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Case Study II – Mid-1942 to Mid-1943

By the middle of 1943 – in fact by the end of May – an important point had been reached in the Battle of the Atlantic. This period saw the end of the large-scale convoy battles which had characterised much of the previous year and although Dönitz at the time saw his withdrawal from such tactics as a temporary state of affairs while he regrouped and re-equipped his battered submarine fleet, U-boats were never again to attain the same degree of actual as opposed to potential threat as they had during several prolonged periods in the last four years of war. But this was a judgement which could only be made with the benefit of hindsight enjoyed by historians and, to a lesser extent, operational analysts. The Allied path in the Atlantic from mid-1943 onwards for the remaining years of war was still to be a tough one and sometimes even hard-fought. 1943 thus has a Janus-like quality and two stories about it come together in the middle of the year. The first concerns the causation of the climax reached in May; the what, how and why of that remarkable outcome, and in this the role of Ultra forms a part of the account and analysis. The second deals with what happened next – not until the end of the war, but for the next few months, and in this too Ultra deserves evaluation and attention.

The hard road from July 1942 to May 1943

The phase of the Battle of the Atlantic that started in July 1942 was one of the hardest for both sides in the conflict. It is characterised by large concentrations of submarines, mid-Atlantic battles against convoys and increasing intensity of conflict. More coldly, certain long-term trends began to work in Allied favour and, despite the wildly fluctuating fortunes of the previous three months, the May 1943 outcome is

perhaps better understood in terms of the longer picture rather than the shorter. The period that preceded this one saw U-boats running riot off the east coast of Canada and the United States largely because of the failure or inability of authorities there to institute an effective convoy system.[1] This combination of lack of escorts and dispersion of merchant vessels assured a plethora of targets for the submarines which had made the long passage from the Biscay bases. So much so, in fact, that submarines enjoyed one of their best periods in the whole war with both total sinkings and productivity at very high levels indeed. It thus led to the revival of their phrase *glückliche Zeit* to describe this period.[2] Although there were some at the time and more afterwards who criticised the Americans for being tardy in setting up a convoy system, a series of these were instituted and gradually extended. But as they spread in the western hemisphere, they were often anticipated at worst and reacted to at best by Dönitz moving his submarines further south and west. Thus the field of submarine operations moved slowly from the US east coast into the Gulf of Mexico and then the Caribbean. There weakly protected convoys or, more commonly, ships sailing independently, were easily picked off. It was only the ever-lengthening passage distances and times that limited the productivity of the U-boats. By the middle of the year it was obvious that Dönitz would either have to deploy his boats even further afield or else change his strategy entirely.

The latter was the course adopted and in July the first operation that year which employed more than 10 submarines was mounted against a convoy; ON113A was the object of attention and in the course of a four-day operation during 23–27 July it suffered the loss of two ships of some 12 000 tons, although one submarine was lost. July, too, was the last month for a year in which the sinking figures in the Atlantic were to be dominated by independents, not convoys. From then onwards the pace was to rise by spasms with more anti-convoy operations, more submarines tending to be allocated to each one and operations lasting for longer periods of time. Although some of these were to be undertaken against convoys in and going to or from the Caribbean, together with a few attacks against convoys to and particularly from West Africa, the bulk of the effort was to be deployed against the main cross-Atlantic traffic, that is, the convoys of the ON and ONS series westbound, and the HX and SC ones in the opposite direction. It is with this crucial traffic and these routes that the following narrative and analysis will be principally concerned.

At the operational level, this meant that Dönitz was forced to choose the most vital route, but also the one most likely to be defended well with sea and air bases which could contribute to the defence of convoys. For him, this was a policy of some risk but also the one that gave him, and thus German strategy more generally, the greatest chance of success. Should he not prevail, then the initiative for the Battle of the Atlantic would pass to the Allies almost completely.

