's analysis and the Proposed Rule rely on ineffective mitigation and monitoring and ignore or improperly discount an array of available mitigation and monitoring that would ensure the least practicable impact, as required by the MMPA, 16 U.S.C. § 1371(a)(5)(i), (ii). These mitigation measures include, for example, avoidance of coastal waters, complex topography, and biologically important areas; the employment of a larger safety zone; pre-exercise passive acoustic monitoring for whales; special rules for night and low-visibility conditions; vessel speed reductions; monitoring and shutdown procedures for sea turtles and large schools of fish; and many others. Below, we describe a number of recommendations that would provide more meaningful protection for marine species while taking account of the Navy's operational needs, *i.e.* they would help ensure the least practicable impact of the Navy's NWTT.[66]

A. Time Area Closures

Despite the vast geographic extent of the Northwest Training and Testing Study Area, the Navy and NMFS have neither proposed nor adequately considered mitigation to reduce activities in biologically important marine mammal habitat.

Virtually all of the mitigation that the Navy and NMFS have proposed for acoustic impacts boils down to a small safety zone around the sonar vessel or impulsive source, maintained primarily with visual monitoring by onboard lookouts, with aid from non-dedicated aircraft (when in the

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[66] NMFS generally dismisses impacts to marine mammal habitat based on the transient nature of training activities, presuming that ships using hull-mounted sonar in particular will move from any particular area. 80 Fed. Reg. at 31769-70. This presumption (and hence, NMFS's cursory consideration of impacts to habitat) overlooks at least two critical factors. First, as explained in detail at pages 26-29 of our DEIS comments, any assumption that sonar and other activities will have no effects on the fish populations that serve as prey to marine mammals and comprise a critical element of marine mammal habitat lacks any valid scientific basis. *See, e.g.,* April 15, 2104 DEIS Comments at 26-27 (describing studies showing that noise cause declines in catch rates in several fisheries). Second, vessels engaged in testing activities – particularly pier side testing – are not transient; the activity takes place in the same place repeatedly. This is particularly true of pier side testing at bases within Puget Sound, including Everett and Bangor, but NMFS does not disclose or analyze the changes that consistent noise can cause to that habitat, nor does it propose any measures to mitigate those effects. The MMPA requires NMFS to perform a far more thorough analysis of the effects that noise from sonar and other activities has on *all* aspects of marine mammal habitat and to develop mitigation to avoid the changes that consistent noise can cause to that habitat.

vicinity) and passive monitoring (through vessels' generic sonar systems).[67] The NMFS mitigation scheme disregards the best available science on the ineffectiveness of visual monitoring to prevent impacts on marine mammals. Indeed, the species perhaps most vulnerable to sonar-related injuries, beaked whales, are among the most difficult to detect because of their small size and diving behavior. It has been estimated that in anything stronger than a light breeze, only one in fifty beaked whales surfacing in the direct track line of a ship would be sighted; as the distance approaches 1 kilometer, that number drops to zero. The agency's reliance on visual observation as the mainstay of its mitigation plan is therefore profoundly insufficient and misplaced.

There is strong consensus — at NOAA and in the scientific community — that spatio-temporal avoidance of high-value habitat represents the best available means to reduce the impacts of mid-frequency active sonar and certain other types of ocean noise on marine biota. Indeed, in a 2010 memorandum from Dr. Jane Lubchenco to the White House Council on Environmental Quality, NOAA recognized the need to improve its Navy mitigation and asserted the importance of time-area restrictions in biologically sensitive areas.[68] It was for this express reason that NOAA, in 2011, established a working group on Cetacean Density and Distribution Mapping, to define marine mammal hotspots for management purposes.[69] Indeed, the Cetacean & Sound Mapping program has been identifying biologically important areas, including areas that overlap with the NWTT Study Area.

These areas were identified by the following procedure, as described on the NOAA CetMap website: "regional experts were asked to compile the best available information from scientific literature (including books, peer-reviewed articles, and government or contract reports), unpublished data (sighting, acoustic, tagging, genetic, photo identification), and expert knowledge to create written summaries and maps highlighting areas within the U.S. Exclusive Economic Zone (EEZ) that are biologically important to cetacean species (or populations), either seasonally or year-round."[70] These areas include reproductive areas, where a particular species or population mates, gives birth, or is found with neonates; feeding areas, where a species or population is consistently found to forage; small resident populations; and, migratory corridors. *Id.*

While NMFS acknowledges this body of science in the Proposed Rule, it inappropriately defers any consideration or analysis of this information until the final rule. There are at least two problems with the agency's failure to apply this available scientific information in the Proposed

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[67] In the NWTT, NMFS fails, for example, to include the establishment of "Planning Awareness Areas" for areas where marine mammals concentrate. It is evident that "Planning Awareness Areas" are feasible because NMFS employs them as a mitigation measure in its permit and related Rule for the Navy's Atlantic Fleet Training and Testing. *See* 78 Fed. Reg. 73010 et seq. (December 4, 2013).

[68] Memorandum from Dr. Jane Lubchenco, Undersecretary of Commerce for Oceans and Atmosphere, to Nancy Sutley, Chair, Council on Environmental Quality at 2 (Jan. 19, 2010).

[69] Memorandum from Dr. Jane Lubchenco, Undersecretary of Commerce for Oceans and Atmosphere, to Nancy Sutley, Chair, Council on Environmental Quality at 2 (Jan. 19, 2010).

[70] See NOAA Cetacean & Sound Mapping "Biologically Important Areas", *available at* http://cetsound.noaa.gov/important.html (last visited on July 10, 2015).

Rule. First, rather than conducting its own analysis of where and how BIAs may inform time-area closures, NMFS has assigned that task to the Navy. It is *NMFS's* responsibility under the MMPA – not the Navy's – to independently consider this information and prescribe necessary mitigation measures to reduce harm to marine mammals.[71] Second, by deferring any review of the Navy's conclusions until the final rule, NMFS is hindering the public's ability to comment on its analysis and use of this information. Where NMFS began its consideration of this information (and discussions with the Navy) over more than 15 months ago, 80 Fed. Reg. at 31779, there is no valid reason – and NMFS provides none – for this delay.

NMFS should have mitigated the Navy's proposed action by limiting Navy sonar and munitions activity that overlap with or take place in close proximity to the biologically important areas identified along the Washington, Oregon, and Northern California coasts and off the coast of Southern Alaska. The failure to do so has resulted in a Proposed Rule that includes a greater number of takes then there would be with this practicable mitigation measure. For this reason, NMFS's Proposed Rule runs counter to the opinion of scientific and agency experts and recent court decisions highlighting the efficacy of setting aside biologically rich areas from harmful sonar use.[72] At a minimum, NMFS should have restricted the Navy's active sonar use and munitions activities within a protective buffer around the following areas with high seasonal or year-round presence of marine mammal species:

1) *NOAA Identified BIAs*: The biologically important areas identified by NOAA in connection with its cetacean mapping project.[73] While BIAs for all west coast species have not been mapped, the areas already identified provide the data to establish initial time-area closures that NMFS should supplement and with the specific areas discussed below and as additional species are mapped.

2) *Olympic Coast National Marine Sanctuary*: A marine protected area recognized as one of the most productive marine ecosystems and established for its unique biodiversity, including marine mammal diversity (29 marine mammal species reside in or migrate through the Sanctuary).

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[71] *See NRDC v. U.S. Dep't of the Navy*, 857 F. Supp. 734, 738 (C.D. Cal. 1994), *vacated by consent decree*, 1994 U.S. Dist. LEXIS 21630 (C.D. Cal. May 5, 1994) (NMFS has an affirmative duty "to reduce as much as practicable the taking of marine mammals.")

[72] Memorandum from Dr. Jane Lubchenco, Undersecretary of Commerce for Oceans and Atmosphere, to Nancy Sutley, Chair, Council on Environmental Quality at 2 (Jan. 19, 2010); *see also* Agardy, T., Aguilar Soto, N., Cañadas, A., Engel, M., Frantzis, A., Hatch, L., Hoyt, E., Kaschner, K., LaBrecque, E., Martin, V., Notarbartolo di Sciara, G., Pavan, G., Servidio, A., Smith, B., Wang, J., Weilgart, L., Wintle, B., and Wright, A, A global scientific workshop on spatio-temporal management of noise, Report of workshop held in Puerto Calero, Lanzarote, June 4-6, 2007 (2007); Dolman, S., Aguilar Soto, N., Notabartolo di Sciara, G., Andre, M., Evans, P., Frisch, H., Gannier, A., Gordon, J., Jasny, M., Johnson, M., Papanicolopulu, I., Panigada, S., Tyack, P., and Wright, A., Technical report on effective mitigation for active sonar and beaked whales (2009) (working group convened by European Cetacean Society); OSPAR Commission, Assessment of the environmental impact of underwater noise (2009) (report issued as part of OSPAR Biodiversity Series, London, UK); Convention on Biological Diversity, Scientific synthesis on the impacts of underwater noise on marine and coastal biodiversity and habitats (2012) (UNEP/CBD/SBSTTA/16/INF/12).

[73] *See* NOAA Cetacean & Sound Mapping "Biologically Important Areas," available at http://cetsound.noaa.gov/important (last visited on July 14, 2015).

3) *Puget Sound:* The Navy has previously affirmed that it will not conduct sonar training within the Greater Puget Sound area without advance approval from the Commander of the Pacific Fleet and the National Marine Fisheries Service. 75 Fed. Reg.69296, 69308 (Nov. 10, 2010) (describing Navy policy prohibiting sonar use without permission). That prohibition is not included in the Proposed Rule. Indeed, NMFS notes that Navy will conduct the "majority" of its activities outside of Puget Sound or "mainly" in the Offshore Area. 80 Fed. Reg. at 31808. NMFS should restrict all sonar training and testing within Puget Sound. At a minimum, the final rule should retain the existing restriction on sonar use within this area.

4) NMFS should prohibit Navy training and testing activities within, and at least 50 miles from, any Marine Protected Area (MPA) boundary. This should apply even where the MPA is located outside the NWTT, because naval training and testing that close to MPAs are likely to negatively impact marine species and resources located within the MPA.

B. Other Mitigation Measures

In addition to the time-area closures discussed above, NMFS must prescribe other measures to reduce the Navy's impacts to their lowest practicable level. *See* 16 U.S.C. 1371(a)(5)(i)(II), (ii) (requiring NMFS to prescribe the "means of effecting the least practicable adverse impact"). As with time-area closures, any one of these measures may be structured to take account of practicability, such as by setting standards for application that allow for deviations, by establishing procedures for exceptions, by discriminating among activities that may have different operational constraints, or by other means. Such measures include but are not limited to:

1) Use of sonar and other active acoustic systems at the lowest practicable source level, with clear standards and reporting requirements for different testing and training scenarios;

2) Expansion of the marine species "safety zone" for hull-mounted mid-frequency sonar to a 4km shutdown, reflecting international best practice, or to 2 km, reflecting the standard prescribed by the California Coastal Commission;

3) Delay or relocation of activities[74] when beaked whales are detected through passive acoustic monitoring within the vicinity of an exercise, in cases where the Navy is unable to determine both range and bearing, even if potentially occurring beyond the established safety zone;

4) Delay or relocation of activities when significant aggregations of any species, or particularly vulnerable or endangered species, are detected by any means within the vicinity of an exercise, even if occurring beyond the established safety zone;

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[74] Here and below, "activities" refers to actions involving any of the acoustic sources or explosives whose take is quantified in the Proposed Rule, or a subset thereof.

5) Use of simulated geography (and other work-arounds) to reduce or eliminate chokepoint exercises in near-coastal environments, particularly within canyons and channels, and use of other important habitat;

6) Avoidance or reduction of training during months with historically significant surface ducting conditions;

7) Delay of activities, or use of power-downs, during significant surface ducting conditions;

8) Avoidance of activities at night and/or in low-visibility conditions (e.g., in fog or in sea-state conditions greater than Beaufort 4).

9) Requirement that all weapons firing in missile and bombing exercises involving detonations exceeding 20 lbs. net explosive weight will take place during the period 1 hour after official sunrise to 30 minutes before official sunset;

10) Use of additional power-downs when significant surface ducting conditions coincide with other conditions that elevate risk, such as during exercises involving the use of multiple systems or in beaked whale habitat;

11) Planning of ship tracks to avoid embayments and provide escape routes for marine animals;

12) Suspension or postponement of chokepoint exercises during surface ducting conditions and scheduling of such exercises during daylight hours;

13) Use of dedicated aerial monitors during chokepoint exercises, major exercises, and near-coastal exercises;

14) Use of dedicated passive acoustic monitoring to detect vocalizing species, through established and portable range instrumentation and/or the use of hydrophone arrays off instrumented ranges;

15) Posting of at least three personnel on watch whose duties include observing the water surface around the vessel, and, in addition, posting of at least two additional personnel on watch as dedicated marine mammal lookouts, whose exclusive responsibility is to monitor for marine mammals;

16) Modification of sonobuoys for passive acoustic detection of vocalizing species;

17) Use of aerial surveys and ship-based surveys before, during, and after multi-unit exercises;

18) Use of all available range assets for marine mammal monitoring;

19) Use of NMFS-certified lookouts for marine mammal detection;

20) Completion of a Lookout Effectiveness Study comparing the abilities of Navy vessel-based lookouts and experienced marine mammal observers (“MMOs”), and requirement of NMFS-certified lookouts or other monitoring enhancements if Navy observers are significantly (*e.g.*, 20%) less likely than MMOs to detect marine mammals;

21) Use of gliders and other platforms for pre-activity monitoring, especially of multi-unit exercises, for purposes of dynamic avoidance of significant aggregations of marine mammals;

22) For underwater detonations and gunnery exercises, compliance with the measures set forth in NMFS’s final rule for Navy operations in the Southern California Range Complex, as published

in the Federal Register on January 21, 2009, at 50 C.F.R. § 216.274(a)(3), with respect to employment of passive acoustic, aerial, and additional vessel-based platforms for monitoring, to the extent these measures are more protective of marine mammals than those currently proposed;

23) Use of dedicated aerial monitoring for all Navy explosives activities using timer delays, and/or all activities involving explosives with a net charge weight above a reasonable level (*e.g.*, 20 lbs.);

24) Avoidance and reduction in the use of timer delays in favor of explosives with positive controls;

25) Application of ship-speed restriction (*e.g.*, of 10 knots) for support vessels and/or other vessels while transiting high-value habitat for baleen whales and endangered species, or other areas of biological significance, and/or shipping lanes;

26) Application of mitigation prescribed by state regulators, by the courts, by other navies or research centers, or by the U.S. Navy in the past or in other contexts;

27) Avoidance of fish spawning grounds and of important habitat for fish species potentially vulnerable to significant behavioral change, such as wide-scale displacement within the water column or changes in breeding behavior;

28) Evaluating before each multi-unit exercise whether reductions in sonar use are possible, given the readiness status of the participants involved;

29) Dedicated research and development of technology to reduce impacts of active acoustic sources on marine mammals;

30) Establishment of a plan and a timetable for maximizing synthetic training in order to reduce the use of active sonar training;

31) Prescription of specific mitigation requirements for individual classes (or sub-classes) of testing and training activities, in order to maximize mitigation given varying sets of operational needs;

32) Additional clean-up and retrieval of the massive amount of discarded debris and expended materials associated with its proposed activities; and

33) Timely, regular reporting to NOAA, state coastal management authorities, and the public to describe and verify use of mitigation measures during testing and training activities.

V. INADEQUACY OF NAVY’s DEIS AS SUPPORT FOR MMPA REGUALTION

NMFS cannot rely on the Navy’s DEIS to fulfill its obligations under NEPA. NEPA requires federal agencies to contemplate the environmental impacts of their actions before committing to a course of action. *Inland Empire Pub. Lands v. U.S. Forest Serv.*, 88 F.3d 754, 758 (9th Cir. 1996) (finding that NEPA is concerned with the process of disclosure, not any particular result). NEPA “ensures that the agency . . . will have available, and will carefully consider, detailed information concerning significant environmental impacts; it also guarantees that the relevant information will be made available to the larger [public] audience.” *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332, 349 (1989); *Inland Empire*, 88 F.3d at 758. Therefore, NEPA requires federal agencies to include an environmental impact statement ("EIS") "in every recommendation or report on . . . major Federal actions significantly affecting the quality of the human environment." 42 U.S.C. § 4332(2)(C).

NMFS's Proposed Rule, which would allow more than 1.2 million takes of marine mammals over the life of the rule, certainly constitutes a major federal action triggering NMFS's independent duty to comply with NEPA. Yet NMFS has not independently fulfilled its NEPA obligations. NEPA encourages and allows agencies to adopt an EIS of another agency, but it must "meet[] the standards for an adequate statement" under NEPA regulations. 40 C.F.R. 1506.3(a). Here, NMFS cannot rely on the Navy's unlawful DEISs. *See, e.g., Sierra Club v. United States Army Corps of Engineers*, 701 F.2d 1011, 1030 (2d Cir. 1983) (holding that permitting agency cannot rely on action agency's inadequate EIS). The Navy's Draft EISs are inadequate for NMFS to wholly adopt for its promulgation of regulations under the Marine Mammal Protection Act authorizing more than a million of instances of take for whales and dolphins.

The purpose of an EIS is to fully inform decision makers of the environmental impacts of proposed activities and alternatives. The fundamental purpose of an EIS is to compel decision-makers to take a "hard look" at a particular action – both at the environmental impacts it will have and at the alternatives and mitigation measures available to reduce those impacts – before a decision to proceed is made. 40 C.F.R. §§ 1500.1(b), 1502.1; *Baltimore Gas & Electric v. NRDC*, 462 U.S. 87, 97 (1983); *Robertson,* 490 U.S. at 349.[75]

The Navy's Draft EIS is self-serving considering only the purpose and need of military readiness, thus limiting the range of alternatives and mitigation. The purpose and need of the proposed action is stated:

> The purpose of the Proposed Action is to conduct training and testing activities to ensure that the navy meets its mission, which is to maintain, train, and equip combat-ready naval forces capable of winning wars, deterring aggression, and maintaining freedom of the seas. This mission is achieved in part by conducting training and testing within the Study Area.