The initial portents were good for the Germans as the year moved on. August was to see merchant-ship sinkings rising again over 500 000 tons, with the best result being at the beginning of the month against SC94 when losses were incurred of 12 ships of 53 000 tons sunk for a loss of two submarines. September saw a marked drop in number of convoy engagements attempted, from 11 to six, but a tendency for these to be on a larger scale. Typically here, packs were of 15 boats rather than the seven of the previous month and although one operation failed to make contact, that against SC99, no submarines were lost during any of these operations and results were obtained, albeit on the low side of Dönitz's expectations, averaging some 18 000 tons per operation. This, too, was one of the few months of the period in which losses of independents exceeded those of convoyed ships.

October saw the scale of the average anti-convoy operation moderating but with an increase in the number of operations attempted. Only one of these failed to make contact and the net result of these was an average loss per convoy of six hulls of 35 000 tons, nearly twice as bad as in the preceding month. All but one of these were against mainstream cross-Atlantic traffic, the exception being the Africa–UK SL125 which, despite a relatively small effort of 34 boat-days, nevertheless had the second-highest results of the month, with 12 ships of 80 000 tons being sunk over five days for no submarine loss. At the other end of the scale from both points of view was the attack on the westbound ON137, which occupied 25 boats for four days, the largest operation of this phase so far, but this was thwarted by poor coordination and bad weather, which denied continuous contact on the convoy.[3] As a result, only two convoy ships of 10 000 tons were lost as was one U-boat, a very poor return indeed for such a large expenditure of effort.

November presents a statistical paradox. On a strict calendar-month reckoning this is a better month for the Germans than October, resulting in the loss of over 530 000 tons compared with less than 430 000 tons and over 20 more ships. However, the two most significant operations in terms of loss were those against SL125 (mentioned in the previous paragraph) and that against SC107 both of which started in the

last days of October and continued into November. The latter started on 30 October and did not complete until 6 November. Such apparent statistical anomalies are bound to arise when analyses using two different time and function-basing systems are followed.[4] In order to understand the progress of the tonnage war, calendar-month statistics are not only invaluable to the analyst but also have the happy property of being one of the criteria used by Dönitz himself in assessing his progress towards his own tonnage Valhalla. On the other hand, the only sensible way of calculating both German and Allied success in convoy operations is to look at the figures pertaining to individual operations from both sides. Perhaps the greater problem in November for the Germans, however, lay in a failure of strategic intelligence, and thus of strategy. Only two days after the conclusion of the SC107 action, the Allies landed significant military forces in northwest Africa – Operation Torch. These landings were carried out simultaneously on both Mediterranean and Atlantic coasts. Mediterranean U-boats were deployed in an attempt to intercept possible landings there but made little or no impact on operations. Such submarines were in any case irrelevant to the Atlantic struggle. They crossed that particular Rubicon by the very act of entering the Mediterranean, a process which had started as early as September 1941 against Dönitz's strenuous objections.[5] The Germans had also assessed that any Atlantic-coast landing was unlikely and, in any case, the invasion convoys passed on their business virtually unscathed. However, as soon as it was appreciated that the operation had in fact been carried out, all available submarines were rushed to areas off the African coast. As a result the cross-Atlantic convoys enjoyed relatively little attention for the rest of the month. Only two operations were mounted, starting in November, both against westbound convoys, and eastbound ones went untouched. Nor did these two do well. ONS144 lost five ships of 25 000 tons and the earlier ON143 had only one sinking; one submarine was sunk.

If November had contained components of failure for Dönitz, it at least had the compensation that, taking the whole calendar month, the sinking-figures were good. December was able to offer no such consolation. Operations were again carried out against convoys in each direction but a phenomenon not seen regularly since the failures of mid-1941 returned to haunt German submarines: an inability to make contact with convoys, and this was quite a strong theme during the month with several failed operations. Even when contact was achieved, success was scanty, despite significant commitment of submarine effort. No convoy operation reached 15 000, far less 20 000 tons sunk and it

was a dismal month. One slight compensation was the relatively rare sinking of an escort, HMS *Firedrake*, the Senior Officer Escort of ON153.[6] The Atlantic tonnage count also came down to under 300 000 tons. The reason for these failures will be explored later in this chapter but one feature of the month worth noting was very poor weather, with heavy storms, to be repeated later in that winter.

January 1943 was no vintage month for the Germans either, with very few operations attempted, partly reflecting a cyclical fall in submarines available. It is perhaps worth taking a rare excursion outside the mid-Atlantic area to find the month's highlight when the Brazil-bound *Delphin* group made a chance encounter with the all-tanker convoy TM1 *en route* from Trinidad to the Mediterranean. A poor escort in bad material repair was no match for the U-boat group and the convoy suffered seven losses from nine, the highest proportional loss of any in the whole war. This indicated the Allied difficulty of trying to maintain significant strength on a worldwide basis. More generally, the month saw less than 200 000 tons of shipping despatched.

February, however, was a completely different story with a rise in operational tempo, but more importantly, from the German point of view, a considerable improvement in results. Not only was the overall tonnage figure restored to nearly 300 000 tons, despite the month being shorter than its predecessor, but there were some good individual convoy actions too. Particularly good results were obtained against SC118 in the first third of the month but even better ones ensued from the last-third onslaught on ON166 with losses of 60 000 and 88 000 tons respectively. It was also important to note that Dönitz was obtaining these results largely against convoys, not independents: no less than 82 per cent of these losses by tonnage were from convoys.[7] Such figures began to indicate that even the measure considered to be the Allied best defence against submarines might be failing. Further, the sheer numbers of submarines deployed in the Atlantic suggested that the days were over when Ultra-informed evasion might by itself permit effective avoidance of U-boat lines and thus the safe passage of all, or at least most, convoys. The Battle was, according to much conventional historiography, about to reach its climax.

Whatever else March might be it was a month of superlatives: the largest-ever pack-operation, with 42 boats involved and two others using more than 20.[8] Casualties to merchant vessels were on a similar scale, four actions producing over 20 000 tons of loss each and the further case of the largest operation reaching the huge figure of 22 ships of 141 000 tons. On such a basis, Dönitz would appear to have been

approaching all that he wanted; high tonnages sunk and minimal submarine losses. But all was not quite so rosy. Firstly, despite the undoubted successes, there were failures too. Two operations, albeit with slight forces, failed to make any contact at all. Secondly, those operations which fell between failure and high success did not achieve very much at all. Principal among these must be HX230 which received the attention of up to 28 submarines over four days and lost only one ship – an Allied triumph not attained because of fate's compensation for what had gone before but as a reflection of hard work and some other factors discussed later in this chapter. The final judgement on this seesaw month must lie in the cold columns of the tonnage figures. A total of less than 510 000 tons – which includes independents – was good but not nearly good enough for the Germans. Since American entry into the war, barely 16 months earlier, this monthly figure had been exceeded on no less than four occasions; however, it was destined never to be reached again.

Despite these qualifications about German performance in March, it was still a good month. April was not. A similar number of operations was undertaken in April as in the preceding month but these were on a much smaller scale. The largest, against HX233, was only of 18 submarines and most were of less than 10. The HX233 operation was the most successful, netting six ships of 41 000 tons and losing two submarines, but no others reached 20 000 tons. Three of the nine operations failed completely; six submarines were lost on anti-convoy operations. The overall total sunk was under 270 000 tons and the proportion in convoy was only 60 per cent. Although not yet at the point of decision, the German offensive was failing and the Allied case improving.

This became even more marked in May. The Germans tried to carry out a similar number of operations as in the preceding months but returning to the large-scale as in March. Of the 10 operations attempted in the first 23 days of May, all but three involved a double-figure number of submarines; two exceeded 20 U-boats, two more were in the low 30s and one used 41. On this scale and with the relatively recent memory of March, Dönitz expected much: this was not to be. Firstly, half these operations failed to achieve anything at all. This did not appear to be a function of size of operation. Both 30-size packs fell into this category. Of the remainder, only three sank more than one ship and two reached sinkings in excess of 10 000 tons. Admittedly there was one 'success', the action against ONS5. That convoy, which had received relatively minor attention at the end of April, again was