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[75] The requirement that an agency must look before it leaps is a bedrock principle of the NEPA process. *Save the Yak Comm. v. Block,* 840 F.2d 714, 718 (9th Cir. 1988). An agency may not decide to proceed with a proposed action until after it has considered the action's potential environmental impacts. But NMFS and the Navy are doing just that in this Proposed Rule: While the Navy has yet to issue a final EIS adopting any of the alternatives discussed in the DEIS and Supplemental DEIS, the Navy and NMFS are proceeding with the MMPA permit process as if the Navy has already adopted Alternative 1. The Navy's pursuit of a permit tied to an analysis in an as-yet unfinished NEPA process demonstrates that the Navy and NMFS have predetermined the result of this NEPA process. This defeats the purposes of NEPA and is unacceptable. The Navy should abandon its intent to undertake any activities tiered to EIS until *after* the NEPA process has been completed. In addition, unless the Navy and NMFS make substantial changes to the DEIS in response to public comments, it can be presumed that the final EIS will be predetermined results that do not satisfy NEPA.

Navy, *NWTT Draft EIS/OEIS* (January 2014). The Navy's purpose and need is unrelated to NMFS's statutory obligations and presents alternatives that are insufficient for the MMPA rulemaking. NMFS's duty is to prescribe regulations for the incidental take of marine mammals "effecting the least practicable adverse impact on such species or stock and its habitat, paying particular attention to rookeries, mating grounds, and areas of similar significance, and on the availability of such species or stock for subsistence uses." 16 U.S.C. § 1371(a)(5)(A)(i). While military readiness effectiveness must be considered, *id.* § 1371(a)(5)(ii), the ultimate purpose of the MMPA is to protect marine mammals and NMFS is charged with that duty. Thus, NMFS has a distinct purpose and need for its proposed regulations governing the incidental take of marine mammals. And that purpose and need would dictate a broader set of alternatives.

The Navy's DEIS and Supplemental DEIS do not "inform decision-makers and the public of the reasonable alternatives which would *avoid or minimize adverse impacts or enhance the quality of the environment*." 40 C.F.R. § 1502.1 (emphasis added). On the contrary, according to the DEIS, both of the Navy's alternatives result in the exact same number of marine mammal takes from training with sonar – over 100,000 per year. Thus, for training activities the DEISs offer no alternative for a decision-maker to reduce harm to marine mammals—not surprisingly since alternatives were not developed in light of NMFS's mandate. Similarly, the DEISs fail to consider adequate mitigation pursuant to NMFS's duties under the MMPA, or take a hard look at population-level impacts for purposes of satisfying the MMPA standard.

NMFS has stated that it "intends to adopt the Navy's NWTT FEIS/OEIS, if adequate and appropriate…to meet its responsibilities under NEPA for the issuance of regulations and LOAs" 80 Fed. Reg. 31738, 31811 (June 3, 2015). Without significant revision, the Navy's Draft EIS and Supplement to the Draft EIS cannot meet NMFS's NEPA obligations. Thus, we urge NMFS to recognize that the EISs are inadequate and to supplement them accordingly.

For the reasons given, we urge NMFS to withdraw the current Proposed Rule and to revise it with a substantially more conservative impact analysis and improved mitigation. As always, we welcome the opportunity to discuss these issues with you and your staff at any time.

Very truly yours,

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Howard Garrett
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Orca Network

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Five Rivers, Oregon

Attachments

ATTACHMENT

CRITIQUE OF THE RISK ASSESSMENT MODEL EMPLOYED TO CALCULATE TAKES IN THE HAWAII RANGE COMPLEX SUPPLEMENTAL DRAFT ENVIRONMENTAL IMPACT STATEMENT

David E. Bain, Ph.D.

Abstract

Rather than using a fixed received level threshold for whether a take is likely to occur from exposure to mid-frequency sonar, the Navy proposed a method for incorporating individual variation. Risk is predicted as a function of three parameters: 1) a basement value below which takes are unlikely to occur; 2) the level at which 50% of individuals would be taken; and 3) a sharpness parameter intended to reflect the range of individual variation. This paper reviews whether the parameters employed are based on the best available science, the implications of uncertainty in the values, and biases and limitations in the model. Data were incorrectly interpreted when calculating parameter values, resulting in a model that underestimates takes. Errors included failure to recognize the difference between the mathematical basement plugged into the model, and the biological basement value, where the likelihood of observed and predicted takes becomes non-negligible; using the level where the probability of take was near 100% for the level where the probability of take was 50%; and extrapolating values derived from laboratory experiments that were conducted on trained animals to wild animals without regard for the implications of training; and ignoring other available data, resulting in a further underestimation of takes. In addition, uncertainty, whether due to inter-specific variation or parameter values based on data with broad confidence intervals, results in the model being biased to underestimate takes. The model also has limitations. For example, it does not take into account social factors, and this is likely to result in the model underestimating takes. This analysis has important management implications. First, not only do takes occur at far greater distances than predicted by the Navy's risk model, the fact that larger areas are exposed to a given received level with increasing distance from the source further multiplies the number of takes. This implies takes of specific individuals will be of greater duration and be repeated more often, resulting in unexpectedly large cumulative effects. Second, corrections need to be made for bias, and corrections will need to be larger for species for which there are no data than for species for which there are poor data. Third, the greater range at which takes would occur requires more careful consideration of habitat-specific risks and fundamentally different approaches to mitigation. The value of the model is that it provides a focus for future research on the effects of noise on marine mammals. In particular, the sensitivity analysis indicates the primary need for data is determining response probabilities of a wide range of species when exposed to received levels near the level at which 50% of individuals respond.

Introduction

The Navy distinguishes two types of takes: Level A, in which there is immediate injury or death; and Level B, in which there is no immediate injury, but cumulative exposure may lead to harm at the population level. However, in certain contexts, Level B harassment may lead to Level A takes through indirect mechanisms.

The population effects of Level A takes on populations are relatively easy to assess, as individuals that are killed are obviously removed from the population, and those that are injured are more likely to die whenever the population is next exposed to stress.

Calculating the population effects of Level B takes is a topic of contemporary research (Trites and Bain 2000). For example, Bain (2002a) explored using energetic consequences of behavior change in conjunction with population dynamics models to estimate population effects of Level B takes. Stress concurrent with Level B harassment would have additional population consequences. Stress may occur in the absence of behavioral change, or the absence of change in significant behavioral patterns such as foraging or nursing, or exclusion from optimal habitat. Lusseau et al. (2006) concluded disturbance caused a decline in and posed a significant threat to the survival of the bottlenose dolphin population in Doubtful Sound, New Zealand. While they noted vessel strikes were occurring (Level A takes), cumulative behavioral effects (Level B takes) were believed to be the primary threat to the population.

Models relating acoustic exposure to takes thus are not sufficient by themselves to interpret the effects of noise on populations. It is likely that different magnitudes of effect, whether physical harm, behavioral change that leads to physical harm, disruption of significant behavioral activities, or behavioral changes that pose negligible risk to populations when they occur only rarely but can become significant when exposure is prolonged or repeated, will have different relationships to noise. The different magnitudes of takes will have different population consequences. Thus it will be challenging to synthesize results of multiple studies, as different measured endpoints may belong on different curves relating them to noise, and different endpoints will have different population consequences. Further, the population consequences can depend on the health of the population (Bain 2002a). All these factors need to be considered when evaluating the environmental consequences of exposing marine mammals to noise.

Unconditional effects

Temporary Threshold Shifts in captive marine mammals are commonly used as an index of physical harm (e.g., Nachtigall et al. 2003, Finneran et al. 2002 and 2005, Kastak et al. 2005). Limiting experimental noise exposure to levels that cause temporary effects alleviates ethical concerns about deliberately causing permanent injury. However, repeated exposure to noise that causes temporary threshold shifts can lead to permanent hearing loss. In fact, chronic exposure to levels of noise too low to cause temporary threshold shifts can cause permanent hearing loss. Animal models (e.g., rats, cats, monkeys, chinchillas) have been used for tests of noise causing permanent physical harm (Henderson et al. 1991, Gao et al. 1992, Blakeslee et al. 1978, Clark 1991). Damage to hearing from noise exposure is an example of unconditional injury from noise. OSHA (2007) requires limiting human exposure to noise at 115 dB above threshold (equivalent to 145 dB re 1 µPa for killer whales, Szymanski et al. 1999) to 15 minutes.

Stress reactions are another available index (e.g., Romano et al. 2004). Ayres (personal communication) found evidence suggesting that whale watching results in increased levels of stress hormones in wild killer whales.

Conditional effects

Changes in behavior resulting from noise exposure could result in indirect injury in the wild. A variety of mechanisms for Level B harassment to potentially lead to Level A takes have been identified.

Gas bubble lesions have been observed in beaked whales (Jepson et al. 2003, Fernandez et al. 2005, Cox et al. 2006). A variety of mechanisms have been proposed for this. While some have proposed these may be due to acoustically mediated bubble growth, and hence are an unconditional consequence of noise exposure (Crum and Mao 1996), it is more likely that these result from decompression sickness. That is, changes in dive behavior may prevent clearance of nitrogen gas from the body, resulting in larger bubbles than would occur in undisturbed dive patterns. One possible change is that beaked whales may remain submerged for an unusually long period of time, and then rapidly ascend. The rapid ascent is a change in behavior that prevents nitrogen from remaining in solution in the blood. Zimmer and Tyack (2007) questioned whether the rapid ascent mechanism would actually result in lesions, and proposed another behavior change that might occur is interruption of deep dives. Deep dives allow the lungs to collapse, preventing nitrogen from reaching the body. Further, a series of rapid breaths at the surface can be used to clear nitrogen absorbed under pressure. Interruption of the normal surface interval can allow nitrogen to build up over time. Changes in depths of dives are of more concern than rapid ascents as this mechanism would be applicable to a wide range of species, while if the rapid ascent mechanism is involved, it would be primarily a concern for deep diving species (Zimmer and Tyack 2007).

While failure to flee may lead to injury in beaked whales, flight may lead to injury in other species. Minke whales have been found stranded after sonar exercises (NOAA and Navy 2001). A minke whale was observed traveling at high speed during exposure to mid-frequency sonar in Haro Strait in 2003. It is easy to see how such behavior would lead to stranding when a beach is located in front of the whale, as minke whales lack echolocation and visibility is limited underwater. Exhaustion from rapid flight leading to heart or other muscle damage (Williams and Thorne 1996) could also account for increased mortality such as was observed in harbor porpoises following sonar exercises in Juan de Fuca and Haro Straits in April and May of 2003. Harbor porpoises, in contrast to

Dall's porpoises, rarely engage in sustained high energy activities such as rapid swimming or bow riding, and hence are less adapted to long distance flight responses.

Even successful flight may have negative survival consequences. In the absence of disturbance, individuals will tend to occupy optimal habitat. Displacement from optimal habitat will have consequences that will depend on the duration of the displacement, the quality of the alternate habitat, and the condition of the individuals at the time of displacement.

Separation of individuals from social units is another consequence of noise exposure that may lead to mortality. In 2003 in Haro Strait, some killer whales responded to mid-frequency sonar by seeking shelter behind a reef. Others chose to flee, resulting in splitting of a pod that historically spent all of its time together as a single unit. While no deaths resulted from this particular incident, other killer whales have been observed separated from their social units resulting in death prior to reunion or requiring human intervention to restore the individual to its social unit (Schroeder et al. 2007).

Temporary threshold shifts may conditionally lead to harm. Impaired hearing ability increases vulnerability to ship strike. In 2003, blunt force trauma was identified as a cause of death in the investigation of harbor porpoise mortalities following exposure to mid-frequency sonar in Washington State. A minke whale was nearly struck by a research vessel in the area where one had been observed fleeing mid-frequency sonar exposure. These species are familiar with boats in that area, and normally avoid them by a wide margin when they can hear them coming.

Impaired auditory ability may also increase predation risk. For example, Dahlheim and Towell (1994) reported an attack by killer whales on white-sided dolphins. The approach by the whales went undetected due to the noise of the research vessel. Further, impaired hearing may impair foraging ability and communication (Bain and Dahlheim 1994).

The Risk Function Model

The risk function uses three parameters. B is the received level at which the most sensitive individuals start to respond with changes in significant behaviors such as foraging. K is the difference in received level between the level at which half of individuals respond and the level at which the most sensitive individuals respond. That is, B+K is the level at which 50% of individuals respond. A is a shape parameter that attempts to capture the variability in responsiveness of the population. That is, are essentially all the individuals the same and the bulk of them become responsive when the received level is near B+K, in which case a simple threshold model would provide a good approximation, or is there a lot of variation in the population, in which case many individuals become responsive when received levels are near B?

The model is based on the hypothesis that some individuals start to respond at lower levels than others. It anticipates that some individuals will hold out until very high levels before responding. The model includes parameters that allow it to be applied appropriately to species with differing noise tolerance. However, the Navy used one set of parameter values to predict the responses of all species. This paper reviews the accuracy of the choice of parameter values, the implications of using the wrong parameter values, and whether the model makes unbiased predictions when uncertainty in the parameter values exists.

Limitations

Like many models, the risk model has limitations. It fails to take into account social interactions. For example, the model anticipates that individuals may move away from a source at different exposure levels, but fails to recognize that this would result in individuals becoming separated from the group. This is likely to lead to the curve becoming asymmetrical, with the "holdouts" responding to the behavior of their schoolmates rather than the sound. As the area exposed to lower levels of noise is larger than the area exposed to higher levels of noise, this would result in more individuals being affected than the model predicts for social species.

The model does not account for multiple sources. Kruse (1991), Williams and Ashe (2007) and Bain et al. (2006) noted that killer whale responses to vessels varied with the number of vessels present. The magnitude of certain responses increased on the order of 10% per source, although Williams and Ashe (2007) noted that large numbers of sources could result in changes in the opposite direction of small numbers of sources, potentially canceling out the effect. That is, rather than a risk function that simply identifies how likely a response is to occur, one that takes into account the magnitude of the response would be ideal.

Pingers have been used to reduce entanglement in gillnets. Kraus et al. (1997) were able to reduce entanglement of harbor porpoises by 90%. Gearin et al. (1996, 2000) used more pingers, and were able to reduce entanglement by 95%. While this could be accounted for by the fact that more pingers increase the minimum sound level at the net (Bain 2002b), Laake et al. (1997, 1998, 1999) found porpoises typically remained much farther from the net than the spacing between pingers, even after the avoidance response declined due to habituation. Thus, the effect of multiple sources seems larger than the effect of fewer sources. Pingers have also been successful in protecting other species from nets (Barlow and Cameron, 1999; Cameron 1999, Stone et al. 1997).

In addition to quantitative changes in response to multiple sources, there may be a qualitative change in the response. For example, noise is used in drive fisheries of many odontocete species to cause stranding or near strandings. That is, multiple sources were used to displace individuals in a particular direction, and the consequences (stranding) were more serious than displacement from the source alone as would result from exposure to a single source.

The risk to the population of qualitatively different responses varies not only with the type of response, but the circumstances. If the response is going ashore, fatalities are highly likely to result. If the response is slowly moving away for a short period of time, no fatalities are likely to result. However, if the response is to slowly move away from a prime feeding area for an extended period of time, and the population is food limited, fatalities may result, and the number is likely to be related directly to the duration of exclusion from the feeding area, and only indirectly to the cumulative sound energy received.

Finally, the model assumes that marine mammals behave independently from each other. This is not likely to be the case. Even species that are normally solitary, like harbor seals, have been observed to school in response to high energy noise (personal observation). To remain a member of a group, individuals must remain in geographic proximity to each other. As more sensitive individuals move away, others who are not sufficiently disturbed by the sound itself would need to move as well to remain members of the group. The result is likely to be a step function at moderate exposure levels rather than the gradual increase in risk predicted by the model. The result would be that risk is underestimated. The proportion of individuals necessary to lead all individuals to respond in a similar manner to noise is likely to vary among species, and propensity to mass strand may be a good predictor of the importance of this effect.

Datasets

The Navy chose to rely upon three datasets.

Captive cetaceans

Studies of captive marine mammals provide an excellent setting for identifying direct effects of sound. E.g., one of the datasets employed by the Navy consists of studies relating short-term exposure of bottlenose dolphins and belugas to high levels of noise to Temporary Threshold Shifts. The Navy (Dept. Navy 2008b, p 3-7) noted aggressive behavior toward the test apparatus, suggesting stress was another consequence of the test (see also Romano et al. 2004). Such effects would be unconditional results of noise exposure.

However, extrapolation of the level at which aggression was observed to the level at which behaviorally mediated effects might occur in the wild is problematic, as this depends on how well trained the subjects were. For example, the Navy has been a leader in training dolphins and other marine mammals to cooperate with husbandry procedures. Tasks like taking blood, stomach lavage, endoscopic examination, collection of feces, urine, milk, semen and skin samples, etc. once required removing individuals from the water and using several people to restrain them. With training, painful and uncomfortable procedures can be accomplished without restraint and with a reduction in stress that has significantly extended lifespans of captive marine mammals (Bain1988).

That is, the absence of avoidance or aggressive behavior does not imply an absence of physical harm, much less the absence of potential for behavior changes that may lead to indirect harm.

Physical harm may occur in the wild without avoidance responses as well. Yano and Dahlheim (1995) found killer whales continued to predate on longlines despite being physically injured by deterrents such as gunshots. Reeves et al. (1996) reviewed other examples from fishery interactions of injurious approaches to deterrence failing.

If belugas and bottlenose dolphins are like killer whales, and the 50% risk level is about 15 dB below the 50% risk level for behavioral change in trained animals (see below), this would put their value around 170 dB re 1 μPa. Even this is likely to be an overestimate, as boat motors with a source level of 165 dB re 1 μPa can cause behavioral changes in bottlenose dolphins (Nowacek et al. 2001.) This new value, 170 dB re 1 μPa, averaged with the other Navy datasets, would drop the average 50% risk level to 160 dB re 1 μPa.

Killer whales

The second dataset is killer whales exposed to mid-frequency sonar from the USS Shoup in Haro Strait, Washington, in May, 2003. The level quoted in the HRC SDEIS (Dept. Navy 2008b) is an estimate of the received levels experienced when mid-frequency sonar was transmitted from about 3 km away. This level caused major behavioral changes in 100% of exposed whales (Risk=1 for Level B takes of a magnitude that in other contexts or species could lead indirectly to physical harm), but was not to believed to have caused Level A takes (the whales did not strand, and received levels were estimated to be too low to have caused threshold shifts, NMFS OPR 2005) in any individuals (Risk = 0). However, much more data are available from the May, 2003 Shoup incident. Behavioral changes were first observed at 47 km (where the received level was estimated to be 121 dB). The behavioral response was tail slapping by about 25% of the individuals observed, which is consistent with observed responses to vessel noise at a similar level. At a distance greater than 22 km, the direction of travel changed away from a feeding area, and hence foraging behavior was disrupted. At this distance, the received level may have increased to the neighborhood of 135 dB re 1 μPa with about 6 dB of reduced spreading loss and 6 dB reduced absorption. This would be comparable to a vessel traveling at low speed approaching to within 10 m, which is very difficult to accomplish without causing whales to turn away. 100% of killer whales responded by abandoning their feeding ground and moving away from the noise source at this received level. While vessels cause diversion from straight-line paths, they have not been observed to displace killer whales from feeding areas (vessels have been observed to displace killer whales from resting areas, but this is likely mediated by presence rather than noise, as the effect is observed in the presence of silent vessels, Trites et al. 1995). Thus it is not surprising that a qualitatively different behavioral response was exhibited. The peak exposure level was estimated to be 175 dB re 1 μPa (HRC SDEIS, although NMFS noted that estimated levels tended to overestimate measured levels by 1-10 dB [NMFS OPR 2005], so the peak exposure level may have been only 165 dB). In addition to changing travel patterns, the pod split, with approximately 50% of the pod continuing to shelter in an acoustic shadow zone, and the other 50% fleeing at high speed. Such behavior has not been observed in the presence of vessels alone. It should be emphasized that 100% of killer whales exhibited a disruption of a significant life process, foraging, at a level that may have been less than 135 dB re 1 μPa, in contrast to the value used in the SDEIS, 169.3 dB re 1 μPa for a 50% response.

Additional datasets are available for killer whale responses to noise. E.g., in Bain and Dahlheim's (1994) study of captive killer whales exposed to band-limited white noise in a band similar to that of mid-frequency sonar at a received level of 135 dB re 1 μPa, abnormal behavior was observed in 50% of the individuals. This is far lower than the level observed in bottlenose dolphins. In addition, Bain (1995) observed that 100% of wild killer whales appeared to avoid noise produced by banging on pipes (fundamental at 300 Hz with higher harmonics) to the 135 dB re 1 μPa contour. This indicates the difference between wild and captive killer whales (non-zero risk in captive marine mammals might correspond to 100% risk in wild individuals of the same species), as well as implying that risk of 100% may occur by 135 dB re 1 μPa for this genus in the wild.

Further, killer whales begin responding to vessel traffic at around 105-110 dB re 1 μPa with minor behavioral changes. By 135 dB re 1 μPa, disruption of foraging may approach 100%. Received level appears to be more important than proximity (Bain 2001). For risk to increase from near 0 at 105 dB re 1 μPa to near 100% by 135 dB re 1 μPa, with A=10, the 50% risk level would need to be about 120 dB re 1 μPa. Substituting 120 for 169 dB re 1 μPa reduces the average level for 50% risk by about 16 dB to 144 dB re 1 μPa. Substituting 135 dB re 1 μPa would reduce the average by 8 dB to 157 dB re 1 μPa.

Finally, the Navy's characterization of the killer whale dataset is incorrect. They indicate the effects observed in the presence of mid-frequency sonar in Haro Strait were confounded by the presence of vessels. However, the effects of vessels on killer whales have been extensively studied (e.g., Kruse 1991, Williams et al. 2002ab, Bain et al. 2006). Behavioral responses attributed to mid-frequency sonar are qualitatively different than those observed to vessels alone. While the observations are anecdotal, they were not inconsistent. The sonar signal was blocked from reaching the whales with full intensity by shallow banks or land masses during three segments of the observation period. The "inconsistencies" can be attributed to differences in behavior depending on whether there was a direct sound path from the Shoup to the whales. It should be noted there was extensive study of this population prior to exposure (see Bigg et al. 1990 and Olesiuk et al. 1990 for a description of typical research protocols), as well as extensive post-exposure monitoring (e.g., Bain et al. 2006).

Right whales

Similarly, the right whale data relied upon are of limited value. While they clearly illustrate that the value at which 50% of animals are influenced is below 135 dB re 1 μPa and are therefore helpful in determining the upper limits of the B+K value, they lack sufficient low level exposures needed to fit the low end of the curve. As with killer whales, the Navy misused the data. They averaged values which resulted in 100% response. Thus the average value exceeds the level resulting in a 50% risk.

Right whales exposed to alerting devices consistently responded when received levels were above 135 dB re 1 μPa. Due to the small sample size (six individuals), it is unclear whether this is close to the 50% risk, the 100% risk level, or both. These data do not allow identification of B, as lower exposure levels were not tested. In mysticetes exposed to a variety of sounds associated with the oil industry, typically 50% exhibited responses at 120 dB re 1 μPa. Thus right whales may be similar to killer whales.

The consequences of using incorrect values can be seen by comparing the observed results of the right whale exposures to alert signals (Nowacek et al. 2004) with those predicted by the Navy model. Using the values of B=120, K=45, and A=10 in the HRC SDEIS (Dept. Navy 2008b), the probability of responses for the exposed whales are shown in column two of Table 1. The formula underestimated the number of takes by a factor of over 500. The Navy proposed using A=8 for mysticetes in recognition of this, and the results are shown in column 3. While improved, the model still underestimated takes by a factor of 183. One could try B=105 and K=15. Using A=10 provides a reasonable approximation, overestimating takes by 20% (column 4). A better approximation is provided by A=2, which predicts the number of takes within 2% (column 5). While the probability of all four right whales exposed to the highest alert signals responding is much less than one in a billion based on the Navy model and allows one to unequivocally reject the Navy's choice of parameter values as applying to that species, numerous other combinations of parameter values would fit the data as well as the values shown in the table here. Substituting 120 dB re 1 μPa for 139 dB re 1 μPa results in an average 6 dB lower at 159 dB re 1 μPa.

Table 1. Risk for right whales (model vs. observed)

Received Level (dB re 1 µPa)	RISK B=120,K=45,A=10	RISK B=120,K=45,A=8	RISK B=105,K=15,A=10	RISK B=105,K=15,A=2
Responded				
148	0.008647	0.022021	0.999973	0.891548
143	0.001217	0.004641	0.999908	0.86521
137	5.92E-05	0.000415	0.999488	0.819864
135	1.7E-05	0.000153	0.999026	0.800039
133	4.06E-06	4.86E-05	0.998059	0.777052
No Response				
134	8.52E-06	8.79E-05	0.998633	0.788974
Error Factor	502	183	0.83	1.01

Datasets not considered

The Navy incorrectly concludes that additional datasets are unavailable. In addition to the other killer whale datasets mentioned above, data illustrating the use of acoustic harassment and acoustic deterrent devices on harbor porpoises illustrate exclusion from foraging habitat (Laake et al. 1997, 1998 and 1999, Olesiuk et al. 2002). Data are also available showing exclusion of killer whales from foraging habitat (Morton and Symonds 2002), although additional analysis would be required to assess received levels involved. The devices which excluded both killer whales and harbor porpoises had a source level of 195 dB re 1 µPa, a fundamental frequency of 10 kHz, and were pulsed repeatedly for a period of about 2.5 seconds, followed by a period of silence of similar duration, before being repeated. Devices used only with harbor porpoises had a source level of 120-145 dB re 1 µPa, fundamental frequency of10 kHz, a duration on the order of 300 msec, and were repeated every few seconds. Harbor porpoises, which the Navy treats as having a B+K value of 120 dB re 1 µPa (with A large enough to yield a step function) in the AFAST DEIS (Dept.Navy 2008a), 45 dB lower than the average value used in the HRC SDEIS, may be representative of how the majority of cetacean species, which are shy around vessels and hence poorly known, would respond to mid-frequency sonar. Even if harbor porpoises were given equal weight with the three species used to calculate B+K, including them in the average would put the average value at 154 dB re 1 µPa instead of 165 dB re 1 µPa.

Harbor porpoise responses to various acoustic devices have been documented in captivity and the wild. Pingers with a source level of 130 dB re 1 µPa displace wild harbor porpoises to a distance of at least 100-1000 m, where the received level was likely in the neighborhood of 80-90 dB re 1 μPa. Studies of harbor porpoises in captivity also found responses to acoustic deterrent devices, but could not be tested at such distances due to limitations in facility size (Kastelein et al. 1997, 2001). This is another example of how studies with captive cetaceans can produce misleading results. Airmar devices with a source level of 195 dB re 1 μPa displaced an estimated 95% of harbor porpoises to a distance of 3 km. While received levels were not measured, they could have been in the neighborhood of 120-130 dB re 1 μPa. These findings are well modeled with a B value of 70 dB re 1 μPa, a K value of 25, and an A value of 4.

Many species are poorly known, due in part to difficulties approaching them from boats and in part because they do not fare well in captivity. Species that may exhibit vulnerability to noise comparable harbor porpoises include many species of Stenella (e.g., striped dolphins), beaked whales, sperm whales (which are best studied from sailboats rather than motorized vessels, and show disruption of foraging at levels below 130 dB re 1 μPa, Jochens et al. 2006), and numerous poorly known species. In contrast, Dall's porpoises are known to bow ride, and appear far less easily disturbed by noise from airguns than harbor porpoises (Calambokidis et al. 1998). They may be an example of a relatively noise tolerant species like the bottlenose dolphins included in the SDEIS.

There are also data that are based on other noise sources. E.g., effects of vessel traffic on whale and dolphin behavior could be interpreted in terms of received levels. While engine noise tends to be continuous rather than intermittent like sonar, in a reverberant environment, mid-frequency sonar may be received as a nearly continuous sound (personal observation).

Likewise, records of marine mammal responses to broadband noise sources like airguns are also likely to be informative. While it may be difficult to extrapolate levels resulting in takes due to potential differences in perception of broadband and narrowband signals, and pulses rather than continuous sounds, they can give an idea of the range of intra-specific and inter-specific variation in B and K values and be applicable to determining the A parameter.

E.g., Calambokidis et al. (1998) found harbor seal responses to airguns typically consisted of visually orienting at received levels from 143 to 158 dB re 1 μPa and moving away at received levels from 158 dB to 185 dB re 1 μPa. However, one harbor seal oriented at 163 dB re 1 μPa rather than moving away. The highest measured received levels for Dall's porpoises were about 170 dB re 1 μPa, but only about 142 dB re 1 μPa for harbor porpoises. Similarly, the highest received levels measured for California sea lions were about 180 dB re 1 μPa, but only about 160 dB re 1 μPa for Steller sea lions. The highest measured received level was also 160 dB re 1 μPa for gray whales. That is, closely related species pairs may differ in their responsiveness to noise by over 20 dB, and taxonomically diverse species pairs may exhibit similar responsiveness.

TTS data similar to those available for cetaceans have been collected from harbor and elephant seals, and California and Steller sea lions (Kastak et al. 1999, 2005). As with cetaceans, field data suggest the Navy parameter values will underestimate takes of some pinniped species, though they may provide a reasonable approximation for harbor seals and California sea lions (e.g., the data described above). Pinniped hearing in species studied to date is less sensitive than in cetaceans (e.g., California sea lions, Schusterman et al. 1972; Steller sea lions, Kastelein et al. 2005; harbor seals, Møhl 1968; northern fur seals, Moore et al. 1987; odontocetes, Au 1993), and it is commonly assumed they are less vulnerable to noise as a result. However, comparisons of Steller sea lions with Dall's porpoises and gray whales exposed to airgun noise indicates this is not always the case. A detailed consideration of pinnipeds is beyond the scope of this paper.

Using the datasets discussed above, 50% risk levels based on trained cetaceans may be 165 dB re 1 μPa, 120 dB re 1 μPa for killer and right whales, and 95 dB re 1 μPa for harbor porpoises. The average of 95, 120, 120 and 165 is 125 dB, 40 dB lower than the 50% risk value of 165 dB used in the Navy model. Even if one uses more stringent criteria for what constitutes takes (120 dB for harbor porpoises, 135 dB for killer and right whales, and 170 dB for bottlenose dolphins), the average would be 140 dB, which is 25 dB lower than the Navy model. Setting B to 100, K to 40, and A to 10 would result in roughly 40 times the number of takes than the model predicts using the Navy's parameter values.

Parameter values

The use of default values for model parameters is problematic. The available data are likely to be biased toward noise tolerant species. That is, species that are intolerant of noise are difficult to approach closely enough to study. They tend to fare poorly in captivity. E.g., spinner dolphins and harbor porpoises showed very poor survivorship in captivity, in contrast to bottlenose dolphins (Bain 1988). Thus averages based on available data are likely to underestimate effects on species for which data are not available.

While the Navy has proposed assuming noise tolerance is predictable along taxonomic lines, which correlate with hearing ability, empirical data do not support this assumption (Bain and Williams 2006). Likewise, there is interspecific variation in noise tolerance in fish (Kastelein 2008).

B Value

The basement value should be set low enough that the risk function predicts takes at the lowest of the level resulting in unconditional injuries, the level at which behaviorally mediated injuries are possible, and the level resulting in minor behavioral changes or stress that can have population level effects with sustained or repeated exposure.

An important property of the model is that the biologically observed basement value is different than the mathematical basement value. The Navy proposes using 120 dB re 1 μPa as the basement value. They indicate the selection of this value is because it was commonly found in noise exposure studies. However, 120 dB re 1 μPa has broadly been found as the value at which 50% of individuals responded to noise, not a small percentage. Further, a mathematical B of 120 dB corresponds to a risk of less than 2% at 150 dB (with K=45 and A=10), which would be difficult to detect in empirical studies. That is, the studies should be re-evaluated to determine the level at which a small percentage of individuals responded, and then a further correction for the difference between mathematical B and the empirically determined biological B would be needed.

However, further consideration should be given to the nature of the responses used in those studies to determine whether they represent significant behavioral changes or are only likely to have a population scale effect with sustained or repeated exposure.

For example, many looked at changes in migration routes resulting from noise exposure, and found that 50% of migrating whales changed course to remain outside the 120 dB re 1 μPa contour (Malme et al. 1983, 1984). These results might be interpreted in several ways. They could be seen as minor changes in behavior resulting in a slight increase in energy expenditure. Under this interpretation, they would not qualify as changes in a significant behavior, and are irrelevant to setting the basement value. They could be interpreted as interfering with migration, even though the whales did not stop and turn around, and hence 120 dB would make an appropriate B+K value rather than B value. Third, the change in course could have been accompanied by a stress response, in which case the received level at which the course change was initiated rather than the highest level received (120 dB re 1 μPa) could be taken as the biological basement value.

As discussed above, sensitive species like harbor porpoises may be significantly affected by levels below 100 dB re 1 μPa (Kastelein et al. 1997, 2000, 2001). Foraging behavior of killer whales can be disrupted by levels on the order of 105-110 dB re 1 μPa or less (Williams et al. 2002ab, data in Bain et al. 2006). These are far below the 120 dB re 1 μPa level proposed, and as mentioned above, the mathematical B value needed to predict detectable changes at 110 dB would be far lower than 110 dB. For example, B=80, K=45, and A=10 predicts a risk of less than 2% at 110 dB.

K Value

The K value reflects the difference between the mathematical B value and the level at which 50% of individuals respond. Since determining the B value has problems of its own, this critique will focus on determining the B+K value. The 50% risk level is relatively easy to determine, and has been commonly reported in the literature, as noted in the SDEIS. However, the most common value was 120 dB re 1 μPa, as noted in the SDEIS, yet these studies were not used to calculate B+K. Instead, other datasets were used, and the numbers derived were not the 50% risk levels. As mentioned above, there are problems with extrapolation of responses in trained animals to wild animals, and the right and killer whale values were based on levels that resulted in nearly 100% risk, not 50% risk. (It may not be possible to determine a level at which 50% risk occurred in killer whales, but perhaps collaboration among killer whale researchers, whale watch operators, and the Navy might identify the B+K level for that event).

The 50% risk level is the median level at which individuals begin to respond, not the mean as calculated in the SDEIS. While there are data suggesting risk of threshold shift is related to duration of exposure, and hence the consequences of exposure to continuous noise sources would be different than exposure to intermittent sources, there are no such data for behaviorally mediated effects. Many species strongly avoid motorized vessels, and hence are more vulnerable to noise than the average of the species considered above. Such species are likely to include those in the sperm and beaked whale families, Pacific right whales, blue whales, melon-headed and pygmy killer whales, right whale dolphins, and Clymene, striped and rough-toothed dolphins. A smaller number of species, like Dall's porpoises, are more tolerant of noise sources than the average of the species considered above. Thus it is unlikely that the average value of B+K across cetacean species would be above 120 dB re 1 μPa, although the value would vary across species.

A value

While the A value is described as relating to the sharpness of the risk function, it also influences the symmetry of the function. As A increases, risk is redistributed from low noise levels to higher noise levels. The relative risk to the population, as opposed to risk to individuals, can be described as the risk to individuals at a given received level times the relative number of individuals receiving that level. As the sound spreads to larger areas, more individuals are exposed to lower levels of noise. The shape of the risk function and the spreading loss model determine the received level that poses the most risk to the population. At high received levels, the risk to the population may be small, because although the risk to individuals is high, the number of individuals likely to be exposed is small. At low levels, the risk to the population may be again small, because although the number of individuals exposed is high, the risk to those individuals is low. At intermediate values, the population experiences the most risk. When A is low, the risk to the population peaks near B, and at high A values, the risk is concentrated near B+K.

The choice of A value appears arbitrary. The Navy indicated they wanted to allow for more response at low levels, and adjusted the A value to accomplish this. However, this would have been better accomplished by lowering the B and B+K values as suggested above.

The significance of an A value underestimating the number of individuals responding to low levels of noise and overestimating the number of individuals responding to high levels of noise is that the area exposed to low levels of noise is larger than the area exposed to high levels of noise, so the calculation would lead to an underestimate of takes.

Calambokidis et al. (1998) employed an appropriate methodology for obtaining data for calculating A values of marine mammals exposed to airguns. They used a small vessel which moved toward and away from the seismic survey vessel, and hence were able to observe behavior and measure received values at distances of over 70 km as well as close to the seismic survey vessel. Thus they were able to observe normal behavior in the presence of low levels of noise, as well as identify levels above which 100% of individuals exhibited behavioral change, and note inter-specific variation in response curves.

Interaction of Terms

It appears that B+K is a stronger predictor of the number of takes than either factor separately. As a result, similar risk curves can be generated for many different pairs of B and K as long as the sum is held constant. K and A together determine the range over which risk rises from 5% to 95%. Similarly, pairs of K and A over a range of values can generate similar risk curves.