under pressure during 4–7 May. The 41 submarines pitted against it did succeed in sinking 12 ships of 56 000 tons. This, by itself, would not have been a bad outcome for Dönitz, but it was accompanied by the loss of six submarines, quite the worst outcome of any convoy battle of this period. This was disappointing to the German leadership but not sufficient to convince them to rethink fundamental methods. The subsequent operations – high on commitment of submarine-days and low on achievement – went from bad to worse with growing losses of submarines. The two last blows were the operations against SC130 which suffered no convoy losses but inflicted three on submarines during 17–19 May, and the similarly fruitless pursuit of HX239, involving 32 submarines which similarly gained nothing but lost two boats on 22–3 May. Dönitz had had enough. Submarines were ordered to the area southwest of the Azores to attack US–Gibraltar convoys, while those with insufficient fuel for this activity were left at sea in an attempt to deceive the Allies about the abandonment of the main routes. On 24 May Dönitz noted in his War Diary:

> The decision [to withdraw from the main routes] denotes a temporary abandonment of the fundamental principles which have so far governed the U-boat campaign. The change of policy is dictated by the need to avoid unnecessary losses in a period when our weapons are shown to be at a disadvantage. It must be realised, however, that as soon as our boats have been equipped with new weapons, the battle in the North Atlantic – the decisive area – will be resumed.[9]

Thus ended what was probably the most intense, hardest-fought and probably most evenly balanced prolonged period of the Battle of the Atlantic. The description of it above is very brief but much more can be said about the 'what' and the 'when' of the events of the Battle of the Atlantic. This can range from works dealing with the naval war as a whole, through the entire Battle of the Atlantic via this particular period to convoy monographs.[10] Accounting for these results is less easy to do, or at least to do so rigorously. There is no shortage of monocausal explanations, ranging from Ultra to the provision of a very few long-range aircraft, through the emphasis given to the antisubmarine war by the Allied high command to specific weapons and sensors. But perhaps, armed with the tools forged from the discussions of the previous chapters, it may be possible to go further along the road of explanation than hitherto.

In this context the key question is 'how', leading on to 'why'. This can best be attempted by looking again at the period for trends, if any, and then considering the causes for these phenomena, all the time bearing in mind the considerations already brought out earlier in the book.

Analysis of July 1942–May 1943

The Allied drivers at the grand strategic level in this period were the stemming then reversal of German advances in Russia – the first contemplated at the outset of this period but not happening until about half-way through it, and the second being set in motion some two months after the end of it; the continuing problems of war in other theatres; and the debate over when and where to re-invade Europe. But although these problems were somewhat abstract for the Allied redoubt in Europe – the United Kingdom – whose priority was survival, this did not mean that they were irrelevant to those islands. Whatever form the European re-entry took, with the possible exception of a most unlikely option making use of basing in the eastern Mediterranean, the British islands were necessary as a springboard, as a supply base and above all as a terminal point for all the facilities implied. Translated from grand strategic conception to military-strategic reality, all the vast material resources for the invasion of Europe had to make their way to Britain by one means or another. On top of this, Britain's basic requirements also generated a considerable requirement for cargo deliveries. This has been discussed in detail above.[11] Convoy was the agreed and accepted method of affording the greatest protection to these supplies and although most histories tend to accentuate those in which incidents occurred, it is worth remembering that even at its most intense, a large number of convoys saw no trace of a submarine.

The historiographical point is well summed up by Marc Milner's phrase 'Happy is the convoy that has no history', to which might be added the coda 'but it is also historically nearly invisible'. More specifically and numerately it is useful to look at an analysis conducted by W. A. B. Douglas and Jürgen Rohwer.[12] In this, among other things, they show, broken down by broad time-blocks, two pieces of data of great interest. The first is labelled 'percentage of convoys intercepted and reported by U-boats'. To use the classification adopted earlier in this book, this clearly takes the submarines beyond the Reconnaissance phase and into Closure.[13]

What is interesting are the three figures adopted by Douglas and Rohwer for the period looked at here – 34, 20 and 54 per cent with the

Table 9.1 Convoy losses by type (those with losses shown in **bold**)