With B=120, K=45, and A=10, the risk function predicts risk is near zero at received levels near 120, and that over 99.9% of takes will occur above 138 dB re 1 μPa. Even with A = 8, 99.9% of takes occur at levels above 135 dB. With A values this large, B is better described as the level at which the risk function is undefined (it requires dividing by 0) rather than the level at which risk becomes negligible. That is, the mathematical basement value and the biological basement value are different. The level at which data from marine mammals show barely detectable risk will be far above the mathematical basement value when K is 45 and A is 8 or 10. When K or A are small, the mathematical and biological B values become similar.

Another way of looking at the difference between the mathematical and biological basement value is to ask how much risk is detectable. In field studies, it will be difficult to distinguish responses that occur in only 5% of individuals from baseline behavior. Even if a study were sensitive enough to detect this, the received level to cause 5% risk is more than 30 dB above the mathematical B value for B=120, K =45 and A=8 or 10. That is, if risk becomes biologically detectable at 120 dB, the B value used in the equation for risk should be far lower. When the model uses the biological B value as the mathematical B value, it does not accurately predict the observed pattern of takes.

Long range effects

The Navy expressed uncertainty over whether there would be long distance effects, even when sound levels were received that are known to cause effects at close range. While I am not aware of observations at 65 nautical miles, responses at over 20 miles have been observed in killer whales to mid-frequency sonar, as well as at over 15 miles to mid-frequency sonar in Dall's porpoises, and harbor porpoises appeared to respond to airguns at over 40 nm (personal observation). The porpoises were responding at distances greater than they would respond to natural predators (killer whales), which are not believed to be detectable at those ranges.

Further evidence of long range responses to noise can be seen in differences in detection rates of some species using acoustic means and ship-based observations. Such studies indicate that species like Pacific right whales and blue whales avoid motorized vessels at distances which place them over the horizon (Wade et al. 2006, Širović 2006).

Uncertainty and Bias

To assess the effects of uncertainty in the parameter values (B, K, and A) on bias in the estimated number of takes, the following method was used. Two spreading loss models were used. A spherical spreading loss model was used, although this was likely to underestimate received levels, particularly at long distances. The other was spherical spreading at close range followed by a cylindrical spreading loss at longer distances model. An accurate model would depend on actual conditions, which would vary from one sonar exercise to another, both as bottom topography varies from place to place and the structure of the water column varies from time to time. The two models chosen should bracket actual conditions, and will serve for purposes of illustration at this stage. In both models, absorption at 3.5 kHz was used to correct for excess attenuation (Richardson et al. 1995). A source level of 235 dB re 1 μPa was assumed for purposes of illustration.

Individuals were assumed to be distributed uniformly with distance from the source, although in practice, action areas will be large enough that density could reasonably be expected to vary. The action area was divided into concentric rings 10 meters across. As the diameter of the ring increased, the area within the ring increased:

$$A = \pi r_o^2 - \pi r_i^2$$

where r_o is the outer diameter and r_i is the inner diameter of the ring.

The risk was calculated for individuals within the ring using the Navy equation, and the relative number of individuals experiencing that risk level was based on the area of the ring. As in the equation for the individuals, the cumulative impact on the population was normalized to 1 based on the Navy default parameters. The effects of uncertainty were observed by allowing the parameters to vary above and below the default values.

Using this model, the contributions of the innermost rings were small, due to their small area, and the contribution of the outermost rings were small, due to the low risk experienced by individuals in those ring. Figures 1-20 show the shape of the risk function and the relative numbers of takes that would occur as a function of received level for a variety of parameter value combinations.

Selected values of B, K and A were used to calculate relative effects, and the results are shown in Table 2 for a spherical spreading model, and Table 3 for a model that assumes spherical spreading for the first 2 km and then cylindrical spreading after that. The default values are shown in bold. Take numbers are based on Alternative 3 in the Hawaii

Range Complex SDEIS (Dept. Navy 2008b), which in turn is based on the No Action Alternative, Table 3.3.1-1. Where the number of takes approaches the size of the population, the actual number of takes will be smaller than shown in the table. However, individuals will be taken multiple times and the duration of takes will be longer than if the calculated number of takes were small. Presumably, longer and more frequent takes of individuals will have more impact on the population than takes due to single exposures.

Table 2. Sensitivity Analysis based on a spherical spreading model

B	K	A	Spreading Model	Relative Effect	Humpback takes	Striped Dolphin takes	Basis
80	45	10	Inv. Square	185.29	2,826,414	867,898	Vary B
90	45	10	Inv. square	75.25	1,147,864	352,471	Vary B
100	45	10	Inv. square	23.92	364,876	112,041	Vary B
110	45	10	Inv. square	5.68	86,643	26,605	Vary B
120	**45**	**10**	**Inv. square**	**1.00**	**15,254**	**4,684**	**SDEIS**
130	45	10	Inv. square	0.14	2,136	656	Vary B
140	45	10	Inv. square	0.02	305	94	Vary B
120	5	10	Inv. Square	167.18	2,550,164	783,071	Vary K
120	15	10	Inv. square	62.22	949,104	291,439	Vary K
120	25	10	Inv. square	18.33	279,606	85,858	Vary K
120	35	10	Inv. square	4.47	68,185	20,937	Vary K
120	**45**	**10**	**Inv. square**	**1.00**	**15,254**	**4,684**	**SDEIS**
120	55	10	Inv. square	0.23	3508	1077	Vary K
120	65	10	Inv. square	0.06	915	281	Vary K
120	75	10	Inv. square	0.01	153	47	Vary K
120	45	1	Inv. square	42.40	646,770	198,602	Vary A
120	45	5	Inv. square	3.27	49,881	15,317	Vary A
120	45	8	Inv. square	1.40	21,356	6,558	Vary A
120	**45**	**10**	**Inv. square**	**1.00**	**15,254**	**4,684**	**SDEIS**
120	45	12	Inv. Square	0.80	12,203	3,747	Vary A
120	45	20	Inv. Square	0.52	7,932	2,436	Vary A
120	45	100	Inv. Square	0.39	5,949	1,827	Vary A
120	**45**	**10**	**Inv. square**	**1.00**	**15,254**	**4,684**	**SDEIS**
105	15	10	Inv. square	251.39	3,834,703	1,177,511	*Orcinus*
105	15	8	Inv. square	250.96	3,828,144	1,175,497	
70	25	10	Inv. square	1070.25	16,325,594	5,013,051	*Phocoena*
70	25	8	Inv. square	1067.49	16,283,492	5,000,123	*Phocoena*

Table 3. Sensitivity analysis based on a model with spherical spreading for 2 km followed by cylindrical spreading.

B	K	A	Spreading Model	Relative Effect	Humpback takes	Striped Dolphin takes	Basis
80	45	10	Hybrid	132.20	2,016,579	619,225	Vary B
90	45	10	Hybrid	65.31	996,239	305,912	Vary B
100	45	10	Hybrid	25.30	385,926	118,505	Vary B
110	45	10	Hybrid	6.67	101,744	31,242	Vary B
120	**45**	**10**	**Hybrid**	**1.00**	**15,254**	**4,684**	**SDEIS**
130	45	10	Hybrid	0.08	1,220	325	Vary B
140	45	10	Hybrid	.005	76	23	Vary B
120	5	10	Hybrid	127.23	1,940,771	595,947	Vary K
120	15	10	Hybrid	59.67	910,213	279,496	Vary K
120	25	10	Hybrid	21.39	326,238	100,177	Vary K
120	35	10	Hybrid	5.37	81,901	25,149	Vary K
120	**45**	**10**	**Hybrid**	**1.00**	**15,254**	**4,684**	**SDEIS**
120	55	10	Hybrid	0.18	2,724	836	Vary K
120	65	10	Hybrid	0.04	570	175	Vary K
120	75	10	Hybrid	0.01	143	44	Vary K
120	45	1	Hybrid	34.16	521,077	160,005	Vary A
120	45	5	Hybrid	3.65	55,665	17,093	Vary A
120	45	8	Hybrid	1.51	23,016	7,067	Vary A
120	**45**	**10**	**Hybrid**	**1.00**	**15,254**	**4,684**	**SDEIS**
120	45	12	Hybrid	0.73	11,103	3,409	Vary A
120	45	20	Hybrid	0.35	5,353	1,644	Vary A
120	45	100	Hybrid	0.17	2,593	796	Vary A
120	**45**	**10**	**Hybrid**	**1.00**	**15,254**	**4,684**	**SDEIS**
105	15	10	Hybrid	171.9	2,622,166	805,181	*Orcinus*
105	15	8	Hybrid	171.3	2,612,718	802,279	
70	25	10	Hybrid	516.41	7,877,318	2,418,864	*Phocoena*
70	25	8	Hybrid	514.46	7,847,573	2,409,731	*Phocoena*
80	45	10	Hybrid	132.20	2,016,579	619,225	“Average”species
100	40	10	Hybrid	40.88	623,525	191,464	Stringent criteria
120	45	10	Social75	1.004	15,315	4,703	75% step
120	45	10	Social50	1.06	16,169	4,965	50% step
120	45	10	Social25	1.49	22,728	6,979	25% step
120	45	10	Social10	3.02	46,067	14,146	10% step

An interesting characteristic of the Navy model is that uncertainty causes it to be biased to underestimate risk. The reason for this bias is that the area receiving higher than the level of sound associated with a 50% risk based on default values is smaller than the area receiving lower levels. Thus if a species is 10 dB more sensitive than predicted (the B value), the cumulative risk is underestimated by a factor of 5.68, while if it is overestimated by 10 dB the correction is 0.14. Similarly, if the error is 20 dB, the correction factors are 23.92 and 0.02, respectively. However, the values average to 6.15, not 1 as would be the case if the default values provided an unbiased estimate. Errors in K show a similar pattern.

Likewise, if the default value of A is too low, it makes little difference in the estimated number of takes. However, if the default value of A is higher than the actual value, the effect on the population can be seriously underestimated when default values are used.

It should also be noted that the bias increases with increasing uncertainty.

Another source of uncertainty is propagation. As noted above, there is uncertainty over propagation that depends on the structure of the water column. Expectations can be based on historical measurements, and actual conditions can be measured to allow re-running propagation models with actual conditions. However, when received levels as a function of distance are higher than predicted, the result is asymmetrical relative to an error of the same magnitude in the opposite direction, as is the case for errors in the receiver parameters. E.g., when a sound channel forms, the area receiving enough noise to cause takes will dramatically increase.

Finally, the magnitude of the difference between parameter values based on reanalysis of the datasets used by the Navy (with harbor porpoises added, a species included in the AFAST Draft DEIS, Dept. Navy 2008a), and the Navy analysis should be emphasized. The number of takes predicted for an average species differs by a factor of more than 100. For humpbacks, this suggests individuals would be taken an average of about 250 times. Of course, when refresh times are taken into account, the number of retakes would be below this number, but the duration of takes would go up as a result. The cumulative effect on the population is likely to be far higher with the increased number and duration of takes predicted when more realistic parameters are used than when the Navy parameters are used.

SEL vs. SPL

Studies with captive marine mammals suggest that SEL provides a good predictor of Temporary Threshold Shift. That is, there is a tight relationship among signal strength, duration, and TTS. However, for behaviorally mediated effects, this relationship is likely to be different. SPL is likely to qualitatively determine the response for signals longer than 1 ms in duration. As long as signals are produced sufficiently often, the duration from the first signal to the last is likely to be more important than the SEL. That is, for low received levels, one second signals produced every 40 seconds for 120 minutes are likely to have more impact than a continuous signal that lasts 10 minutes, even though the latter contains far more sound energy (600 seconds versus 180 seconds), as a behavioral response will be sustained for hours rather than minutes.

When attempting to predict effects of takes on the population, a take table with multiple columns should be developed. One based on SEL could be used to characterize direct effects such as threshold shifts. The next two should be based on SPL. The first of these should be analyzed to evaluate the total number of individuals that would change their behavior as a result of noise exposure, with particular attention paid to exposure in high risk areas (canyons, near shore, near shipping lanes) for potential indirect injuries. The third analysis would consider duration of exposure (in hours of exercise rather than in the SEL sense) to determine whether factors such as stress, displacement from preferred habitat, changes in foraging success and predation risk, etc., would result in cumulative effects that would alter population growth in a manner equivalent to lethal removals (Bain 2002a).

Summary

In summary, development of a function that recognizes individual variation is a step in the right direction. However, the selected equation is likely to produce underestimates of takes. This is due both to social factors increasing the likelihood of a response at low exposure levels, and asymmetries in the number of individuals affected when parameters are underestimated and overestimated due to uncertainty. Thus it will be important to use the risk function in a precautionary manner.

The sensitivity analysis reveals the importance of using as many datasets as possible. First, for historical reasons, there has been an emphasis on high energy noise sources and the species tolerant enough of noise to be observed near them. Exclusion of the rarer datasets demonstrating responses to low levels of noise biases the average parameter values, and hence underestimates effects on sensitive species. In particular, exclusion of the Navy's own interpretation of harbor porpoise data resulted in an increase of B+K by 11 dB, and a reduction in estimated takes by a factor of about 5. Second, uncertainty is correlated with bias. That is, even if a representative set of noise exposure-response data are used to calculate parameter values, the statistical uncertainty resulting from small samples results in biased parameter estimates that lead to underestimation of effects. Thus when estimating takes, it will be important to correct for bias. When estimating population effects on poorly known species, it will be important to be precautionary.

An important error in the selection of parameter values was in interpretation of existing data. Extrapolating behavioral changes in beluga and killer whales and bottlenose dolphins trained to tolerate physical harm that is in their long-term best interest to the threshold for onset of any physical harm in wild individuals is problematic. A similar mistake was made with the right whale data. The level at which 100% of individuals responded was used as the value at which 50% of individuals responded (B+K).

Likewise, the level at which 100% of killer whales responded to mid-frequency sonar is less than the value derived for B+K in the HRC SDEIS (Dept. Navy 2008b).

The "broad overview" of studies reported responses to received levels of 120 dB re 1 μPa by 50% of individuals. That is, 120 dB re 1 μPa should be taken as a "default" value for B+K, not B. Studies which looked at the level at which statistically significant changes were observed, rather than the level at which 50% of individuals responded found lower levels for B. As a result, B is overestimated, and B+K (the level at which risk is 50%) is as well. The use of data from trained dolphins and white whales biased the average B+K value upward. The exclusion of the effects of AHD's and ADD's on harbor porpoises further biases these values, though the sensitivity analysis suggests that using average values to extrapolate takes is unlikely to be accurate due to the broad range of inter-specific variation.

It is likely that biological B values should be in the range from just detectable above ambient noise to120 dB re 1 μPa. The resulting mathematical B value could be tens of dB lower, not the 120 dB re 1 μPa proposed. For many species, risk may approach 100% in the range from 120-135 dB re 1 μPa, putting K in the 15-45 dB range. A values do not seem well supported by data, and in any case, are likely to be misleading in social species as the risk function is likely to be asymmetrical with a disproportionate number of individuals responding at low noise levels. Re-evaluating the datasets identified by the Navy and including harbor porpoises, an average B+K value of 125 dB was found, and the over-representation of species that fare well in captivity likely biases the average above what it would be for all species. Rather than one equation fitting all species well, parameters are likely to be species typical. As realistic parameter values are lower than those employed in the HRC SDEIS (Dept. Navy 2008b), AFAST DEIS (Dept. Navy 2008a) and related DEIS's, take numbers should be recalculated to reflect the larger numbers of individuals likely to be taken. The difference between the parameter values estimated here and those used in the SDEIS suggests takes were underestimated by two orders of magnitude.

The large number of takes predicted when more sensitive species are used as sources of the parameters indicates that many individuals are likely to be taken many times, and the potential for population scale effects to result from small behavioral changes becomes significant.

Assuming spherical spreading out to 2 km followed by cylindrical spreading, B=120, K=45 and A=10 (the Navy values), most takes occur where the received level is greater than 157 dB re 1 μPa and the distance is less than 13 km. With stringent criteria for what constitutes a take derived in the reanalysis (B=120, K=20, A=10), most takes would occur where the received level is below 145 db re 1 μPa and the distance is over 43 km. With the average values calculated here (B=80, K=45, and assuming A=10), most takes would occur where the received level is below 135 dB re 1 μPa and the distance is over 80 km. These values predict over 100 times more takes as the Navy values, as well as the need for very different approaches to mitigation.

The Navy recognizes that the occurrence of conditional effects is important to assessing the impact of noise exposure. As such effects are the result of both received levels and environmental conditions, permit conditions will be important in determining these. The potential for conditional harm suggests using mitigation to limit the potential for actual harm. E.g., the risk of causing stranding can be minimized by restricting exercises to areas far from shore. Limiting the duration of exposure can limit the consequences of long-term displacement, risk of injury from prolonged flight, and limit cumulative effects. The risk of causing gas bubble lesions can be minimized by restricting use near canyons, for extended periods of time, and limiting the number of sources. The absolute effects can be minimized by conducting exercises in areas where population density is low, or at times of year when species of concern are absent.

Finally, it will be important to assess the cumulative effects of noise combined with other factors and population status (Wade and Angliss 1997) to assess the likely effects of sonar exercises on marine mammal populations.

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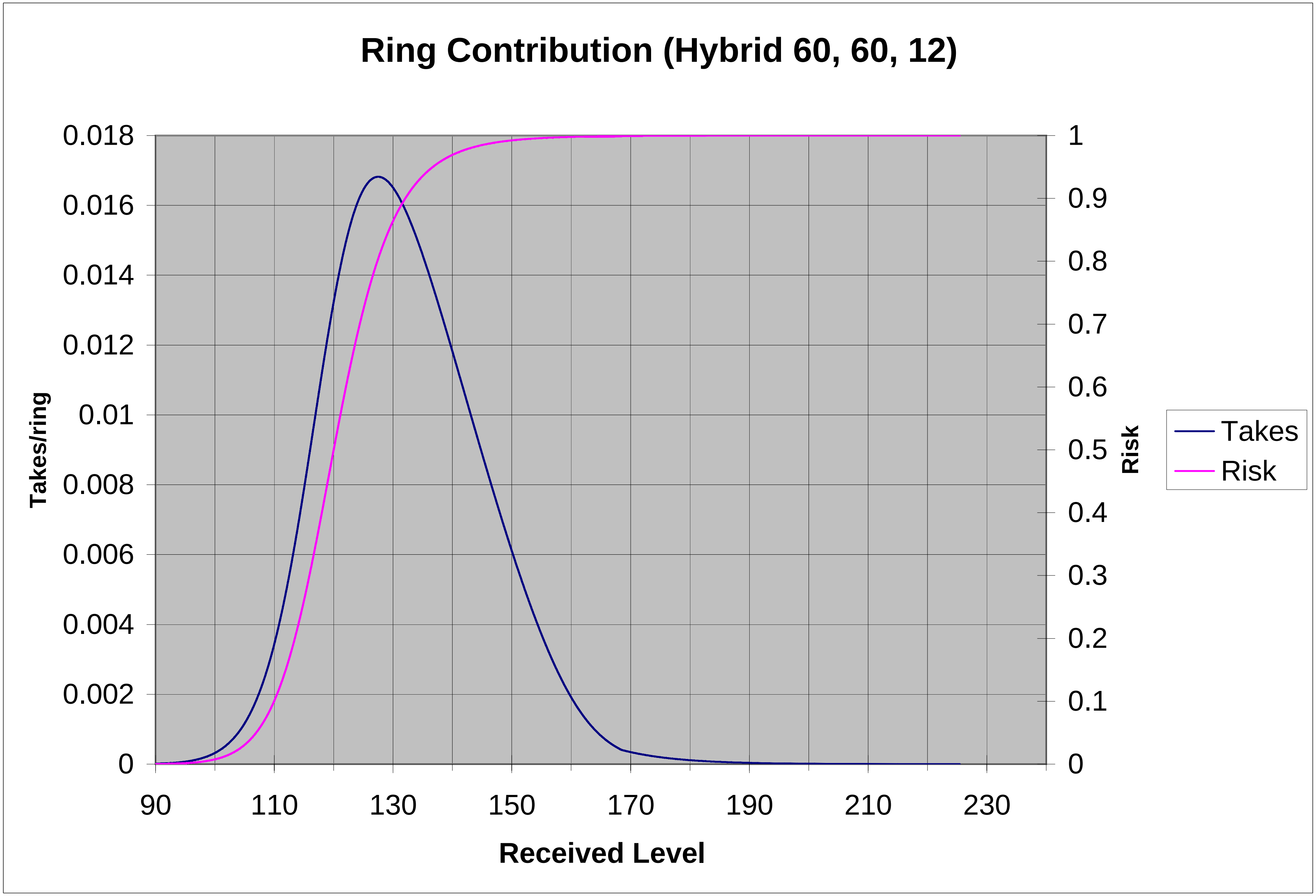
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0.014
0.012
0.01
0.008
0.006
0.004
0.002
0
Risk
1
0.9
0.8
0.7
0.6
0.5
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90
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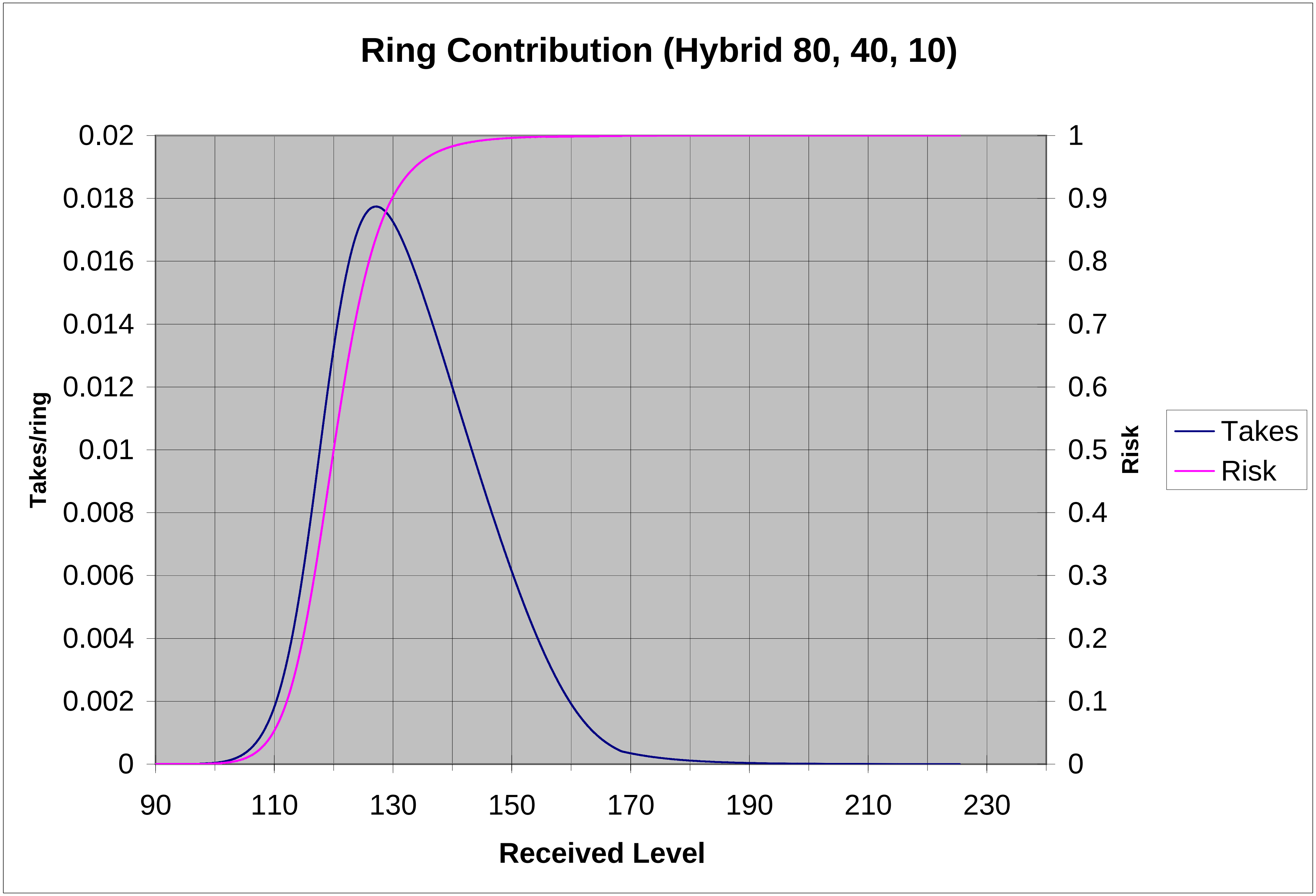
130
150
170
190
210
230
Received Level
Takes
Risk



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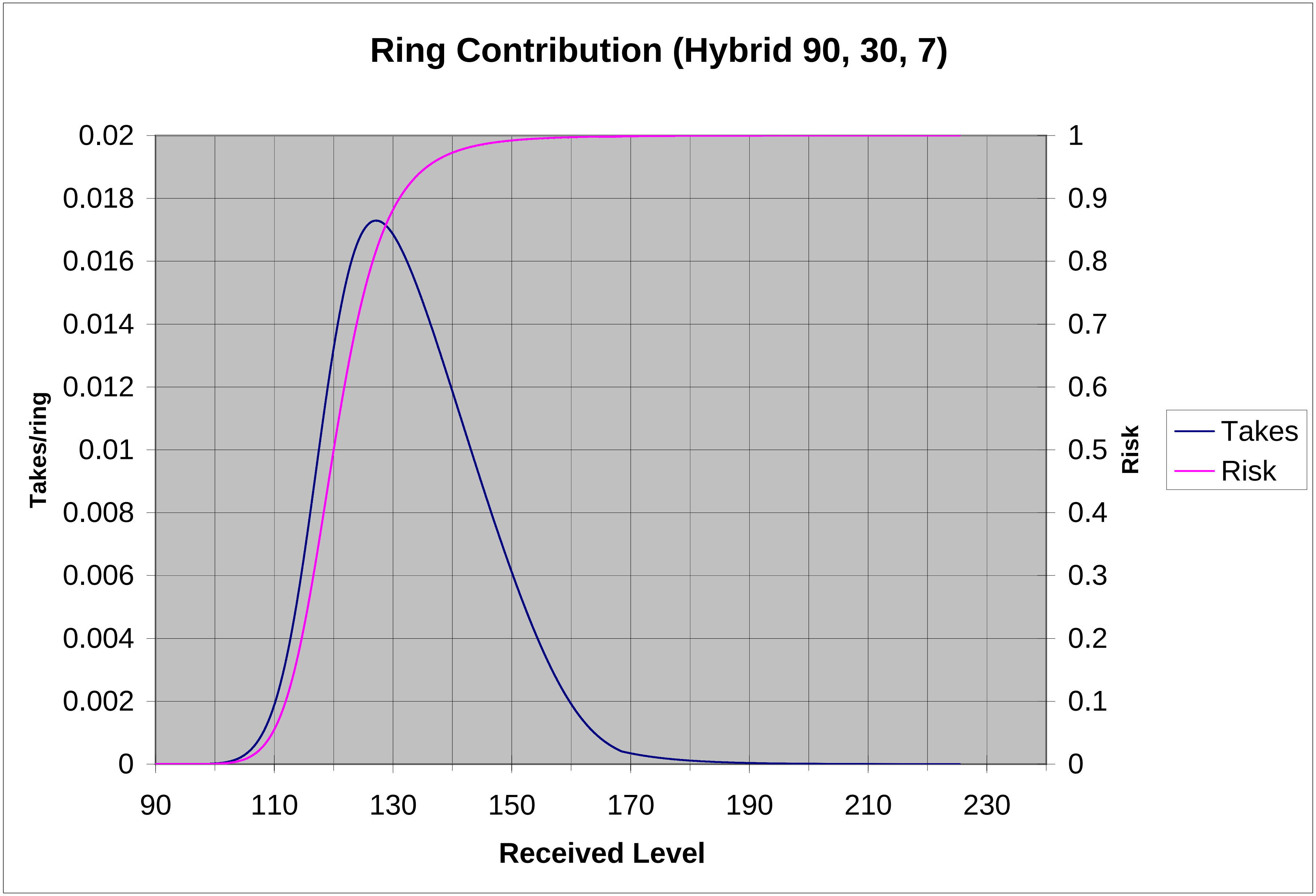
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0.012
0.01
0.008
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0.004
0.002
0
Risk
1
0.9
0.8
0.7
0.6
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0.3
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90
110
130
150
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190
210
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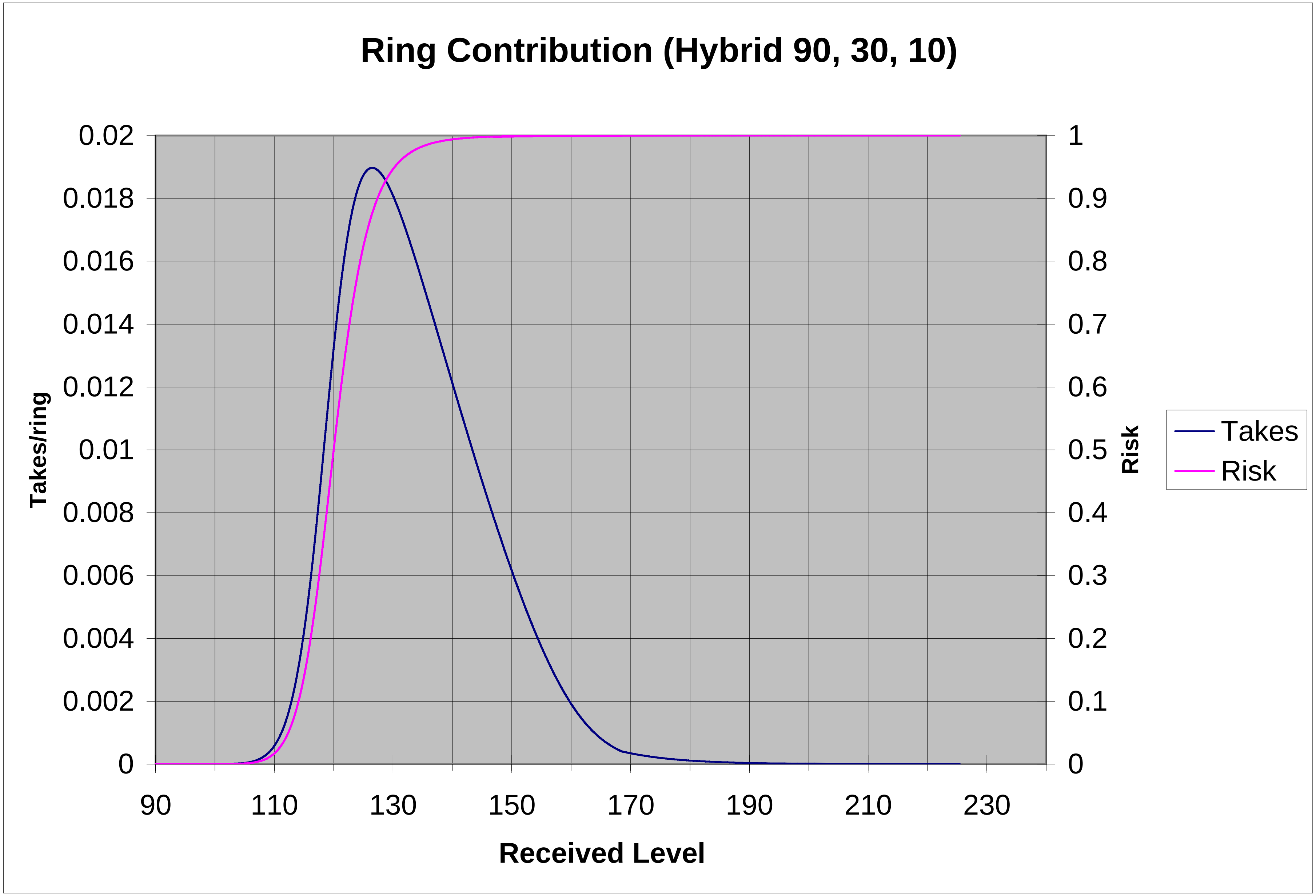
Received Level
Takes
Risk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0.002
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Risk
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0.8
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0.6
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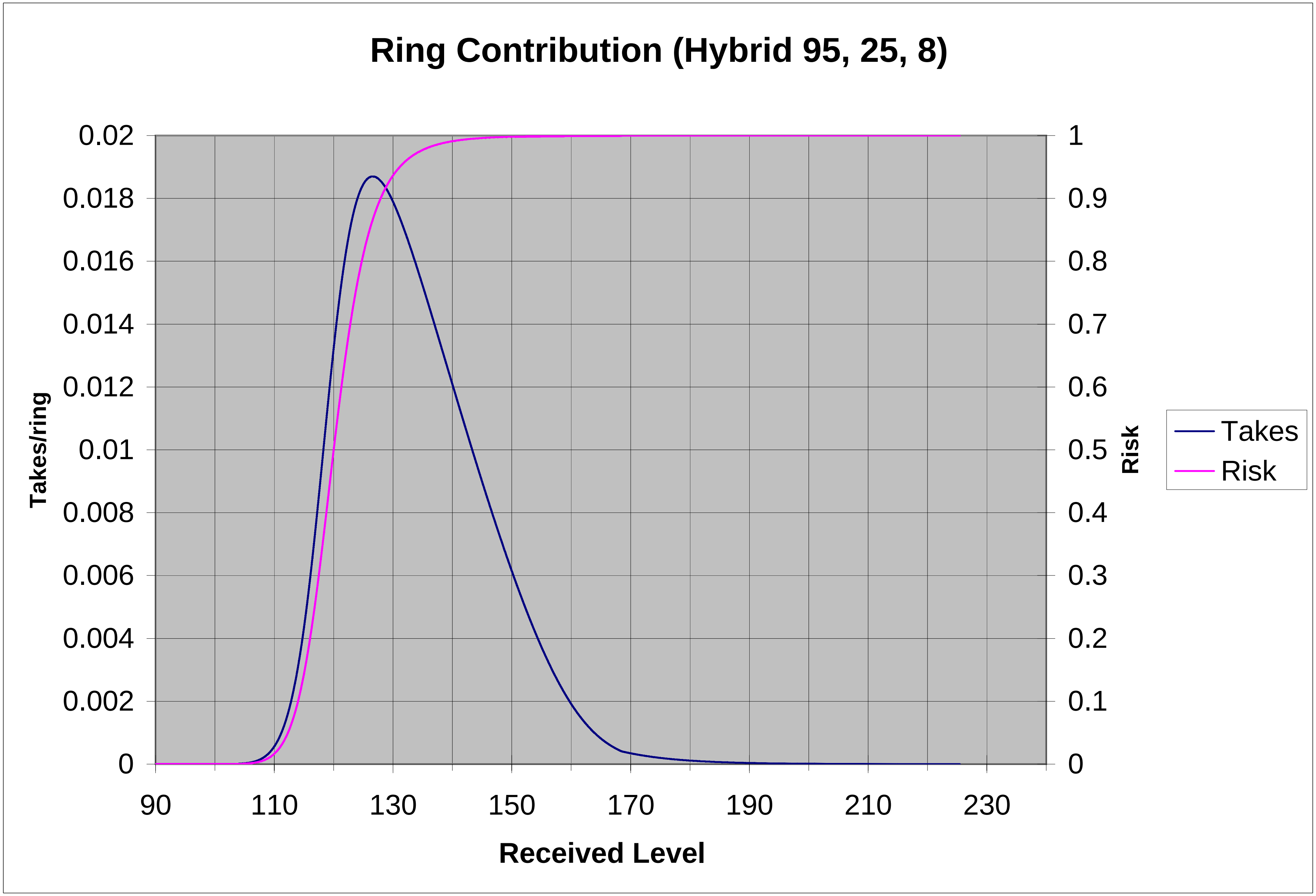
Received Level
Takes
Risk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0.004
0.002
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Risk
1
0.9
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90
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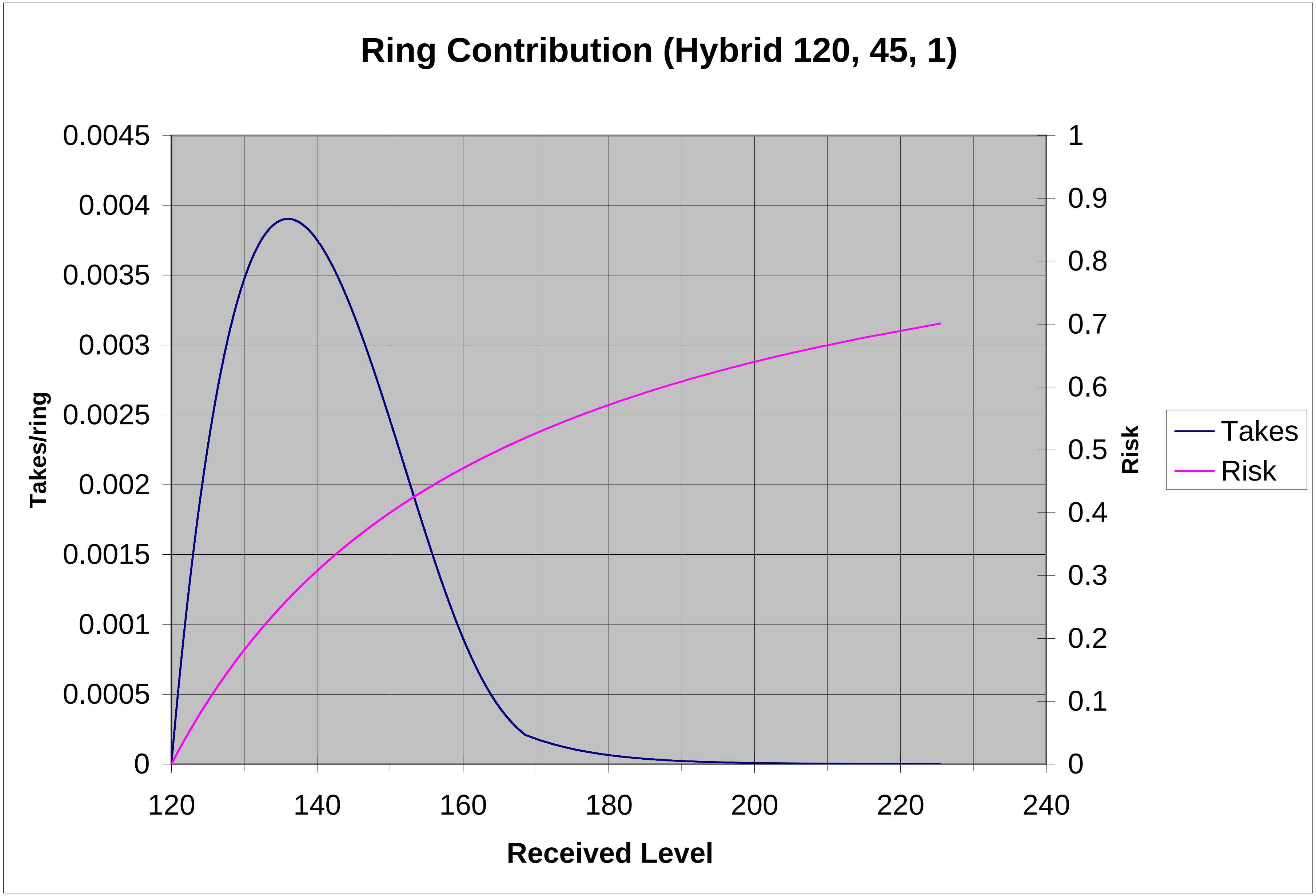
Received Level
Takes
Risk