Eastbound	HX	**209** 210 211 **212** 213 214 215 216 **217 218** 219 220 221 222 **223 224** 225 226 **227 228 229 230 231 232 233 234** 235 236 **237** 238 **239**
	SC	**94 95** 96 **97** 98 **99 100** 101 102 103 **104** 105 106 **107** 108 109 110 111 112 113 114 115 116 117 **118** 119 120 **121 122** 123 124 125 126 127 **128 129 130**
Westbound	ON	**113** 114 **115** 116 117 118 119 120 121 122 123 124 125 126 127 128 **129** 130 **131** 132 133 134 135 **136 137** 138 **139** 140 141 142 **143 144** 145 146 147 148 149 150 151 **152 153** 154 155 156 157 158 159 160 161 162 163 164 **165 166 167 168** 169 170 171 172 173 174 175 **176**
	ONS	New Series **1 2 3 4 5 6 7**

lower middle figure applying to January 1943 only. But what this also means is that 66, 80 and 46 per cent of convoys for the same periods had no contact with German submarines.

Another way of expressing this is to look at the mainstream cross-Atlantic convoys during the period, that is the HX and SC convoys eastbound, and ON and ONS convoys in the opposite direction.[14] In Table 9.1 the first sequential mention of a convoy is initiated by one of that type being brought under attack and the last follows a similar criteria. Convoys attacked are shown in bold type.

Douglas and Rohwer make a similar point by showing percentages for convoys attacked by packs in the same periods as they used for their earlier analysis; that is August–December 1942, January 1943 and February–May 1943. Here the figures are 14, 4 and 24 per cent respectively. By now the analysis is concerning itself with Closure and Attack. Two points arise from this. Again using the complementary figures, this suggests that in Douglas and Rohwer's three subsections of the period 86, 96 and 76 per cent of convoys escaped pack attack altogether.[15] The further point is to look at the relationship between these two categories of data.

The general figure is derived by studying the same relationship for the other periods throughout the war. The relationship figure (as derived from Rohwer and Douglas's diagram) for the two longer periods shown is not very different from the general one in any statistically significant way. The January 1943 figure does stand out from the others. Two comments can be made on this. Firstly, by studying Douglas and Rohwer's entire diagram it is clear that the Relationship is at its most volatile when the Intercepted figure is also relatively low. The diagram shows two especially low figures in summer 1941 and the first half of 1942 when the derived relationships are 100 and 18 per cent respectively. Clearly the January 1943 figure may suffer from a similar problem. Further, when the actual number of operations attempted by the Germans in January 1943 is considered, this is very small indeed, suggesting considerable statistical unreliability.[16] What

Table 9.2 Douglas and Rohwer data – comparison

	Aug.– Dec. 42	*Jan. 43*	*Feb.– May 43*	*General*
A. % Convoys intercepted	34	20	54	
B. % Convoys attacked	14	4	24	
Relationship B:A %	41	20	44	c50

can be done, however, with rather more confidence, is to deduce a general relationship for the chances of converting an interception of a convoy into an attack: this would appear to run in the order of around, or more likely just under, 50 per cent both in this period (August 1942–May 1943) and more generally.

This is important in helping to determine the efficacy of various antisubmarine measures. When the 40–50 per cent figure is considered to be the norm and the Germans either do very much better or worse than this then it will probably be worth looking for an explanation. But perhaps this is a rather crude way of looking at the analytical problem, because although failure to attack is significant, so too is failure to achieve very much. Obviously in order to build up the tonnages desired by Dönitz, rather more than just carrying out one attack by one submarine is necessary: the more targets, and the bigger they are, the better. This suggests another approach which might be used in parallel – looking at each operation from the German perspective as input and output. This has the advantage of being readily amenable to numerate analysis although it is probably less easy to ascribe reasons, in other words to answer the 'why' question with quite such confidence. On the other hand it may make it easier to approach this latter stage of analysis if only by excluding some of the less likely explanations and hypotheses.