Ring Contribution (Hybrid 120, 45, 1)
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0
Risk
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0.9
0.8
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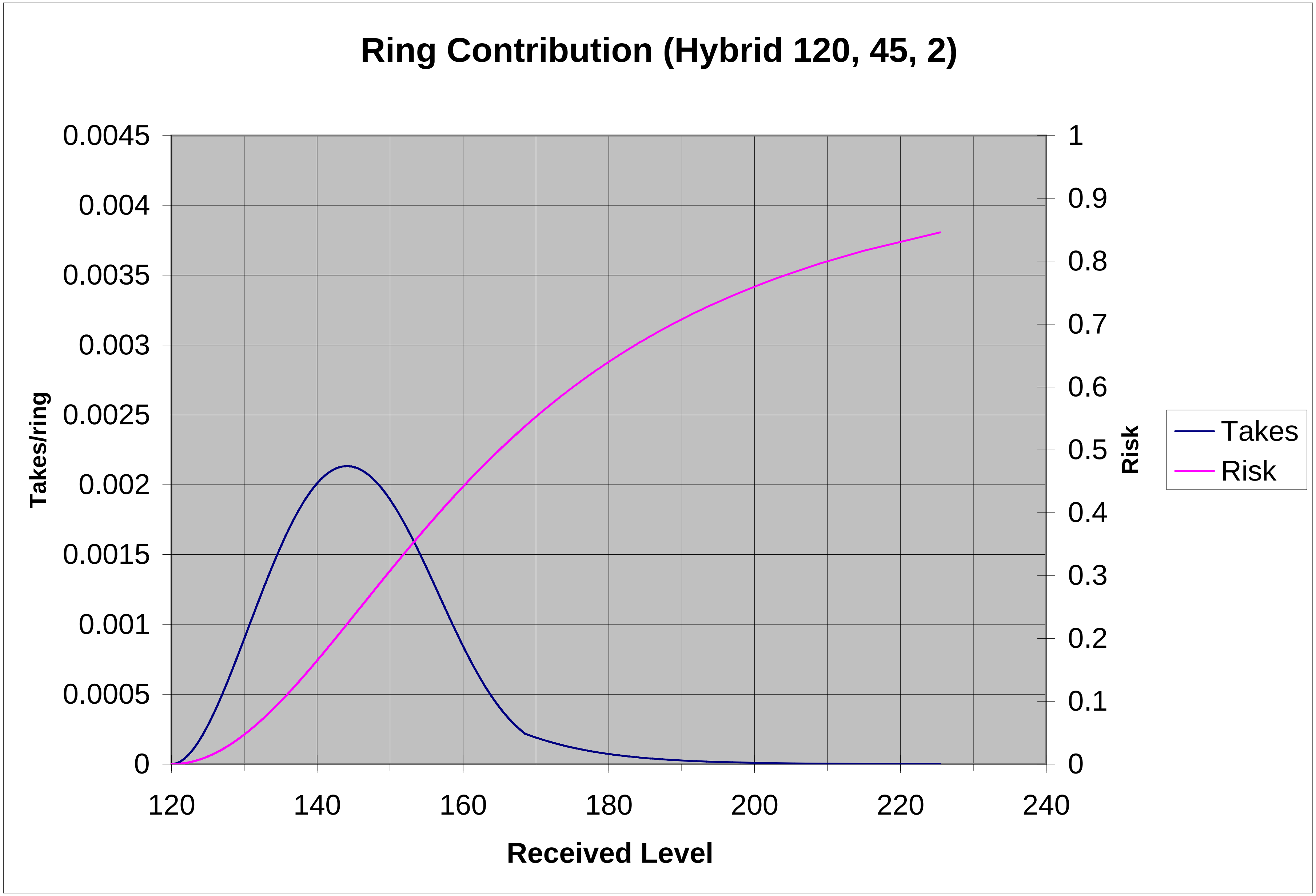
Received Level
Takes
Risk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0.0005
0
Risk
1
0.9
0.8
0.7
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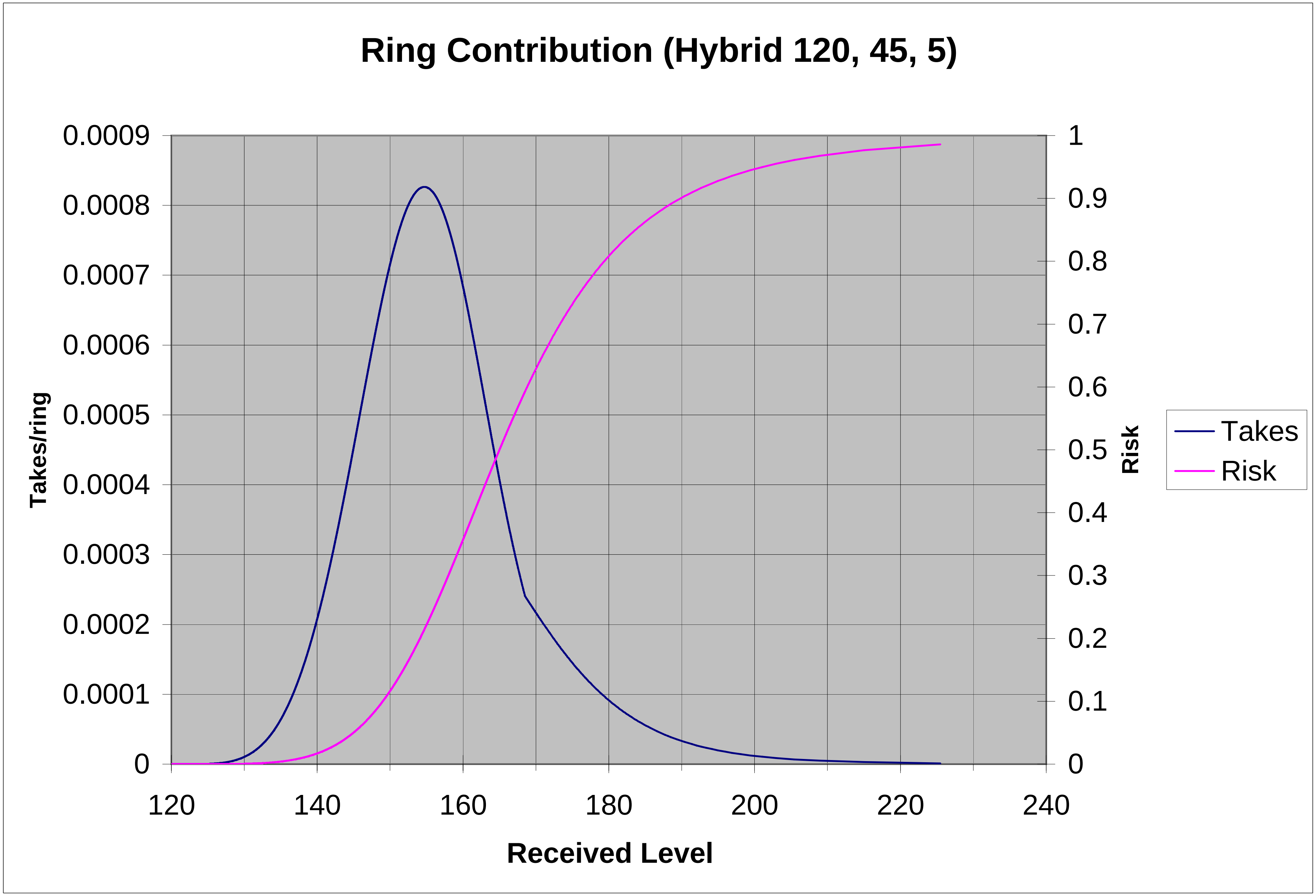
220
240
Received Level
Takes
Risk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0.0005
0.0004
0.0003
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0.0001
0
Risk
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0.8
0.7
0.6
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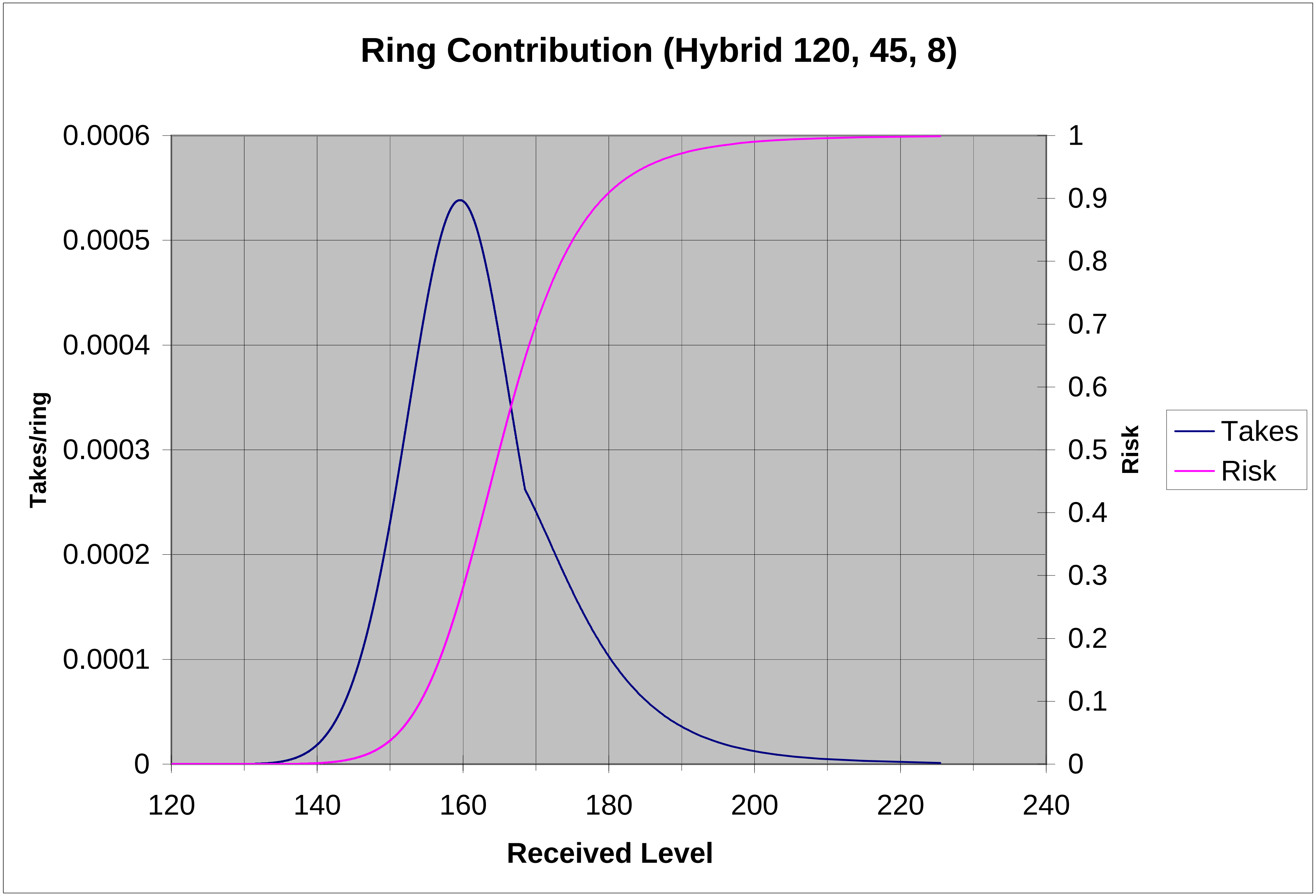
Received Level
Takes
Risk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Risk
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0.8
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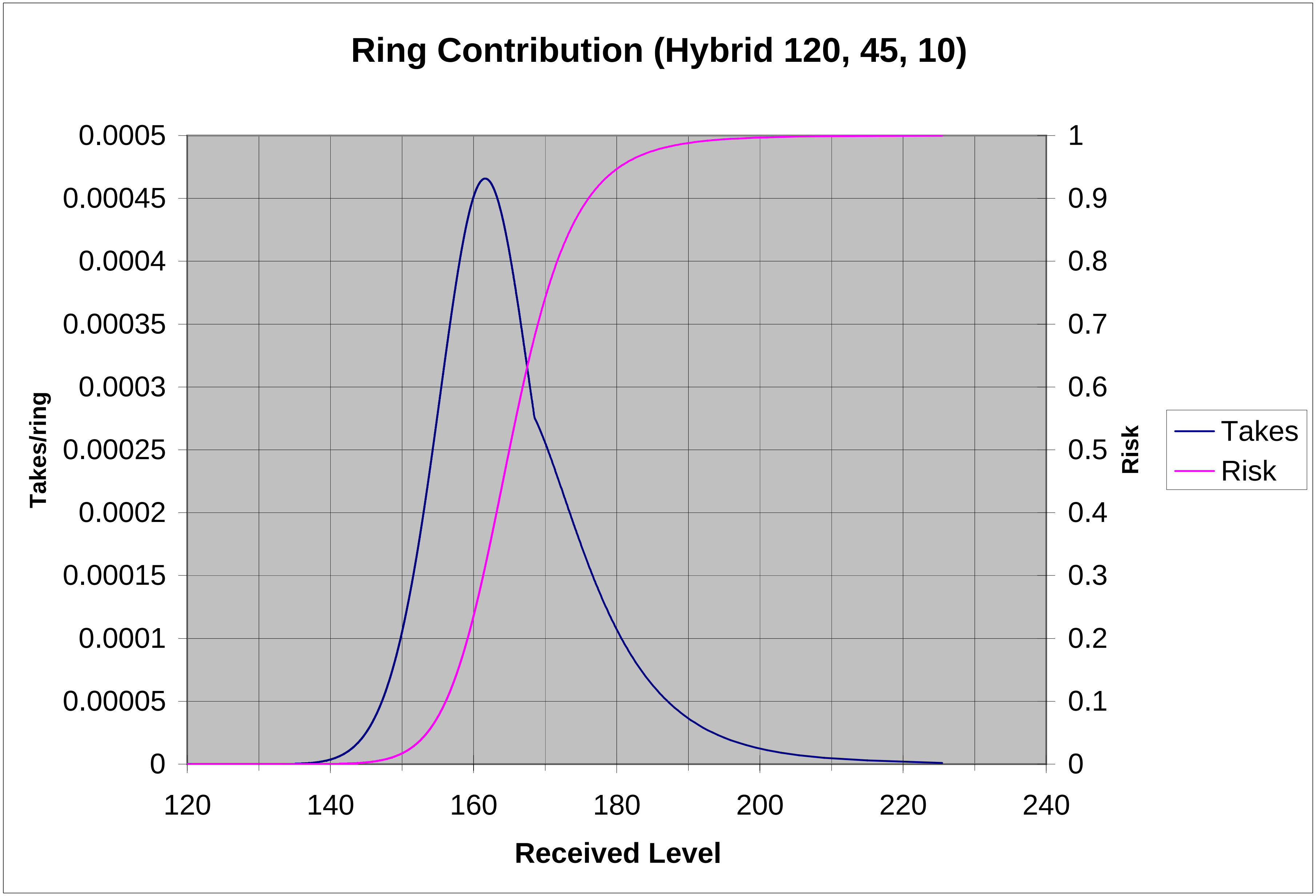
Received Level
Takes
Risk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0.00035
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0.00025
0.0002
0.00015
0.0001
0.00005
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Risk
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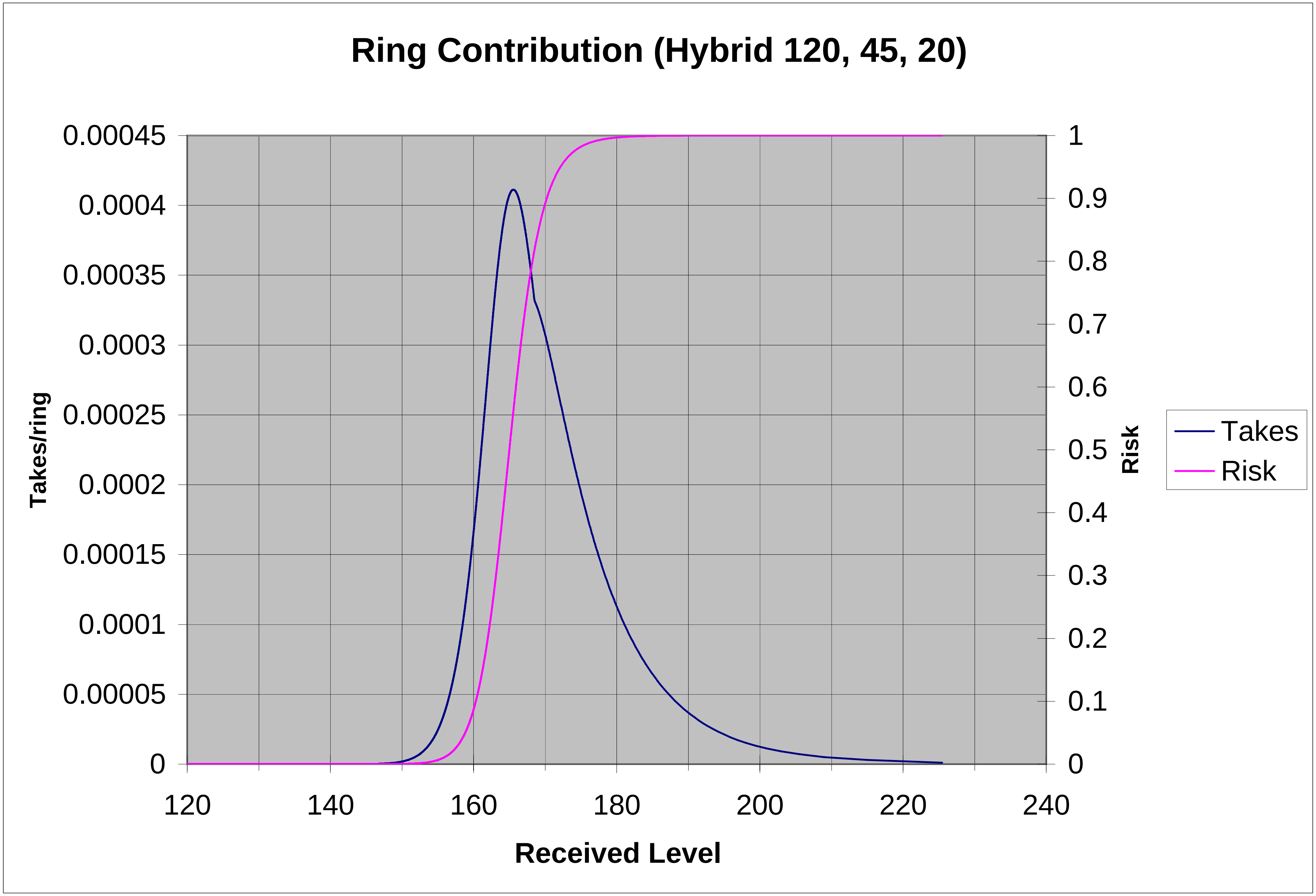
Takes
Risk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0.0002
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0.0001
0.00005
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Received Level
Risk
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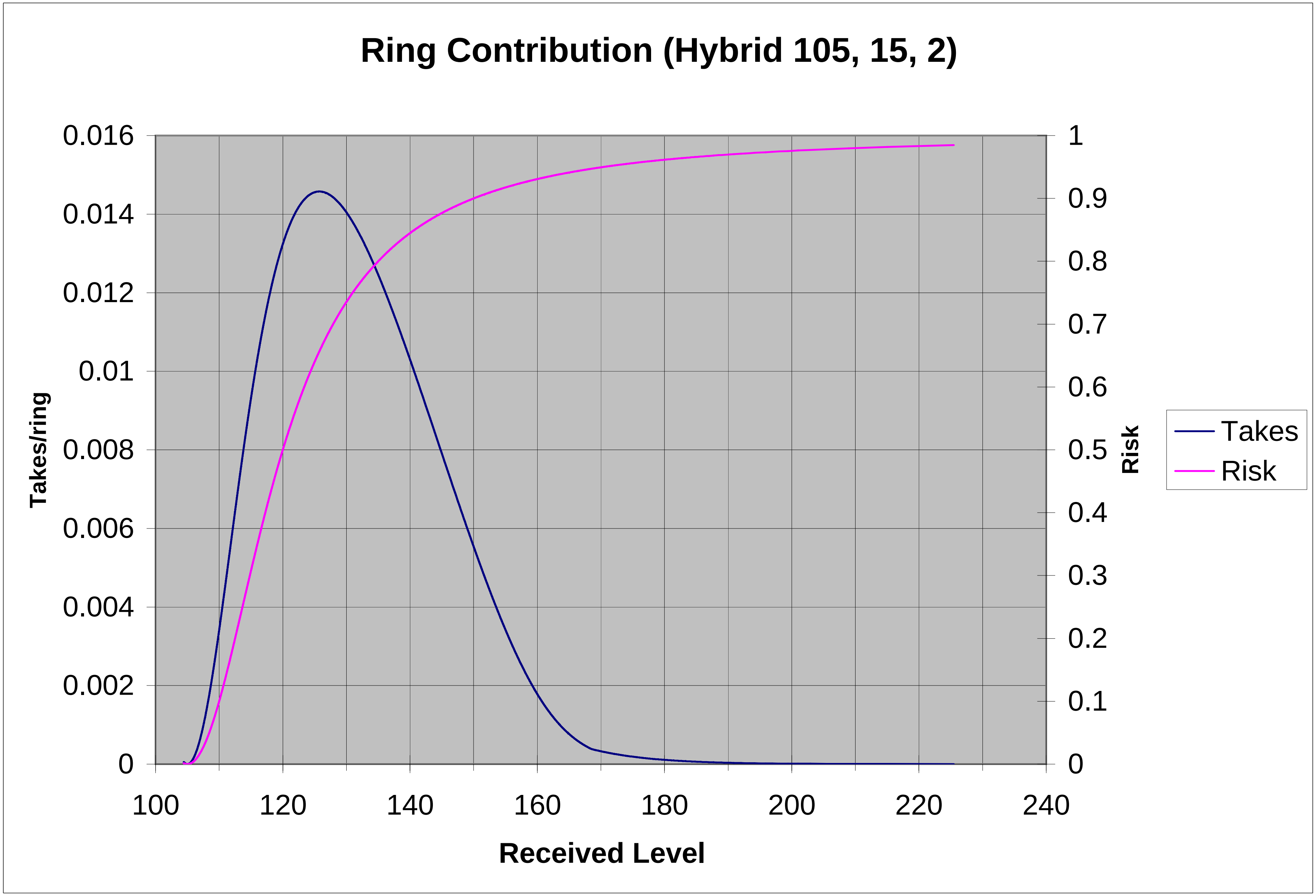
Takes
Risk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0.006
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0.002
0
Risk
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0.8
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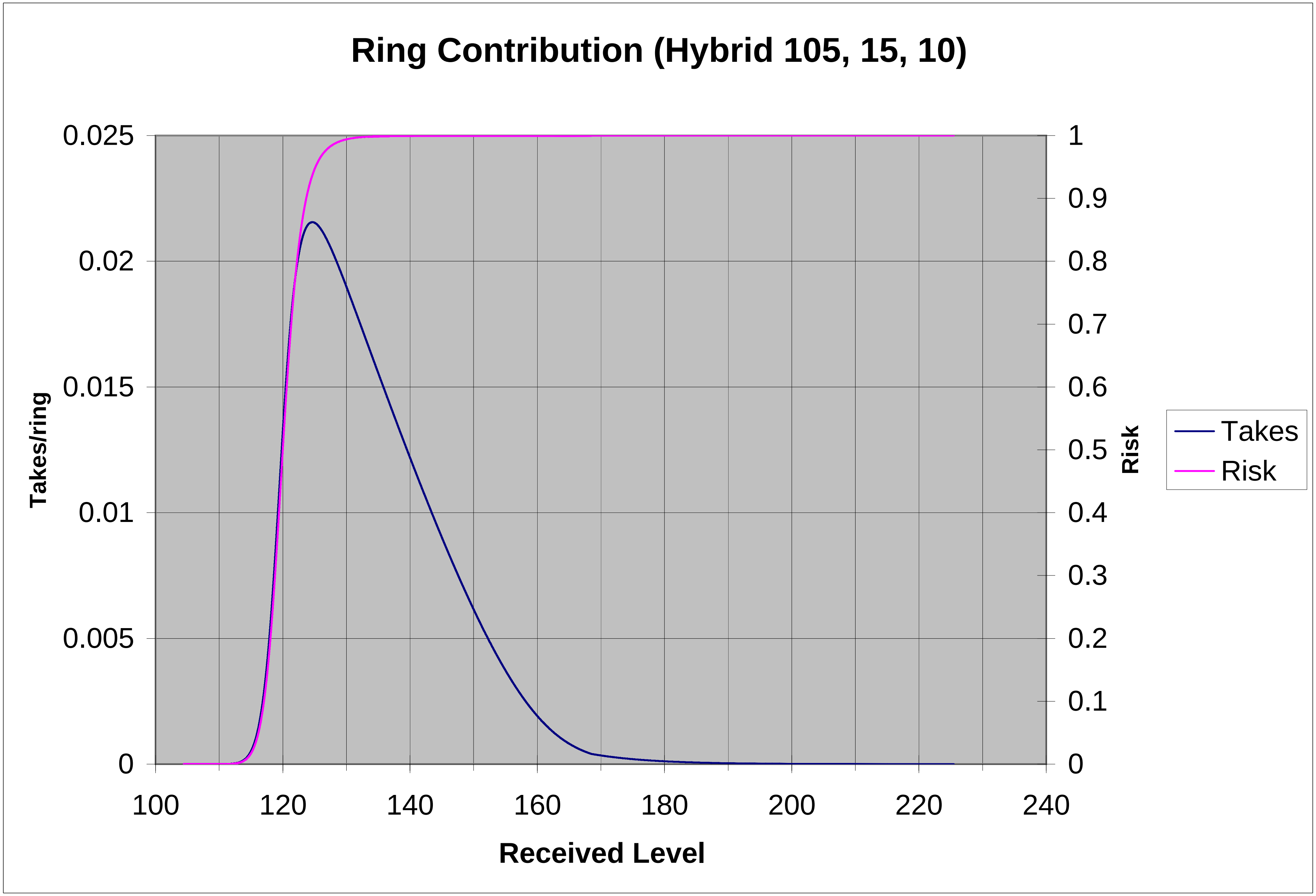
Received Level
Takes
Risk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Takes
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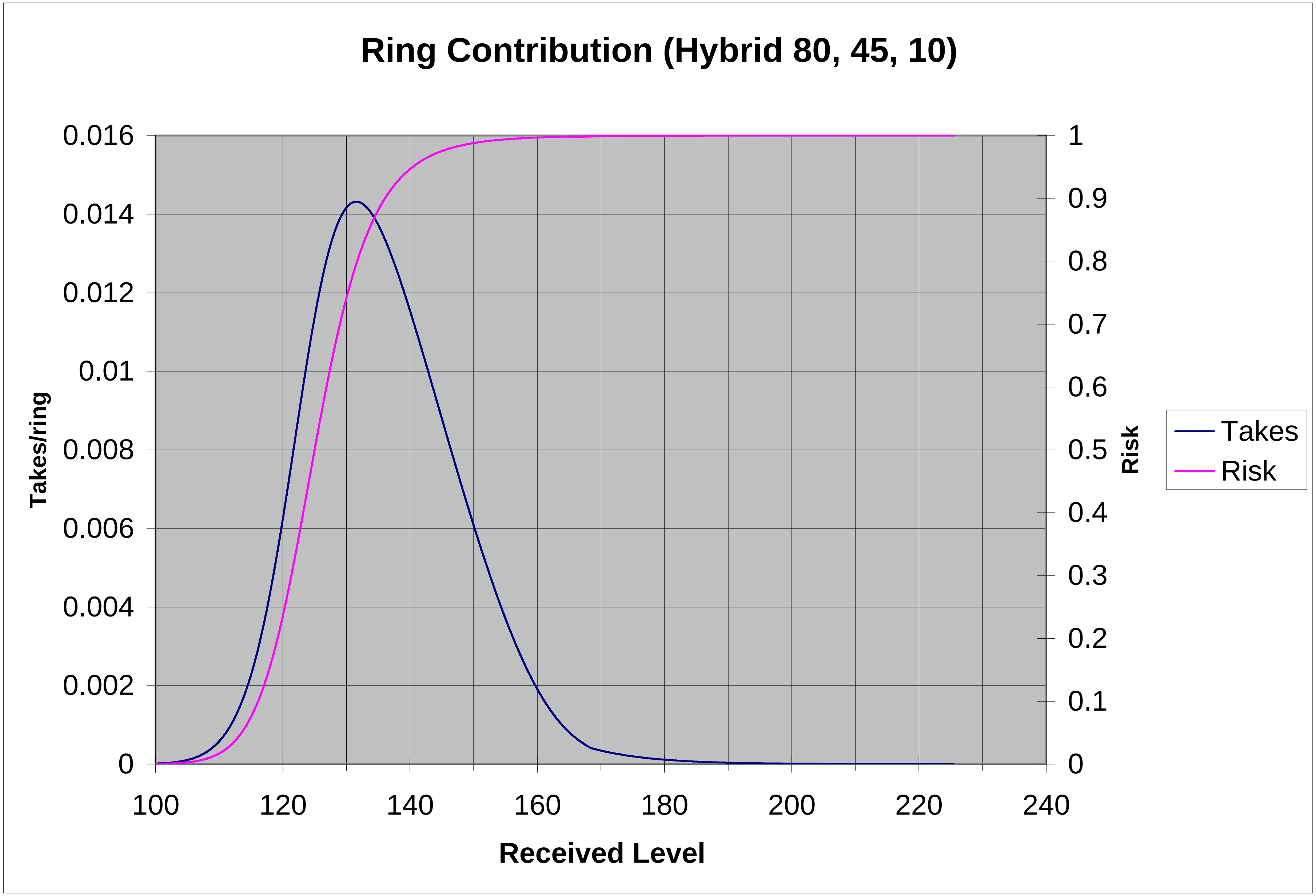
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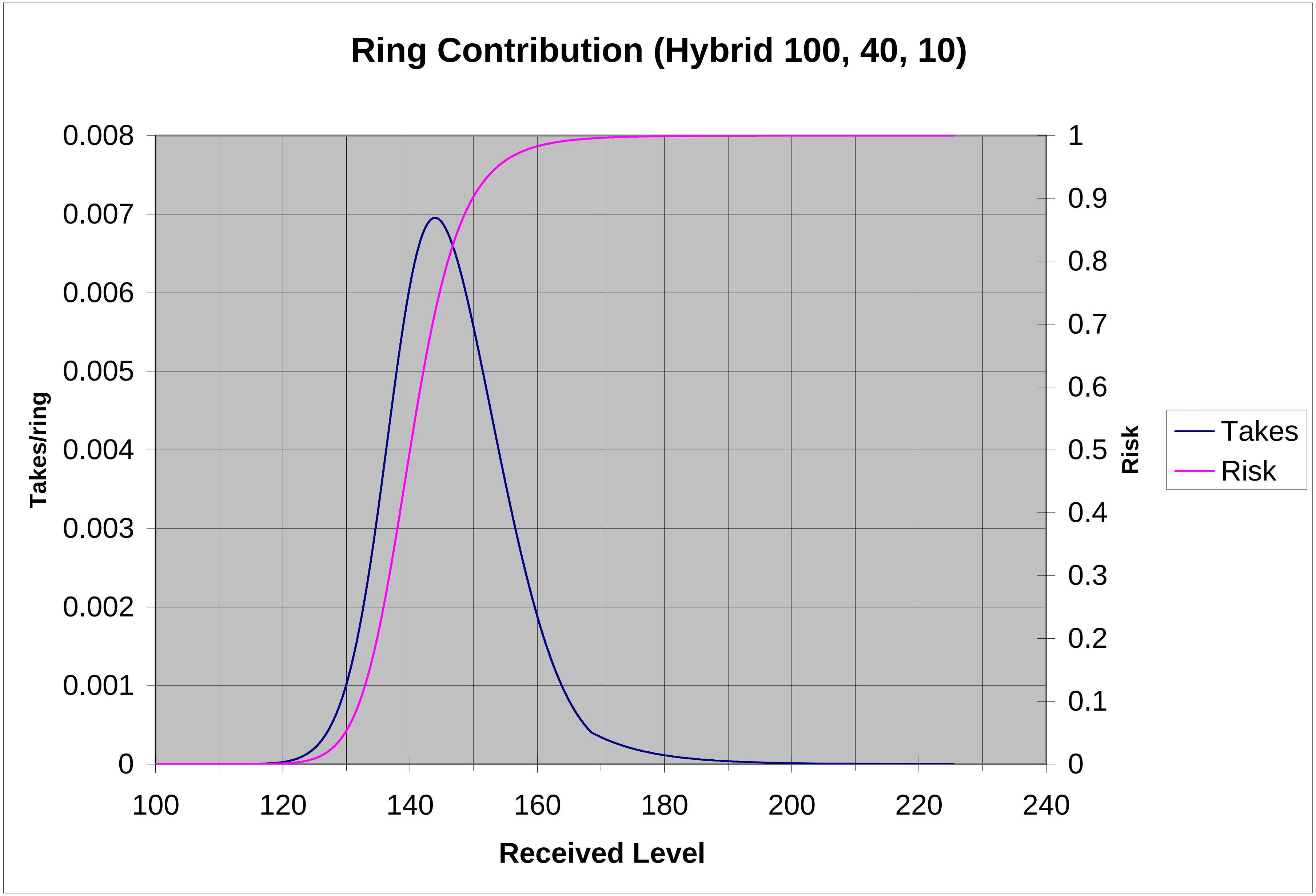
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Risk
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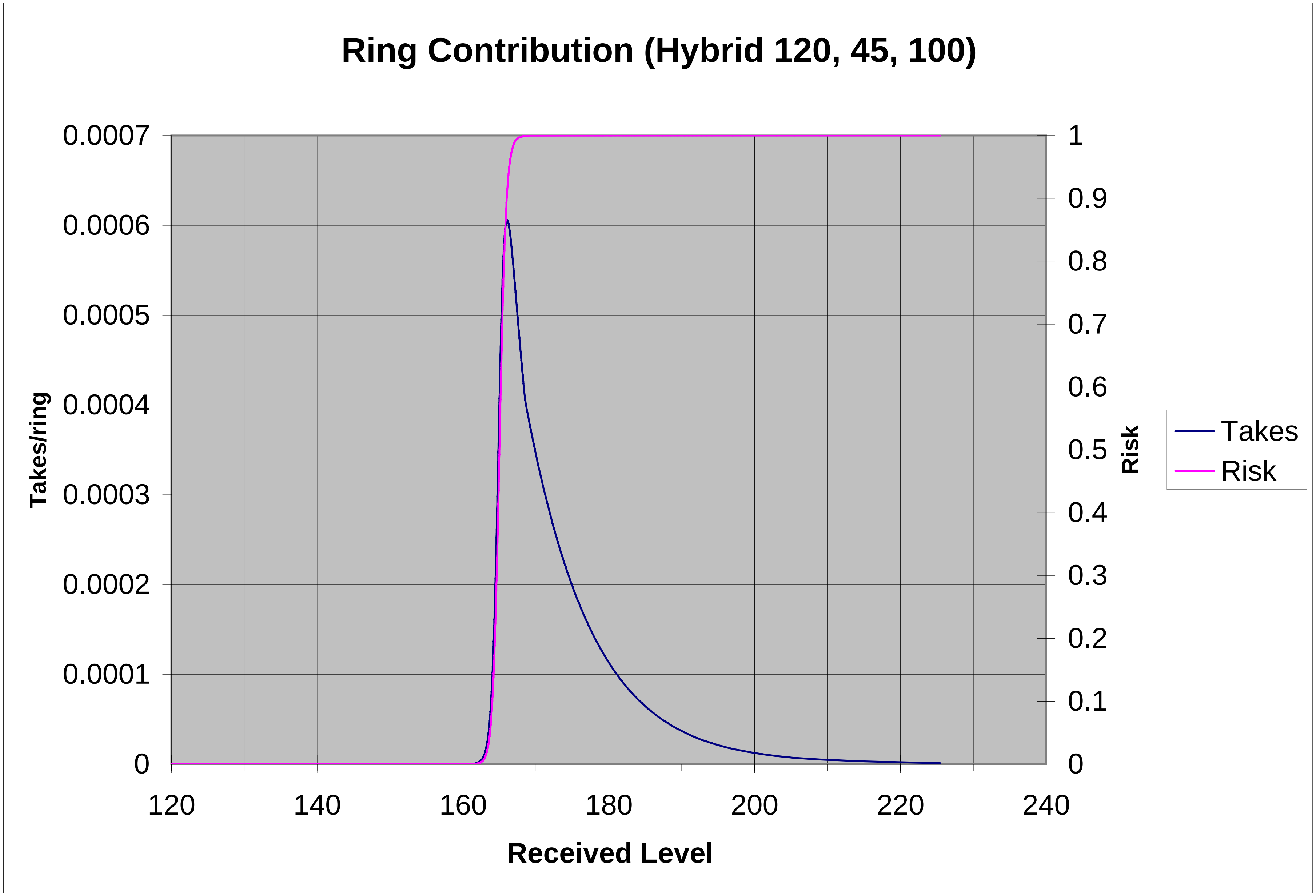
Takes
Risk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Risk
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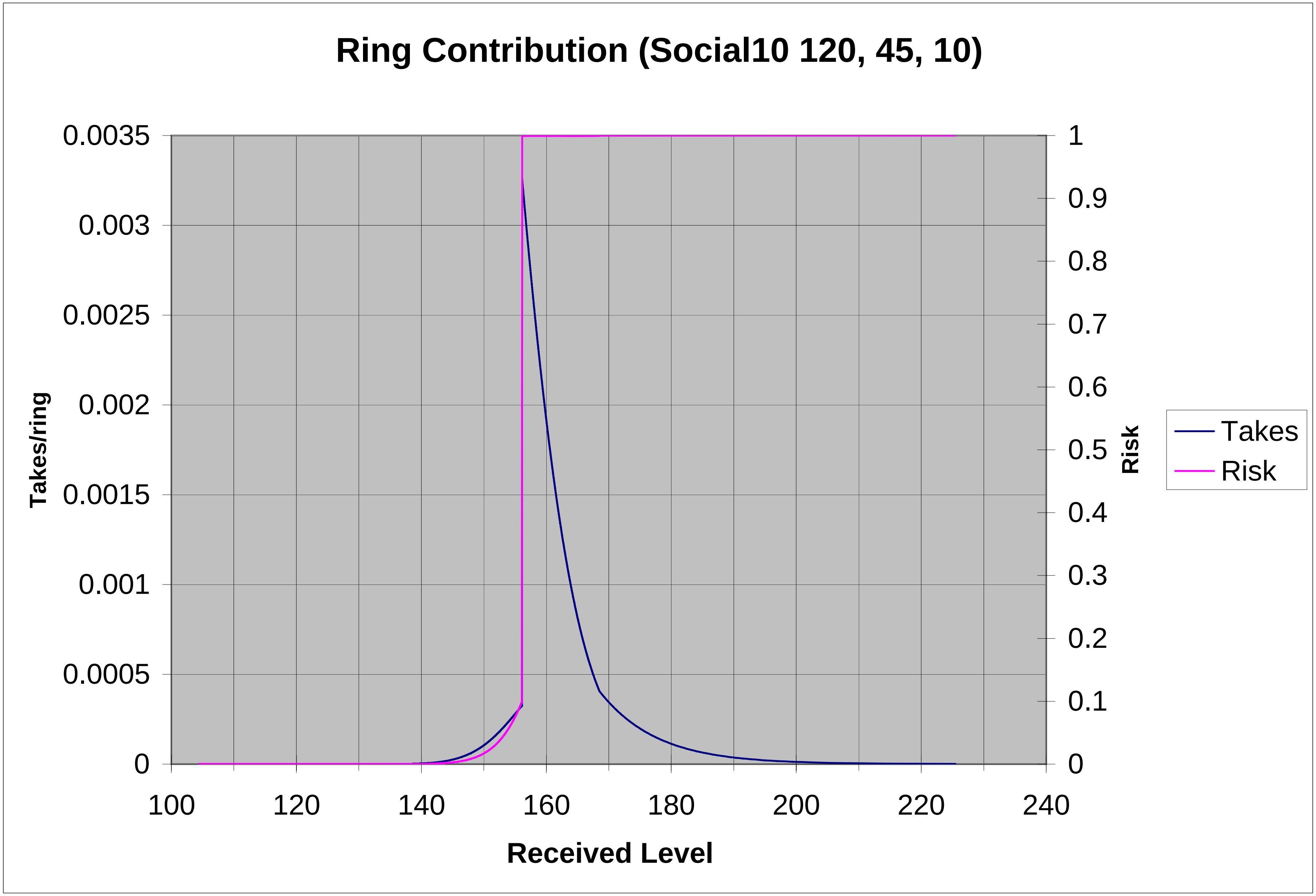
Risk