What then are the quantities that should be dealt with? In the first instance, commitment of submarines in terms of both numbers of boats and time spent on specific operations is perhaps the main thrust to the input side of the balance. If a holistic approach was to be taken to this then the whole field not just of submarine operations themselves but also operating cycles, turnround times, building rates, time for training and submarine losses would all have to be considered. These will not receive anything like a full treatment here not because they are unimportant but because these subjects and their interrelationships are so complex and extensive that they deserve study on their own account. As some indication of the breadth and depth of these topics, the work of Brian McCue is instructive.[17] In his book he attempts to look more closely into the relatively limited field of Bay of Biscay transits by U-boats in 1942 and 1943. This an important study, as it is his contention that submarines who returned to the Biscay bases spent ever-longer periods of time being turned round there and the avoidance of Bay transits – one in and one out – not only removed two potentially vulnerable operations from the submarine but also obviated the deleterious effect of long operational down-time between

them. The means of avoiding the return was replenishment at sea, possibly of weapons and certainly of fuel either by means of a surface ship or, as the war moved on, more probably from another submarine, sometimes specifically designed for that role. Clearly, there were limits, both material and human, to how long a submarine could remain at sea, even with this assistance. But even if 'double' patrols were all that was to be attained on a regular basis, the effect on operational availability would be significant. The point of mentioning this is not to look into that subject more fully but to realise that even this relatively restricted investigation takes a whole book and within it certain facets such as the repair and turnround times are taken as givens rather than described in depth.[18] Here it is only intended to reiterate the point that submarines available to attack convoys are a subset of boats at sea, in turn themselves only a proportion of operationally available submarines (*Frontboote*), which are lastly part of the total of U-boats built.

These relationships are of course dynamic, and both size and proportion showed signs of change during the course of the war. It is rare to see representation of the classification described above and to have an explanation of their inter-relationships during the course of the war. Part of the problem is methodological. Some parameters lend themselves fairly readily to quantification, such as the total number of submarines, but even here there can be difficulties. For example, from as early as 1941 there is a growing discrepancy between the total number of submarines as evidenced by BdU's war diary and base records. Initially this is insignificant but by the end of the first quarter of 1943 it has risen to 20 and by the end of the war has reached 70.[19]

As the analysis approaches the combat area, the problem tends to become one of definition. How frequently is the 'boats at sea' figure compiled: quarterly, monthly, weekly, daily? Does it matter? What is the definition of when a submarine is engaged in an operation against a convoy? Does it matter which convoy it is? Does Dönitz know which convoy (or convoys in the case of the HX229/SC122) his submarines are up against? These all present difficulties and it is not always possible to write up every nuance of definition: this is, after all, a history and not a laboratory report.

Nevertheless some trends and definitions emerge in this period. These are:

- A sharp rise in the total number of submarines
- A less pronounced and more erratic rise in the number of operational submarines (*Frontboote*)

- A very similar rise curve for Atlantic *Frontboote*
- The proportion of *Frontboote* actually at sea on operations fluctuated a fair amount in this period but was typically of the order of 37 per cent
- The number of submarines at sea engaged in specific anti-convoy operations (as against general reconnaissance) at any one time was very variable indeed

For example on 18 March when the HX229/SC122 battle was in full swing statistics might be as in Table 9.3

It has to be pointed out that this was a fairly busy day by the standards of the Battle of the Atlantic but, even so, less than 70 per cent of Dönitz's North Atlantic boats are engaged in anti-convoy operations; put another way only 45 per cent of his total at sea; yet again, less than 20 per cent of *Frontboote* or just over 10 per cent of the total. To compile such data for every day of the period of interest would not only be laborious but would also be difficult to interpret. It was also the case that once Dönitz had his system working, there was a degree of stability to the system. This is best described as one in which submarines, once clear of Biscay, moved to a mid-North Atlantic grouping. These had no permanence in themselves, with new boats joining and others with fuel and other stores reaching the end of their endurance, departing. Nor did the groups maintain any long-term nominal identity. Sometimes two smaller ones would be joined into a larger one or a larger might be split. In March 1943 the following names were used: *Wildfang, Burggraf, Raubgraf, Stürmer, Dränger* and *Seewolf*. The ideal use of a group was to position it so that it could make successive attacks on convoys running in opposite directions. The area felt to be most productive was that which, at the start and for much of the period, lay outside reliable coverage of shore-based aircraft, known as the 'Air Gap'. There submarines might expect to have a few days of operations against any convoys it found, subject only to the attentions of the surface escort. The ideal was very rarely attained, with groups obtaining good

Table 9.3 Submarine deployment, 18 March 1943

Deployment	*Number*
Total	393
Frontboote	212
Operational at sea total – under BdU control	92
Operational at sea – BdU control – other than North Atlantic	32
Operational at sea – BdU control – North Atlantic	60
North Atlantic – specific convoy operations – HX229/SC122	41

results against a convoy moving in one direction before shifting their attentions to one bound in the opposite direction. The process in practice tended to be rather messier, for a number of reasons. Firstly, there was rarely precise and timely information on the location of convoys. Although Dönitz and his staff had built up a good idea of the general convoy system, there were too many variations of time and place to be able to intercept without further intelligence. But for the reasons described earlier in this book, even with such information there was rarely a precise forecast available. Nor did the intelligence system always reach even this imperfect standard. For example, the largest convoy battle of the war, that against HX229/SC122, was precipitated not by direct intelligence but by the chance sighting of one of the convoys.[20]

In analytical terms, this means that there tends to be a gap between two types of performance measurement: that of the overall tonnage sunk against the total of boats at sea (overall productivity and that derived from the specific anti-convoy operations of this period (tactical efficiency once engaged). Although having such a gap is philosophically unsatisfying, it can be argued that it matters little in significance. The former is the acid-test in determining the success or otherwise of the tonnage war as it actually happened. By using counterfactual hypotheses, it could be argued that a number of palliatives could have given the Germans better results than they experienced, but this is rarely done both rigorously and numerately.[21] Turning to the specific anti-convoy operations, these have the advantage of having reasonably discrete information that can be used for analysis. Further, they can look at inputs of submarine numbers and days of commitment. As outputs, tonnage sunk is also well known, as is the loss of submarines. It is not suggested that either Allied high commands worked on specific criteria of numbers as guides to their decision-making, but such information certainly assists in determining the underlying trends and thus in evaluating the various causal factors.

In looking at the specific anti-convoy operations, that is, those shown clearly in Hessler's diagrams as having been conducted, certain immediate trends become apparent:

- The tendency to have more submarines involved in each operation as time goes on, starting with an average of seven in July 1942, and never dropping below double figures after August
- At the same time having an even more pronounced trend for the maximum number in any one operation to rise. July's largest was 10 but by October an operation using more than 20 boats had taken

place. In 1943, this rose even more with twenties becoming relatively commonplace and ones involving more than 40 submarines occurring twice
- There is very little variation in the length of each operation, very few months showing averages different from 3–4 days
- Average results by month for 1942 are not especially good, with only one month, October, rising above the barrier of three ships or 20 000 tons sunk per convoy attacked
- In 1943 the first three months all pass this barrier: April and May do not
- On the Allied side, submarine sinkings, averaged monthly, only exceed one per anti-convoy operation in the last month of the period
- Sinking two or more boats per operation only becomes relatively common in some months in 1943.

Such characteristics help in understanding the situation a little more clearly because they indicate some of the characteristics of convoy warfare in this period but presented individually they rarely convey very much and even collectively they may seem unremarkable. But this in itself is important to convey the thesis that what happened in 1943 (up until late in May) was not the playing out of an intense see-saw struggle which started in March of that year but rather that the much longer period which started in July 1942 has marked, if progressive, homogeneity. In this context white knights, be they Ultra in December 1942 or B-24 Liberators in the following spring, remain important but only because they form part of a whole, like the poor bloody infantry (the convoy system, perhaps) and primitive artillery (surface escorts) as well as a number of other factors. It is also important to consider not just the list of characteristics adduced immediately above but also their relationship to each other in a number of bilateral comparisons, because these too have an important story to tell. Those considered are:

- The tonnage of merchant shipping sunk per boat-day on anti-convoy operations
- The number of merchant ships sunk per submarine sunk (known generally as the exchange rate).

In examining these it is sometimes useful to look at direct comparison before proceeding to look at relationships where two parameters are combined in an arithmetical way. Thus it is with boat-days engaged on operations and tonnages sunk (see Fig. 9.1). What this indicates is that