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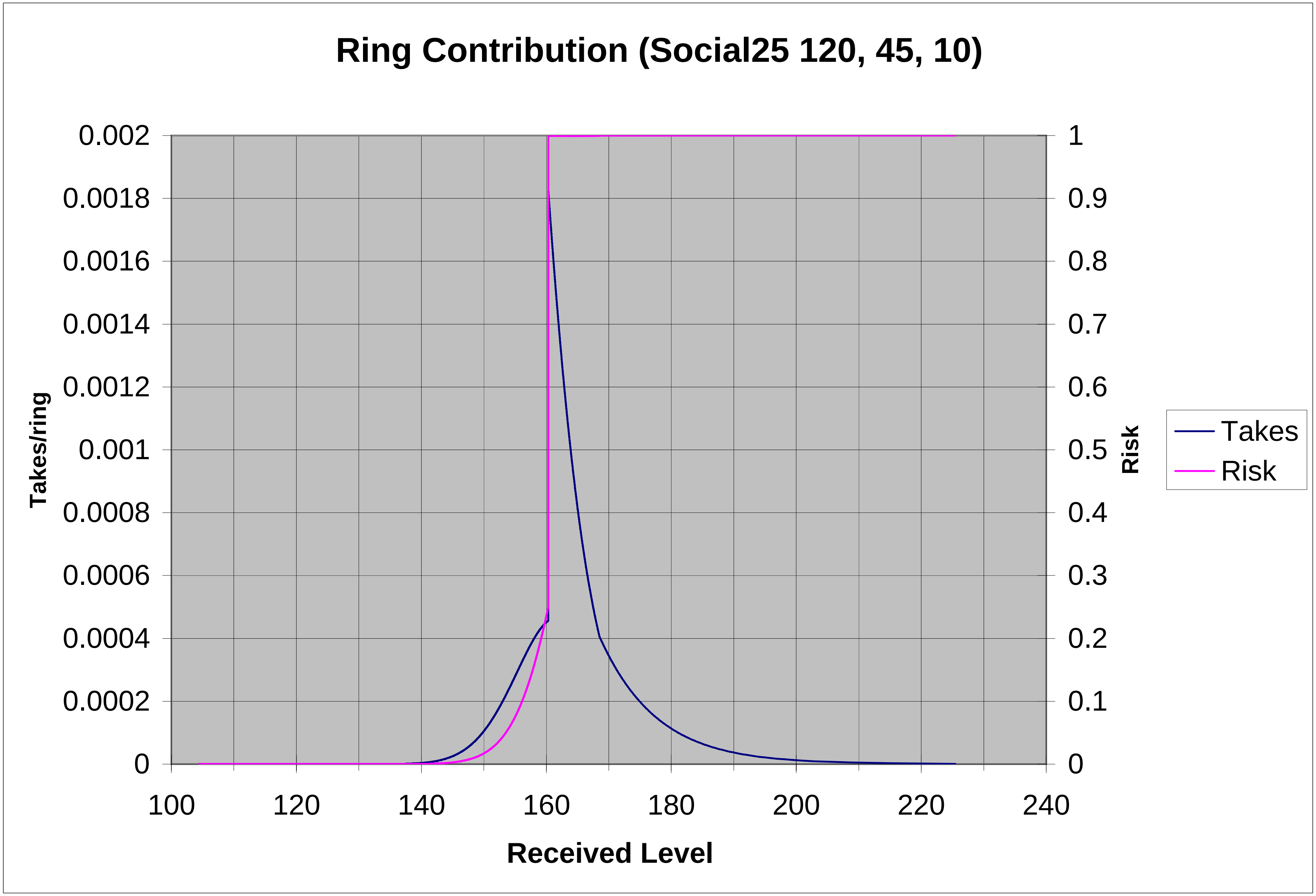
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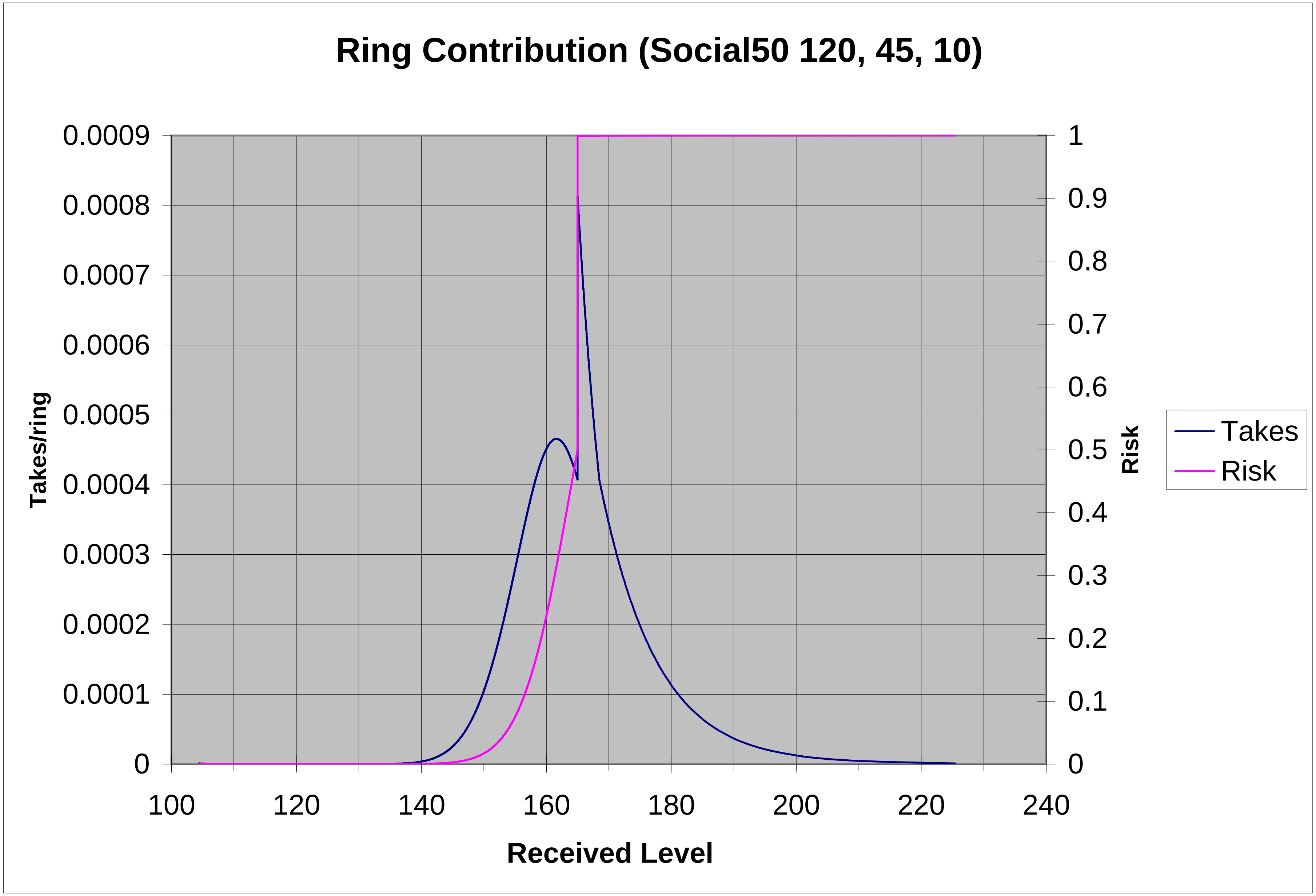
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Risk
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Received Level
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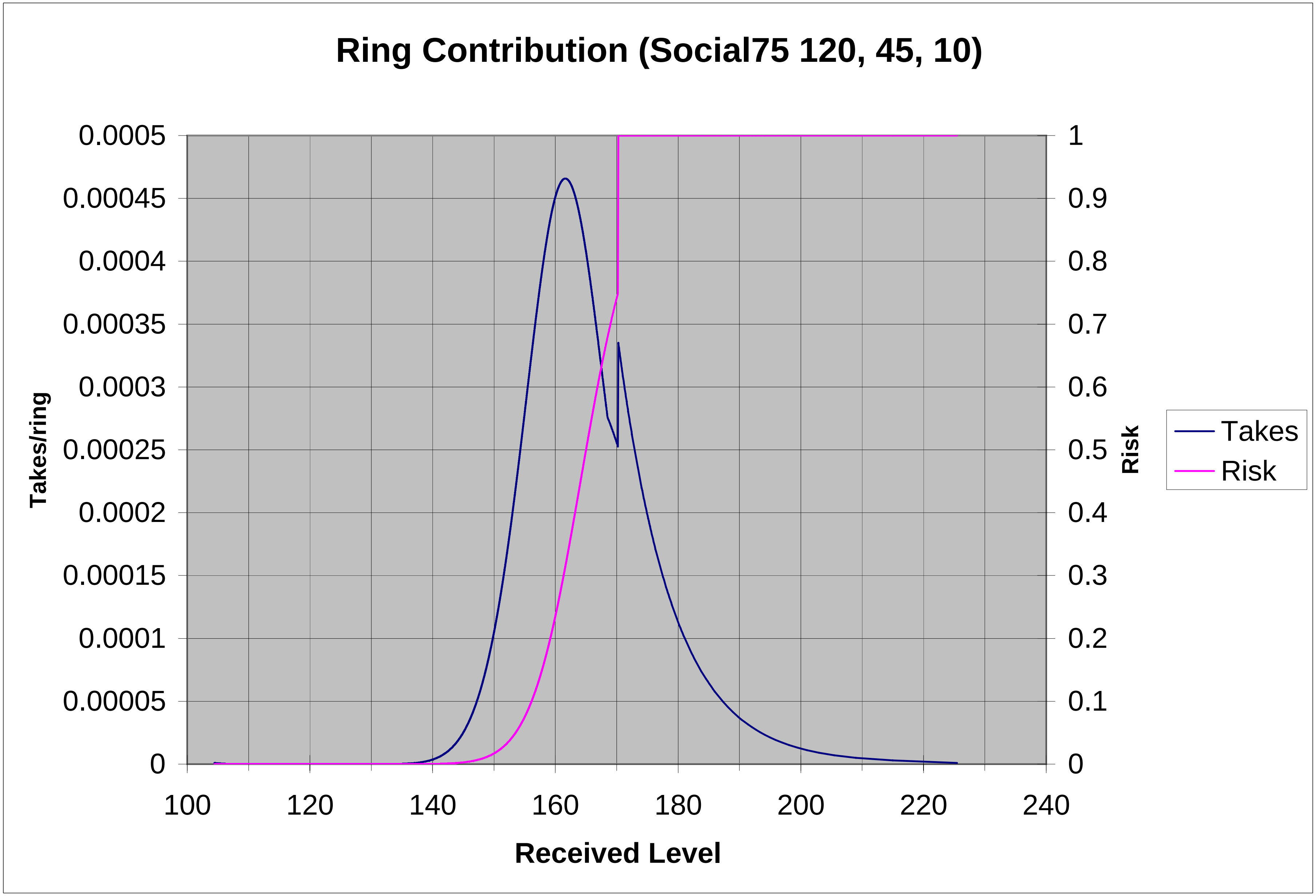
Risk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